

Wind Turbine Syndrome – a Developing Issue

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Introduction

The number of wind turbines in the world has grown considerably in the last decade; the U.S wind energy market installed nearly 10 GW in 2009, increasing the country's installed capacity by 39% and bringing the total installed grid connected capacity to 35 GW.¹ So too have the number of complaints from individuals living near wind turbines. These complaints range from nausea, vomiting, cardiac arrhythmia, blood pressure changes, insomnia, and headaches. In the medical community, some have noted a connection between these ailments and living near the proximity of a wind turbine.² The term "Wind Turbine Syndrome" was coined by Dr. Nina Pierpont to represent the conditions noted above.

Dr. Pierpont conducted research on symptomatic people living near 1.5 – 3.0 MW industrial wind turbines built since 2004.³ Pierpont studied 38 people from ten families who complained of medical ailments as a result of living within a 1.5 km (0.93205 miles) range of nearby wind turbines. The individuals completed questionnaires and were later interviewed. From these interviews, Pierpont determined that the noise, vibration and shadow flicker of the turbines triggered

¹ "Global Wind Power Boom Continues Despite Economic Woes." *Global Wind Energy Council News*. GWEC, 2 Mar. 2010. http://www.gwec.net/index.php?id=30&tx_ttnews%5Btt_news%5D=247. Web. 6 Mar. 2010.

² Lipow, Gar. "Attack on Industrial Wind Puffed with False Peer Review Claims." *Grist.com*. 3 Aug. 2009. <http://www.grist.org/article/2009-08-03-attack-on-industrial-wind-puffed-with-false-peer-review-claims>. Web. 11 Nov. 2009.

³ "Wind Turbine Syndrome - K-Selected Books." *Wind Turbine Syndrome, A Report on a Natural Experiment*. Nina Pierpont. http://www.kselected.com/?page_id=6560. Web. 1 Dec. 2009.

the complaints.⁴ Her website, “windturbinesyndrome.com,” documents her writing and collects testimonies from others who say they are affected by the condition. Though the Portland Oregonian, USA Today, and the UK Independent have supported Pierpont’s notion of Wind Turbine Syndrome, others are skeptical that wind turbines have such an effect on human health. Some believe Pierpont’s test group was too small to yield conclusive results, while others criticize that Pierpont’s work has not been accepted by any peer-reviewed scientific journals, the standard first step in publishing original research.⁵ Despite this controversy, Dr. Pierpont self-published her study, titled “Wind Turbine Syndrome: A Report on a Natural Experiment,” in 2009.⁶

Pierpont’s introduction of “Wind Turbine Syndrome” has sparked much scientific and political debate. In recent years, scientists have evaluated the alleged disorder more seriously to test its validity. Some scientists speculate that a wind turbine’s visual, high frequency and low frequency noise characteristics are the causes of such medical complaints. Though the American Medical Association does not consider Wind Turbine Syndrome a valid disease to date, its existence creates complications for wind turbine developers and municipalities in the siting process.⁷ For example, to construct a wind turbine in New York

⁴ Id.

⁵ Lipow, Gar. "Attack on Industrial Wind Puffed with False Peer Review Claims." *Grist.com*. 3 Aug. 2009. <http://www.grist.org/article/2009-08-03-attack-on-industrial-wind-puffed-with-false-peer-review-claims>. Web. 11 Nov. 2009.

⁶ Id.

⁷ "Wind Turbine Syndrome - K-Selected Books." *Wind Turbine Syndrome, A Report on a Natural Experiment*. Nina Pierpont. http://www.kselected.com/?page_id=6560. Web. 1 Dec. 2009.

State, an Environmental Impact Review must be performed under New York State's Environmental Quality Review Act. This law requires developers to evaluate the environmental effects within a specified area surrounding the turbine's proposed site and includes an evaluation of how the turbines are likely to impact individuals inhabiting the nearby area.

In this paper, I hope to assist the Wind Action Group in gaining a better understanding of "Wind Turbine Syndrome" and its implications in the wind turbine siting process. The paper is divided into two sections: section one provides the reader with the necessary background information, including the basic terminology of wind turbine components, a brief analysis of the relevant parties in the siting process is, and an academic overview of the contemporary studies and reports on Wind Turbine Syndrome. Various regulations for noise annoyance and setback distances are discussed to help the reader understand the inadequacies of the current regulations. Section two of this paper moves beyond the introduction and touches on the legal implications of wind energy. The SEQRA process is discussed as it relates to Wind Turbine Syndrome's effect on the siting process, specifically in the environmental impact assessment, and the prevalence of Wind Turbine Syndrome-like symptoms in lawsuits is discussed at length. Sections one and two, when read together, will lay a foundation so that the Wind Action Group can best approach the issue of "Wind Turbine Syndrome."

Part I

An Introduction to Wind Turbine Syndrome

Assumptions

It is important to note several assumptions that are relevant to the discussion of Wind Turbine Syndrome. There is no concrete evidence that Wind Turbine Syndrome exists. However, the medical world is certain that visual and sound annoyances from wind turbines may cause stress and that stress can be the onset to such conditions associated with Wind Turbine Syndrome. It is also important to note that annoyance is difficult to study because it is inherently subjective and is self-reported by those suffering from the symptoms.⁸

⁸ David M. Hessler, Environmental Sound Survey and Noise Impact Assessment-Noble Wethersfield Wind Park- Towns of Wethersfield and Eagle, NY; for Noble Environmental Power, LLC, January 2007.

Background

There are numerous reports on Wind Turbine Syndrome performed by government agencies, private developers, and academic institutions. Several common terms are used throughout each report, and it's important to have a general understanding of the vocabulary before further examining the health effects of wind turbines.

* * *

Noise is defined as unwanted sound, and not all noise needs to be excessively loud to represent an annoyance or interference.⁹ Because the human ear can detect such a wide range of sound pressures, sound pressure is converted to Sound Pressure Levels (hereinafter referred to as "SPL"), and is measured in units called decibels (dB).¹⁰ Sound is often measured and described in terms of its overall energy and thus takes all frequencies into account. However, the process of human hearing differs at various frequencies; humans are less sensitive to frequencies below 250 Hz than they are to mid-frequencies of approximately 500 Hz to 1000 Hz, and are most sensitive to frequencies in the

⁹ "Noise and Hearing Loss." *American Speech-Language-Hearing Association / ASHA*. <http://www.asha.org/public/hearing/disorders/noise.htm>. Web. 1 Apr. 2010.

¹⁰ "Decibel." Def. 2. *Wordnetweb.princeton.edu/perl.webwn*. Web. 14 Nov. 2009.

1,000 to 5000 Hz range.¹¹ Therefore, sound measurements are often adjusted as a function of frequency to account for human perception and sensitivities.

The abbreviations dB(A), dB(B), and dB(C) are often used to denote the use of weighting filters used to approximate the human ear's response to sound. The human ear is not equally sensitive to all frequencies since some frequencies are judged to be louder for a given signal than others.¹² The A-weighted decibel scale, dB(A), performs compensation by discriminating against frequencies in a manner similar to the sensitivity of the human ear; it is used to describe sound in a manner representative of the human ear's response. Using this filter, the sound level meter is less sensitive to very high and very low frequencies, and approximates the ear for medium sounds. This is the most common scale for assessing environmental and occupational noise.¹³ The B- weighting scale, dB(B), is not commonly used. It approximates the ear for medium-loud sounds around 70 dB.¹⁴ The C-weighting scale, dB(C), is suitable for subjective measurements at very high SPLs. This filter does not de-emphasize the frequencies below 1,000 Hz as A-weighting does, but it is used for a

¹¹ Ellis, Ken. "Understanding Sound." *Sound and Light Training*. <http://www.kodachrome.org/salt/sunderst.htm>. Web. 2 Apr. 2010.

¹² "Sound Level SPL to DB - Pressure Level Sound Pressure Sound Intensity." *Conversion of Sound Units (Levels)*. <http://www.sengpielaudio.com/calculator-soundlevel.htm>. Web. 21 Feb. 2010.

¹³ Stallen, P. (1999): A theoretical framework for environmental noise annoyance. *Noise and Health* 1, 69-80.

¹⁴ Id.

measurement that must include low frequencies. It approximates response of human ear to loud sounds.¹⁵

Symptoms of Wind Turbine Syndrome have been attributed to the low frequency noise emitted from a wind turbine and a turbine's shadow flicker. Shadow flicker is the on-and-off flickering effect of a shadow that is caused when the sun passes behind the rotor of a wind turbine; it can affect individuals both indoors and outdoors.¹⁶ Low frequency sound is typically not audible to the human ear, but is believed to cause certain breathing and digestive problems in humans living in close proximity to the turbines.¹⁷ Low frequency noise also has the tendency to cause vibrations in building structures within a certain radius of the turbine, and thus affects people especially during sleeping hours. Due to an increase in ambient noise during daylight hours, the low frequency vibrations often go unnoticed during public, daytime activities.¹⁸

The turbine's low frequency noise emissions create the rumble sound that can cause a vibration in nearby structures, which is attributed to turbulent inflow of air in to the blades. Atmospheric turbulence, like wind speed, is variable.¹⁹

¹⁵ Id.

¹⁶ Kamperman, George W., and Richard R. James. *The "How To" Guide to Siting Wind Turbines to Prevent Health Risks From Sound*. 28 Oct. 2008. Web. 11 Oct. 2009.

¹⁷ Id.

¹⁸ Eja Pederson, "Human Response to Wind Turbine Noise- Perception, Annoyance and Moderating Factors, Occupational and Environmental Medicine," The Sahlgrenska Academy, Gotenborg 2007.

¹⁹ Van Den Berg GP. 2004. Effects of the wind profile at night on wind turbine sound. *Journal of Sound and Vibration*. <http://www.wind-watch.org/documents/?p=25>. 1 March, 2010.

Turbine induced turbulence must be accounted for in cases of more than one turbine because turbulence from other turbines is likely to enhance noise annoyance for nearby residence.²⁰ In order to minimize wake turbulence, wind turbines are usually sited at a distance of 5 rotor diameters away from each other, but the spacing depends on the manufacture and the turbine model.²¹

It is important to establish and include the background noise surrounding a potentially impacted area when determining a wind turbines location. In the siting process, it's important to note whether the surrounding area is an urban or rural setting; ambient or background noise levels in an urban setting are typically louder and thus mask the noise annoyance from the nearby turbines. As rural settings contain less ambient noise than urban settings, the turbines are typically sited at a further distance from residential locations to reduce the resulting noise disturbance. Rural communities generally have a background sound level between 20 and 30 dB(A), sometimes lower.²² For communities located one or more miles away from major roadways, nighttime background sound levels of

²⁰ Committee on Environmental Impacts of Wind Energy Projects, National Research Council. *Environmental Impacts of Wind Energy Projects*. Publication. The National Academies Press, 2007.

http://www.nap.edu/catalog.php?record_id=11935. Web. 15 Mar. 2009.

²¹ Samorani, Michele. *The Wind Farm Layout Optimization Problem*. *Research Paper Series*. Leeds School of Business, 28 Jan. 2010.

[http://leeds.colorado.edu/uploadedFiles/_Documents/Faculty_and_Research/Working_Papers_Series/Operations_and_Information_Management/The%20Wind%20Farm%20Layout%20Optimization%20Problem%20\(2\).pdf](http://leeds.colorado.edu/uploadedFiles/_Documents/Faculty_and_Research/Working_Papers_Series/Operations_and_Information_Management/The%20Wind%20Farm%20Layout%20Optimization%20Problem%20(2).pdf). Web. 4 Feb. 2010.

²² "Protective Noise Levels." Condensed Version of EPA Levels Documents. NPC Library, 1974. <http://www.nonoise.org/library/levels/levels.htm>. Web. 14 Jan. 2010.

less than 20 dB(A) are common.²³ Thus, a new noise source with a strong low frequency content is more significant when in a remote rural community than in a suburban or urban area with more traffic and other noises.²⁴

Residences who live within 1.5 km (0 .093 miles) of wind turbines often complain of sleep disturbance from the wind turbine at night.²⁵ This can be attributed to a decrease in background noise from the daytime hours to the nighttime hours, as well as normal atmospheric changes.²⁶ In the daytime, warm air rises, both carrying sound upward and creating turbulence that scatters the turbine noise. This creates a more ground-based ambient noise, which in turn masks turbine sounds. When the air stabilizes at night, it appears that noise from the wind turbine can carry much farther than expected.²⁷

²³ Id.

²⁴ Eldred, K. M. "Assessment of Community Noise." *Journal of Sound and Vibration* 22nd ser. 43.2 (1975): 137-46. Web. 22 Nov. 2009. <http://www.sciencedirect.com>. Web. 21 January. 2010.

²⁵ The Noise Association. 2006. *Location, location, location*. An investigation into wind farms and noise by The Noise Association. <http://www.countryguardian.net/Location.pdf>. Web. 15 March. 2010.

²⁶ Depending on the location of the residence, background noise is often comprised of traffic noise, outside activities in the surrounding area, and noise annoyance from appliances in the house.

²⁷ Cummings, Jim. *The Acoustic Ecology Institute Fact Sheet: Wind Energy Noise Impacts*. Rep. Santa Fe: AEI, 2008. Print.

Relevant Players in the Wind Turbine Siting Process and Corresponding Studies on Wind Turbine Syndrome

Since the beginning of the twenty-first century, there have been notable studies throughout the world debating the legitimacy of Wind Turbine Syndrome. These reports and studies are helpful in analyzing how best to avoid the current issues encountered in the wind turbine siting process. Analyzing these conclusions can help one gauge the industry's future developments, which will assist the Wind Action Group in visualizing a siting practice that assists developers, municipalities and citizens today and well into the future. There may be possible bias in some of the studies below, so it is important that one examines agencies that released them as well as the agency's potential motivation in publishing them.

Private Organizations

Private organizations, such as community groups, environmental organizations and activists, participate in the siting process to ensure their concerns are heard. Generally, these groups may support wind projects because of the jobs and tax revenues generated as well as the benefits to air pollution and global warming. Others may be skeptical because of concerns about wind turbine noise, visual impacts, traffic disturbances during the turbine's construction,

conflict with wildlife, and impacts on scenic or environmentally sensitive areas.²⁸

The studies that tend to support the validity of Wind Turbine Syndrome performed by private organizations all note that the low frequency noise, shadow flicker and high frequency noise of the wind turbines are most likely causing symptoms of Wind Turbine Syndrome. Several studies mentioned the deficiencies of various standards for siting wind turbines. In particular, these studies suggested that current setback standards do not account for low frequency vibrations and should be extended to no less than one mile.²⁹

Wind developers, typically independent power companies or utilities, usually initiate the siting review process by submitting a request for a use permit to the appropriate agency. The developer's immediate interest in the process is to win approval for the project as quickly and as cheaply as possible. Long, expensive proceedings with an uncertain outcome create problems for the developer's ability to secure financing. Beyond the success of any one project, the developer wants to demonstrate a successful project record to maintain its credibility with investors, policy makers, and the public.³⁰ Wind developers often

²⁸ Pagano, Margareta. "Are Wind Farms a Health Risk? US Scientist Identifies 'wind Turbine Syndrome'" *The Independent*. 2 Aug. 2009. <http://www.independent.co.uk/environment/green-living/are-wind-farms-a-health-risk-us-scientist-identifies-wind-turbine-syndrome-1766254.html>. Web. 19 Mar. 2010.

²⁹ Julian T. and Jane Davis, "Living with Aerodynamic Modulation, Low Frequency Vibration and Sleep Deprivation- How Wind Turbines Inappropriately Placed can Act Collectively and Destroy Rural Quietitude." *Proceedings of Second International Meeting on Wind Turbine Noise*, Lyons, France, Sept. 2007.

³⁰ "Paying for Wind: Financing Wind Energy Projects in the U.S." *Nixon Peabody*. Renewable Energy World, May-June 2004. <http://www.nixonpeabody.com/publications>

emphasize the benefits of wind power and support studies that combat the link between wind turbines and declining human health.

There are various reports that deny the validity of Wind Turbine Syndrome. For example, the American Wind Energy Association (hereinafter referred to as “AWEA”), and Canadian Wind Energy Association (hereinafter referred to as “CanWEA”), released a review in December, 2009, that suggests that “there is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects; that the ground-borne vibrations from wind turbines are too weak to be detected by, or to affect humans; and that the sounds emitted by the wind turbines are not unique, and that there is no reason not to believe that the sounds from these turbines could plausibly have direct adverse health consequences.”³¹ Seven members selected by AWEA and CanWEA performed the study. The seven-member panel included medical doctors, audiologists, and acoustical professionals from the United States, Canada, Denmark, and the United Kingdom. The panel undertook an extensive review, analysis and discussion of a large body of peer-reviewed literature, specifically with regard to the sound produced by wind turbines. This expert Panel was tasked with reviewing the current literature available on the issue of perceived health effects of wind turbines. AWEA’s CEO, Dennis Bode, stated that “[t]he objective of the panel was to provide an authoritative, scientific

[_detail3.asp?ID=789](#). Web. 11 Nov. 2009.

³¹ Colby, David, Robert Dobie, Geoff Leventhall, David M. Lipscomb, Robert J. McCunney, Michael T. Seilo, and Bo Sendergaard. *Wind Turbine Sound and Health Effects: An Expert Panel Review*. Rep. AWEA & CanWEA, 2009. Print.

reference document for those making legislative and regulatory decisions about wind turbine developments.”³² It is important to keep in mind that this study was prepared for and sponsored by AWEA and CanWEA, which could raise questions about its objectivity.

A study performed by the National Wind Coordinating Committee (hereinafter referred to as “NWCC”), observed various community reactions to the local wind development projects, with the intent of identifying circumstances that distinguish welcomed projects from projects that were not well received by communities.³³ The NWCC was also interested in examining the changes in community perceptions before, during and after project construction, as well as in recognizing what wind project developers can do to address the concerns that often recur at wind project sites. The organization performed several case studies using an issue-comparison technique to identify common public concerns. These included bird impacts and other biological concerns, visual impacts, noise, and road and traffic concerns.

The interviews and background conducted during this research identified many keys to molding a successful partnership between wind energy developers, local communities, governments, and other concerned parties. By educating the public using techniques that meaningfully communicate the results of developing

³² "Panel Concludes Wind Turbine Sounds Not Harmful ." *Wellsphere - Health Knowledge Made Personal*. SustainableBusiness.com, 22 Dec. 2009. <http://stanford.wellsphere.com/green-living-article/panel-concludes-wind-turbine-sounds-not-harmful/927429>. Web. 12 Jan. 2010.

³³ National Wind Coordinating Committee. "Wind Power Facility Siting Case Studies: Community Response." *Www.nationalwind.org*. BBC Research & Consulting, June 2005. Web. 3 Oct. 2009.

the site early, listening carefully to community concerns and gathering information as needed, developers were able to effectively reduce the number of community complaints linked to the ailments of Wind Turbine Syndrome. The NWCC study emphasized the importance of collaboration between developers and local governments in attending to local citizen/community concerns.³⁴ When the community is aware of and has a say in developments within their area, they are more likely to show pride in the wind turbines and in some cases, even celebrate the wind energy projects in their community.

Government Agencies

The government also plays a large role in the wind turbine siting process; most siting process activity occurs at the local and state level, so governments also have an important role regulating this process. At the state level, environmental agencies such as the New York State Department of Environmental Conservation (hereinafter referred to as “DEC”), may require water quality certifications for projects requiring a federal permit. If a transmission line is needed, that can also trigger state involvement through the New York State Public Service Commission (hereinafter, referred to as “PSC”).³⁵ In New

³⁴ Id.

³⁵ Great Lakes Wind Collaborative. "State and Provincial Land-Based Wind Farm Siting Policy in the Great Lakes Region: Summary and Analysis." *Scribd.com*. Great Lakes Commission, Jan. 2010. Web. Feb. 1.

York State, an Environmental Impact Assessment is required, under SEQRA.³⁶ County level planning and zoning boards are often heavily involved in providing siting approval. Wind developers must demonstrate compliance with applicable land use designations and zoning ordinances.

In late February of 2009, the Minnesota Department of Health (hereinafter referred to as “MDH”), received a request from the Office of Energy Security in the Minnesota Department of Commerce for a “white paper” evaluating possible health effects associated with low frequency vibrations and sound arising from large wind energy conversion systems. MDH responded by issuing a report on May 22, 2009, detailing the public health impacts of wind turbines. The report identified that the symptoms encompassed in Wind Turbine Syndrome were an issue for those living within a half a mile radius of the turbines, but noted that such concerns decreased dramatically outside the half-mile setback.³⁷ However, if the turbine is subject to aerodynamic modulation because of shear caused by mountains, trees and buildings or different weather conditions through the rotor plane, turbine noise may be heard at a greater distance.³⁸ MDH stressed that most available evidence suggests that complaints occur more often when turbines are visible or when shadow flicker occurs. The report also noted that for some projects, wind velocity for a wind turbine project is measured at ten meters

³⁶ The NYS SEQRA process will be discussed in further detail in the appropriate section.

³⁷ Minnesota Department of Health, Environmental Health Division. *Public Health Impacts of Wind Turbines*. Rep. 2009. Print.

³⁸ *Id.*

and then modeled to the height of the rotator.³⁹ As most turbine rotators far exceed ten meters in height, these models are likely to under-predict wind speed that will be encountered when the turbine is built. Higher wind speed will result in noise exceeding model predictions.

Scholarly Reports

Numerous academics and industry experts throughout the world published reports on wind turbines and their influence on human health. Early research in this area was primarily comprised of surveys; residents living within the vicinity of industrial wind turbines complained of high levels of disturbance regarding interruptions in sleep cycle and sound annoyance. A survey in 2001 regarding a wind farm in Kewaunee County, Wisconsin,⁴⁰ reported that 52% of those living within a distance of 400 to 800 meters (0.249 to 0.497 miles), 32% of those living within a distance of 800 to 1500 meters (0.497 to 0.932 miles), and 4% of those living within 1600 and 3200 meters (0.994 to 1.988 miles) of a wind turbine found the resulting noise to be an issue. A total of 67% of those living within 250 to 400 meters (0.155 to 0.249 miles) and 35% of those within 400 to 800 meters (0.249 to 0.497 miles) reported being awoken by the sound in the previous

³⁹ Id.

⁴⁰ The landscape of Kewaunee county is described as “undulating to gently rolling”.

year.⁴¹ The most notable issue reported by the 223 respondents was sleep loss.⁴² In 2007, a similar survey was given to 1,100 New Zealand residents living up to 3.5 km (2.175 miles) from a wind farm. A total of 604 of these residents responded, and 75% of all respondents reported hearing the noise.⁴³

Doctor Amanda Harry, a general practitioner in the United Kingdom, conducted surveys on a number of residents living near several different turbine locations and reported a similar collection of symptoms from all sites. A study of forty-two respondents showed that 81% felt their health had been affected. Of the 81% that felt their health had been affected, 76% thought it was sufficiently severe to consult a doctor. A total of 73% felt their life quality had been adversely impacted.⁴⁴

It is important to note that the quality of research in this area is low, as there are no peer-reviewed studies on Wind Turbine Syndrome that exist to date. Most early reports are surveys using self-completed questionnaires. Though response rates have been high, it is more likely that those who feel they have

⁴¹ Hanning, Christopher. *Sleep Disturbance and Wind Turbine Noise*. Rep. Stop Swinford Wind Farm Action Group, June-July 2009. <http://www.algonquinadventures.com/waywardwind/docs/Hanning-sleep-disturbance-wind-turbine-noise.pdf>. Web. 1 Apr. 2010.

⁴² Kabes DE and Smith C. 2001. Lincoln Township Wind Turbine Survey, Agricultural Resource Center, University of Wisconsin Extension/ Cooperative Extension. May 16, 2001. <http://www.aweo.org/windlincoln.html>. 2 Apr. 2010

⁴³ Hanning, Christopher. *Sleep Disturbance and Wind Turbine Noise*. Rep. Stop Swinford Wind Farm Action Group, June-July 2009. <http://www.algonquinadventures.com/waywardwind/docs/Hanning-sleep-disturbance-wind-turbine-noise.pdf>. Web. 1 Apr. 2010.

⁴⁴ "Effects Of Wind Farms On Health & Safety." *Save Western NY*. <http://www.savewesternny.org/health.html>. Web. 1 Feb. 2010.

been affected will respond to the surveys than those who have not experienced symptoms. Most of the studies were initiated after the turbines started operation and were generally commenced in response to the complaints. The surveys above are open to criticism for their design because the invited symptom reporting was not controlled, but despite the deficiencies, the results nevertheless indicate that some subjects are severely affected by wind turbine noise at distances thought by the industry to be safe.

* * *

The studies mentioned above provide necessary background to understanding the shortcomings of the current siting process. By addressing these inadequacies, many believe that the complaints from nearby residence's will likely decrease. In understanding the relevant players involved in the siting process and reviewing the significant studies to date, the Wind Action Group is better equipped to examine the current noise limits and setback regulations to remedy their inefficiencies. With such knowledge, the Wind Action Group can work to ease the fears associated with Wind Turbine Syndrome.

Various Regulations on Noise Annoyance and Setback distances

State Governments in both the United States and abroad set noise regulations that define appropriate sound levels allowed to infiltrate residential areas. By reviewing a variety of these regulations and comparing them against the number of complaints received in the area, we can determine which standards work best to circumvent symptoms associated with Wind Turbine Syndrome.

There are two ways to attempt to mitigate the health effects associated with Wind Turbine Syndrome: setbacks, measured by distances, and noise regulations, measured by decibel level. Many concerns associated with safety, noise, and aesthetics can be addressed by ensuring adequate distances between the wind turbine and residences. Although no consensus on appropriate distance or types of setback exists, there are common themes that appear in a number of wind energy regulations. Concerns associated with noise annoyance from wind turbines are mitigated by regulated noise limits during the daytime and nighttime hours, which must account for ambient noise present in the siting area.

In the United Kingdom and other European countries, the wind industry complies with stricter noise limits than it does in the United States. For example, in 2007, Austria set noise limits for 35 dB(A), while Germany and Denmark had a 40 dB(A) limit. During the same year, Wisconsin had a noise limit set at 50 dB(A),

while Michigan set its limit at 55 dB(A).⁴⁵ The Environmental Protection Agency (hereinafter referred to as “EPA”), offers guidance that recommends an outdoor noise limit of 55 dB(A). The Noise Levels Document also suggests that 10 dB(A) be subtracted from this level in quiet rural areas.⁴⁶ Industry representatives on state governmental committees may work to establish sound limits and setbacks that are lenient and favor the industry.⁴⁷

The World Health Organization (hereinafter referred to as “WHO”), recommends that if the dB(C) is greater than 10 dB over the recorded dB(A), the low frequency components of the noise may be important and should be evaluated separately. In addition, WHO claims “it should be noted that a large proportion of low-frequency components in noise may increase considerably the adverse effects on health.”⁴⁸ For sounds that contain a strong low frequency component typical of wind turbines, WHO believes these limits may need to be even lower than 30 dB(A) to avoid health risks.⁴⁹ The International Standards Organization (hereinafter referred to as “ISO”), recommend 25 dB(A) as the

⁴⁵ Ramakrishan, PH. D., P Eng., Ramani, “Wind Turbine Facilities Noise Issues” Dec. 2007 Prepared for the Ontario Ministry Environment. http://www.ene.gov.on.ca/envision/env_reg/er/documents/2008/Noise%20Report.pdf. 24 Feb, 2010.

⁴⁶ Lawton, Catherine M. "Noise Control Regulations Related to Wind Energy Facilities." Wind Watch Org. 11 Mar. 2004. <http://www.wind-watch.org/documents/wp-content/uploads/Lawton-Noise.pdf>. Web. 12 Mar. 2010.

⁴⁷ Lawton, Catherine M. "Noise Control Regulations Related to Wind Energy Facilities." Wind Watch Org. 11 Mar. 2004. <http://www.wind-watch.org/documents/wp-content/uploads/Lawton-Noise.pdf>. Web. 12 Mar. 2010

⁴⁸ Minnesota Department of Health Environmental Health Division. *Public Health Impacts of Wind Turbines*. Rep. 2009. Print.

⁴⁹ Id.

maximum nighttime limit for rural communities in the 1996-1997 report.⁵⁰ Due to the higher levels of ambient noise, sound levels of 40 dB(A) and above are only appropriate in suburban communities during the day and urban communities during the day and night. There are no communities where 45 dB(A) is considered acceptable at night.⁵¹ It is important to note that the above regulations relate to all noise disturbances, not just those emitted from wind turbines.

In some jurisdictions, when noise has an obvious tonal content, a penalty or correction may be used to account for additional annoyance.⁵² The penalty for tones varies between 0 dB (no penalty) and 6 dB. This penalty is added to the measured dB level before it is compared to the legal allowable noise limit. A 1997 study suggested that when dB(C) subtracted from dB(A) is greater than 15 dB, an addition of 6 dB to the measured A-weighted level is a simple procedure for addressing background annoyance.⁵³ Under this method, about 71% of predictions of annoyance are correct.⁵⁴

⁵⁰ Available at: [Http://www.euro.who.int/Noise/activities/20040721](http://www.euro.who.int/Noise/activities/20040721). References found in report on third meeting at pages 13 and others

⁵¹ Id.

⁵² Tonal sound can be caused by the rotation of shafts, generators and gears operating at natural frequency, unstable airflow over the turbine's holes or slits; or non-aerodynamic instabilities interacting with the blade. Tonal sounds can have a distinct pitch, like a music note, and do not start or end abruptly.

⁵³ Kjellberg, A., Tesarz, M., Holberg, K., and Landström, U. 1997. Evaluation of frequency-weighted sound level measurements for prediction of low-frequency noise annoyance. *Environment International*. Vol. 23, pp. 519-527. Cited in Leventall, G. 2003.

⁵⁴ Wolfe, Joe. "DB: What Is a Decibel?" *UNSW: Music Acoustics*. School of Physics at UNSW, Sydney, Australia. <http://www.phys.unsw.edu.au/jw/dB.html>. Web. 21 Feb. 2010.

As is evident from the above regulations, there is often a different noise limit proposed in the daytime and nighttime. This is because ambient noise typically decreases in the evening hours, especially between 10 pm and 4 am, and because most individuals sleep during these hours. Many studies, several of which are detailed below, note the connection between sleep deprivation and the ailments associated with Wind Turbine Syndrome. It is worth noting that all government and industry-sponsored research in the United Kingdom used reported awakenings from sleep as indirect evidence of the effects of turbine noise and thereby dismissed the subjective symptoms.⁵⁵ Because most individuals are not able to recall sleep disturbance, this approach may seriously underestimate the affect of wind turbine noise on sleep. However, the draft New Zealand standard on wind farm noise in 2009 acknowledges that sleep disturbance is the major consequence of wind turbine noise, and is often linked with the ailments associated to Wind Turbine Syndrome.⁵⁶

Basing their actions on health and safety concerns alone, some local governments passed ordinances blocking or limiting wind energy projects that developer's claim are unrealistic. On February 5, 2010, the Tazewell County Board of Supervisors in West Virginia approved a tall structure ordinance that prevents wind farm construction on the county's scenic ridgelines. The ordinance

⁵⁵ Meerlo, P et al. 2008 Restricted and disrupted sleep: Effects on autonomic function, neuroendocrine stress system and stress responsively. *Sleep Med Rev* 12: 197-210.

⁵⁶ Third, John. "A Failed Promise." *Gauntlet Magazine*. 3 Oct. 2009. http://www.gauntlet.co.nz/Stories/1_33.htm. Web. 11 Mar. 2010.

prohibits structures taller than forty feet on the ridgeline and structures taller than 120 feet above certain elevations. Developers believe that most of the land that the ordinance prohibited is ideal for wind turbines; the terrain as well as the wind's speed and direction in the prohibited areas are likely to help limit the turbine's noise annoyance perceived by nearby residents.

Other ordinances appear to be less limiting in the setback distances. Wilton Wisconsin adopted an ordinance establishing setbacks of 2,640 feet (0.5 miles) from residences and noise limits of 40 dB(A) or 40 dB(C) within 100 feet of any residence with a limit of no more than 5 dB(A) or dB(C) over ambient noise levels.⁵⁷ In New York State, a model ordinance was established prescribing a setback at variable distance from 1.5 times the sum of the proposed structure height to 1500 feet (0.284 miles).⁵⁸ Using an average structure height of 450 feet, a setback under this formula would be 675 to 1500 feet (0.130 to 0.284 miles). The noise requirement states that audible noise should not exceed 55 dB(A) when measured at the site property line. Vermont established a notice requirement for petitions involving wind-generating facilities, stating that notice must be provided to all towns wholly or partially within a minimum radius of ten

⁵⁷ Choo, Kristin By. "The War of Winds." *ABA Journal - Law News Now*. American Bar Association, 1 Feb. 2010. http://www.abajournal.com/magazine/article/the_war_of_winds/. Web. 21 Feb. 2010.

⁵⁸ Daniels, Katherine. "Wind Energy: Model Ordinance Options." *Www.powernaturally.org*. NYSERDA, Oct. 2005. Web. 1 Feb. 2010.

miles from each of the proposed turbines.⁵⁹

There have been several recommendations from health and other officials as to proper setbacks for wind turbines, who believe that such setbacks would decrease the number of complaints stemming from Wind Turbine Syndrome. These setbacks range from just below one mile, to approximately 1.3 miles.⁶⁰ (For a complete listing of these recommendations, please refer to table 1.0 in the appendix.) Various jurisdictions have defined methods to determine proper setback distances. For example, in Illinois, the Pike County Zoning board defined a minimum setback of 1.1 T from the nearest property line. "T" is defined as the height of the tower plus the length of one blade. Using a 450-foot wind turbine, this regulation would require a setback of just less than one mile. The ordinance specifies a setback of 3 T (0.256 miles) from homes. However, a turbine sited on a landowner's property may be as close as 1.1T if the landowner consents prior to construction.⁶¹ In Pennsylvania, however, the Municipalities Planning Code Model Ordinance (hereinafter referred to as "MPC"), states that all wind turbines shall be setback from the nearest occupied building no less than the greater of

⁵⁹ "Vermont Commission on Wind Regulatory Policy: Finding and Recommendations." *Publicservice.vermont.gov*. 15 Dec. 2004. Web. 12 Dec. 2009.

⁶⁰ See Table 1: Recommendations for setback of residential properties from industrial wind turbines. Borrowed from Hanning, Christopher MD. "Sleep Disturbance and Wind Turbine Noise" June 2009. <http://www.wind-watch.org/documents/wp-content/uploads/Hanning-sleep-disturbance-wind-turbine-noise.pdf>. 19 March, 2010.

⁶¹ Pike County Chamber of Commerce. "Pike County - Wind Turbine Siting Standards (Illinois) - Open Energy Information." *Energy Information and Data / OpenEI.org*. 11 Jan. 2010. [http://en.openei.org/wiki/Pike_County_-_Wind_Turbine_Siting_Standards_\(Illinois\)](http://en.openei.org/wiki/Pike_County_-_Wind_Turbine_Siting_Standards_(Illinois)). Web. 21 Feb. 2010.

the maximum set back requirements for that zoning classification where the turbine is located, or 1.1 times the turbine height, whichever is greater. For a non-participating landowner's property, a setback distance of no less than five times the hub height should be established.⁶²

Ontario's Green Energy Act

In September of 2009, the regulations for wind energy development under the Ontario Green Energy Act (hereinafter referred to as "OGEA"), were released. This Act essentially removes municipalities from the approval process and puts the final decision of projects with the Ontario government. Wind facilities generating over 2 kW but less than 50 kW will require a Renewable Energy Approval (hereinafter referred to as "REA"), however, the approval requirements are simplified and there are no mandatory setbacks. Wind facilities over 40 kW generating a noise level of 102 dB(A) or louder must meet a minimum 550-meter (0.3416 mile) setback from buildings used by people. The setback distance increases from there depending on the number of turbines at a site and the collective noise produced.⁶³ However, the 550-meter setback rule can be avoided. Where background noise exceeds 40 dB, a noise study can be done to determine the appropriate distance. These setbacks need not apply if the

⁶² "Model Ordinance for Wind Energy Facilities in Pennsylvania." *Pawindenergy.org*. 2006. Web. 11 Mar. 2010.

⁶³ See Table 3.0 in the appendix for the specific setback distances

proponent submits a report prepared in accordance with the Ministry of Environment's (hereinafter referred to as "MOE"), "Noise Guidelines for Wind Farms," dated October of 2008.

These 2008 MOE noise regulations divide receptors into three classes: class one indicates an area with an acoustical environment typical of a major population center, where the background noise is dominated by an urban hum; class two describes an area with an acoustical environment that has qualities representing both class one and class three, and class three areas signify a rural area with an acoustical environment that is dominated by the natural sounds having little or no road traffic. The sound limits are defined by whether the receptors are in class one or two areas, which are considered to be urban, and class three receptors, which are considered rural environment.⁶⁴

Typically, noise regulations require a 40 dB(A) limit at a home, school or institution.⁶⁵ However, the noise limitation and the setback distance are based on the wind turbine's height as well as the number of turbines located within a close proximity. In practice, this translates into setbacks of about 400 to 500 meters (0.249 – 0.312 miles) from receptors for an isolated modern turbine and about 650 to 800 meters (0.404 – 0.497 miles) from receptors for a group of three similarly spaced turbines.⁶⁶

⁶⁴ Id. See table 3.0 in the appendix

⁶⁵ ⁶⁵ Ellis, Ken. "Understanding Sound." *Sound and Light Training*. <http://www.kodachrome.org/salt/sunderst.htm>. Web. 2 Apr. 2010.

⁶⁶ Harrison, John P. Inadequacy of Wind Turbine Noise Regulations and Their Application. Presentation to the Annual Conference of the Canadian Acoustics

The OGEA also includes a provision with regards to feed-in tariffs (hereinafter, referred to as "FIT"), to help guarantee a stable price for renewable energy. FIT's prove to be very effective mechanisms for integrating renewable energy sources into state, regional and national energy portfolios. On April 7, 2010, 185 projects were announced with the goal of generating enough energy to power 600,000 homes. These projects are in addition to the 510 renewable energy contract offers totaling 112 MW that were approved in March of 2010. A total of 60% of the 2500 MW that were issued in these contracts are dedicated to wind projects.⁶⁷ The concept of FIT's has had difficulty gaining traction in the United States, but supporters and critics will no doubt monitor how Ontario's commitment to an FIT based strategy unfolds as well as whether Ontario's mechanisms to promote renewable energy prove successful.

Though Ontario's FIT provisions of the OGEA look to be a success to wind turbines, citizens and municipalities are skeptical of its success. The OGEA states its intent is to remove barriers for the wind turbine industry, which include standardizing planning and environmental checks and balances that are applied as a matter of course in the development of any significant industrial projects in

Association. Queen's University, Physics Department, Sept. 2009. Web. 29 Nov. 2009.

⁶⁷ Cooper, Dave. "Capital Power Wins Wind Contract." *Edmonton Journal*. Canwest Publishing Inc., 9 Apr. 2010. <http://www.edmontonjournal.com/business/Capital+Power+wins+wind+contract/2782241/story.html>. Web. 11 Apr. 2010.

Ontario.⁶⁸ Wind turbine developers, under the OGEA, need only demonstrate that a project will meet the energy goals of the acts. The developers can opt not to perform environmental studies, which significantly restrict Ontarians from any say in wind turbine siting process. Because the act abrogates to itself municipal powers in relation to renewable energy projects, opponents criticize the loss of an adequate forum for the public voice.⁶⁹ The act virtually eliminates municipal planning rights by severely curtailing environmental rights. Some believe the OGEA creates lucrative rates of return for investors through long term contracts to provide green energy to Ontario's electrical grid. Should developers suffer financial losses in their endeavors, Ontario consumers are required to subsidize rates. One section of the act even provides that "consumers are required to contribute toward the amount of any compensation arising from a distributor's lost revenues arising from a rate reduction."⁷⁰ As the OGEA was merely passed in 2009, it appears that its future challenge will be meshing the growth of successful renewable energy projects while upholding municipal and citizen say in project decisions.

⁶⁸ Section 4 entitles the Government to designate wind-industry projects and to remove barriers and promote access to transmission and distribution systems for these projects.

⁶⁹ Ministry of Environment. "Provincial Approvals for Renewable Energy Projects." *Ontario*. Queen's Printer for Ontario, 2010. Web. http://www.ene.gov.on.ca/en/business/green-energy/docs/REP_Guide.pdf. Web. 16 Mar. 2010.

⁷⁰ Brown-John, Lloyd. "Green Energy Act Arrogant and Offensive «." *Wind Concerns Ontario*. Windsor Star, 7 Apr. 2010. <http://windconcernsontario.wordpress.com/2010/04/07/green-energy-act-arrogant-and-offensive/>. Web. 11 Apr. 2010.

A Critique of Current Setbacks and Noise Regulations

In his report “Inadequacy of Wind Turbine Noise Regulations and Their Application,” John P. Harrison discusses the inadequacies of current regulations, especially those defined in the OGEA, but his analysis can be applied to regulations throughout the world.⁷¹ Harrison argues that a wind turbine’s intrusion at night, amplitude, modulation and turbulence, coupled with the prediction models inability to accurately assess visual and acoustic disturbances help to show that the current noise limits in their application are too lenient; changes are needed if wind development is to continue and expand. As rural regions are likely to be below 25 dB(A) at night, typical guidelines, such as the ISO’s dB 40, allow a 15 dB(A) intrusion above background noise levels.⁷² Harrison stresses that the amplitude modulation resulting from the wind turbine’s noise due to the periodic blade passage frequency should not be averaged away by regulations based on an average sound level. Dr. Leventhall, a frequent consultant to the wind industry wrote: “[a]t times – varying sound is more annoying than a steady sound of the same average level and this is accounted

⁷¹ Harrison, John P. “Inadequacy of Wind Turbine Noise Regulations and Their Application.” *Presentation to the Annual Conference of the Canadian Acoustics Association*. Queen's University, Physics Department, Sept. 2009.

<http://www.wind-watch.org/documents/wp-content/uploads/Harrison-inadequacy-noise-regulations.pdf>. Web. 29 Nov. 2009.

⁷² Id.

for by reducing the permitted level of wind turbine noise.”⁷³ The consensus is that this periodic change in blade passage frequency amounts to about a 5 dB(A) of amplitude modulation. Though the regulations average this in to the overall sound level, the ear does not average this swooshing sound and thus, it adds to the annoyance associated with wind turbine noise. To combat this issue, Harrison suggests that a 5 dB(A) penalty is needed to account for this modulation.⁷⁴ Additionally, he recommends that one performs an analysis of turbulent inflow noise for both atmospheric and wake turbulence.⁷⁵

Negative health impacts have been observed wherever large turbines are placed too close to where people live. In Mars Hill, Maine, families living 3,500 feet (0.663 miles) or less from the wind turbines reported that they experienced severe negative health effects.⁷⁶ When referring to Tables 1.0 and 2.0 in the appendix, it is hard to ignore the disconnect between the current setback distances in play when compared against the recommendations from

⁷³ Boone, Rinus. "Internoise 2001." *The 2001 International Congress and Exhibition on Noise Control Engineering*. The Hague, Holland, 27 Aug. 2001. Web. 14 Mar. 2010.

⁷⁴ A penalty is often added to or subtracted from to the dB(A) in sound estimates if any specific tones that are objectionable to the human ear are omitted in the initial estimate. Using this added penalty to a standard helps provide equations for calculating the noise level at any wind speed and distance from the turbine. The human ear (and mind) discerns pure tones more easily than random (white noise). As such, authorities may wish to take that into account when doing sound estimates. They consequently often have rules which specify that you add a number to the db(A) figure in case you have pure tones present in a sound. For example, if a wind turbine meets a sound pressure level standard of 45 dB(A), but produces a strong whistling, 5dB(A) are subtracted from the standard. This forces the wind turbine to meet a standard of 40dB(A).

⁷⁵ As of 2009, there were no jurisdictions requiring turbulence noise their approval process.

⁷⁶ Montville Wind, Setbacks. www.montvillewind.org. 11 Feb. 2010.

researchers. This contrast suggests that the Wind Action Group should consider recommending lengthening the setbacks and implementing more stringent noise regulations in order to protect human health.

Part II

A Legal View of Wind Turbines and the Siting Process

New York State Law- SEQRA

New York's SEQRA law leaves many ambiguities in its application to wind turbines. Such ambiguities seem to allow for too much flexibility in the duties of municipalities when siting the turbines. If municipalities and developers had a "best practices" wind turbine siting guide that fit within SEQRA's scope, then these best practices would help close the uncertainties.

SEQRA states that one must complete a full environmental assessment form for actions likely to require an Environmental Impact Statement (hereinafter referred to as an "EIS").⁷⁷ One recommendation to include within the best practices is that if there is one or more place of residence within one mile of the siting destination, a complete EIS will become necessary to proceed in siting the turbine. A place of residence can be an expansive definition, used to define institutions that require special consideration, such as dwellings, hospitals and schools. Additionally, to account for the different noise disturbances of a city or urban environment, the EIS standards should differ depending on whether the setting is rural or urban.

As wind turbine disturbance levels have shown to be less disruptive to negative activities performed in outdoor urban settings, different, less stringent

⁷⁷ Department of Environmental Conservation. "Environmental Assessments - NYS Dept. of Environmental Conservation." *New York State Department of Environmental Conservation*. <http://www.dec.ny.gov/permits/45586.html>. Web. 22 Jan. 2010.

standards should exist for turbines located within one mile of outdoor centers only.

Complications Encountered

Individuals have different levels of sensitivity to noises, including wind turbine noise.⁷⁸ For example, one neighbor may complain of a lack of sleep due to low frequency sound, while a second neighbor, less than 100 feet away, may have no complaints. Often times, these differences are based on previous exposure history and personality traits. To further complicate matters, SEQRA requires that a positive or negative determination of environmental significance must be made prior to constructing a wind turbine.⁷⁹ When these two problems are looked at together, it is hard to ignore the questions that follow. What if one person is found to suffer health effects within a prescribed distance from the turbine? Is this enough to trigger SEQRA's requirement of significance? How are the developers to treat an individual's sensitivity to wind turbines? Though these issues have yet to be resolved, the Wind Action Group must flag them and take

⁷⁸ Rogers, Anthony L. *Wind Turbine Noise, Infrasound and Noise Perception. Renewable Energy Research Laboratory.* University of Massachusetts, 18 Jan. 2006. www.windpoweringamerica.gov/pdfs/.../mwwg_turbine_noise.pdf. 17 Mar. 2009

⁷⁹ Department of Environmental Conservation. "Environmental Assessments - NYS Dept. of Environmental Conservation." *New York State Department of Environmental Conservation.* <http://www.dec.ny.gov/permits/45586.html>. Web. 22 Jan. 2010.

them into account when determining proper setbacks to best avoid any possible issues.

Another complication worth noting involves the allocation of extra costs incurred in performing a thorough EIS under SEQRA. The developers are the ones who typically bear the costs of an EIS, but if accurate visual and acoustical assessments must be performed, costs are likely to increase. There must be a balance between when developers are expected to bear the extra costs and when such costs are unnecessary.

Draft EIS for Town Of Westfield, NY.

As there are many unresolved issues surrounding SEQRA's and its EIS, it is helpful to examine the most recent Draft Environmental Impact Statement (hereinafter referred to as "DEIS"), to examine how developers are trying to mitigate the environmental harms encompassed by Wind Turbine Syndrome. The town of Westfield in Ripley, New York, just posted a DEIS in April of 2010 for an upcoming wind project. To comply with SEQRA, the developers performed a sound level survey to determine what background noise levels were present as well as to determine the nearest potentially sensitive receptors under wintertime leaf-off conditions, and summer leaf-on conditions.⁸⁰ The tests were performed during various seasons to account for the leaf and other vegetation rustling due

⁸⁰ The receptors are mainly residences in this case.

to wind, as such foliage is a contributing factor in background sound levels.⁸¹ The summer survey took place for fourteen days, while the winter survey was conducted over thirteen days. The sound levels were measured in consecutive 100-minute intervals over each survey period. Seven monitoring stations were elected to cover the project site. This study also took into account the natural sound generated by the wind itself when establishing the minimum background SPL available to mask potential wind turbine sound.⁸² The wind speed was measured at ten meters above ground level over each survey period, using a temporary weather station set up at the most exposed monitoring station.⁸³

In Westfield, the local regulatory noise limit states that noise produced during wind turbine operation shall not exceed 50 dB(A), measured at the boundaries of the closest parcels that are owned by non-site owners.⁸⁴ To comply with these standards, developers also implemented the guidelines for evaluating potential community impacts from noise sources as defined in DEC's Program Policy "Assessing and Mitigating Noise Impacts."⁸⁵ These guidelines identify at least two measures for assessing sound impacts that the developers

⁸¹ Ripley-Westfield Wind, LLC. "3. Environmental Settings and Impacts." *Ripley-Westfield Wind Farm*. Ecology and Environment, Inc., 15 Feb. 2010. <http://www.ripleywestfieldwind.ene.com/files/EIS/Section%203%20-%20Environmental%20Setting%20and%20Impacts.pdf>. Web. 11 Mar. 2010.

⁸² Id.

⁸³ Turbine sound is most significant at high speed. This is when the level of natural masking sound is normally high due to tree or grass rustle, thus reducing the perceptibility of the turbines.

⁸⁴ Ripley-Westfield Wind, LLC. "3. Environmental Settings and Impacts." *Ripley-Westfield Wind Farm*. Ecology and Environment, Inc., 15 Feb. 2010. <http://www.ripleywestfieldwind.ene.com/files/EIS/Section%203%20-%20Environmental%20Setting%20and%20Impacts.pdf> . Web. 11 Mar. 2010.

⁸⁵ Id.

adopted. The two measures used were (1) the maximum SPL (project plus background) at receptor and (2) the differential between the project SPL and ambient sound at a receptor.⁸⁶ The maximum threshold referenced in the guidelines state that most humans find a sound level of 60 dB(A) – 70 dB(A) as creating a condition of significant noise effect.⁸⁷ The DEC guidance concludes that in non-industrial settings, the maximum allowable SPL should not exceed 65 dB(A) at the receptor. When using the second measure, the guidelines recognize a 10 dB differential as the threshold for undue adverse impacts, recommending “an increase of 10 dB deserves consideration of avoidance and mitigation measures in most cases”.⁸⁸

The Westfield DEIS states that no adverse impact of any kind related to low frequency sound is expected from this project, claiming that concerns about excessive low frequency noise from proposed wind farms have grown out of “misinformation or anecdote without any basis in current fact.”⁸⁹ The document asserts that no further examination was needed because the “modern wind turbines of the type proposed for this project do not generate low frequency or infrasonic sound to any significant extent and no such impact of any kind is

⁸⁶ SPL is the abbreviation for Sound Pressure Level, which is also referred to as Decibel.

⁸⁷ Program Policy. New York State Department of Environmental Conservation. Environmental Permits. *Assessing and Mitigating Noise Impacts*. DEC, 6 Oct. 2000. http://www.dec.ny.gov/docs/permits_ej_operations_pdf/noise2000.pdf , Web. 2 Apr. 2010.

⁸⁸ Id.

⁸⁹ Id.

expected.”⁹⁰ The DEIS claims that early wind turbines had blades downwind of the support tower, which produced periodic thumping, but that the effect no longer exists with the upwind blade arrangement used today. Deferring to a study in 2007 by Sondergaard, the DEIS alleged that for a typical 1.5 MW turbine, sound levels taper down steadily in magnitudes toward the low end of the frequency spectrum and that sound energy below about 40 Hertz is actually comparable to the sound energy in a natural rural environment where the measurements were made. This study is contrary to most research to date, as it suggests that modern industrial turbines no longer emit disturbing low frequency noise. This DEIS additionally referenced the AWEA and CanWEA report to support their lack of further examining the low frequency noise impacts of the Westfield project.⁹¹

The Environmental and Settings Impact portion of the DEIS was a total of 381 pages, and fifty-two of these pages were dedicated to the relevant sound impacts of the wind turbines. Of the fifty-two pages dedicated to sound, only one page discussed the impacts of low frequency noise. Research on Wind Turbine Syndrome indicates that the low frequency sound from wind turbines has the greatest effect on human health.

⁹⁰ Ripley-Westfield Wind, LLC. "3. Environmental Settings and Impacts." *Ripley-Westfield Wind Farm*. Ecology and Environment, Inc., 15 Feb. 2010. <http://www.ripleywestfieldwind.ene.com/files/EIS/Section%203%20-%20Environmental%20Setting%20and%20Impacts.pdf>. Web. 11 Mar. 2010.

⁹¹ Colby, David, Robert Dobie, Geoff Leventhall, David M. Lipscomb, Robert J. McCunney, Michael T. Seilo, and Bo Sendergaard. *Wind Turbine Sound and Health Effects: An Expert Panel Review*. Rep. AWEA & CanWEA, 2009. Print.

Increasing Prevalence of Wind Turbine Syndrome like Symptoms in the Legal World & Siting Process

The lack of clarity and guidance in the wind turbine siting process is hard to ignore; the developer's responsibilities are vague, and fixed noise limits and setback distances are undefined. As such, there are a growing number of lawsuits filed by individuals living in close proximity to wind turbines against municipalities and developers.⁹² In recent years, a number of suits were filed against the developers, where plaintiffs alleged nuisance for noise, vibrations, interference with light, aesthetic concerns, and diminution of property value due to the turbine's disturbances. While the results of these cases have been mixed, enough have resulted in positive outcomes for the plaintiffs, which suggest that more complaints are sure to be filed as wind energy development continues to increase.

For example, in 2009, a complaint was filed in Mars Hill, Maine, against First Wind.⁹³ The defendants included the wind farm developer, a general contractor, and inhabitants of the Town of Mars Hills, a body politic that was the co-applicant to the Maine Department of Environmental Protection for the construction of the wind turbines in question. The plaintiffs complained that noise from a nearby turbine was invasive, causing them loss of enjoyment of life, loss

⁹² These lawsuits refer to the symptoms of Wind Turbine Syndrome, though they are not referred to as Wind Turbine Syndrome when referred to in the lawsuit.

⁹³ Mars Hill Residents v. First Wind (Main.) Date of complaint: August 9, 2009.

of peace and quiet, and loss of full use of their homes and land. Some of these *Mars Hill* plaintiffs required medicinal treatment and counseling. Others continued to lose sleep and suffer from other physical and emotional ailments. The courts have not ruled on this case yet, and there are several other similar actions pending where no formal court opinion is yet available.

As wind turbines are a fairly recent phenomenon, there is little precedent for courts to use in deciding a case based on a wind turbine nuisance claim. The few cases that courts are likely to use as precedent for future cases are worth noting, as they will provide some general guidance as to how the courts will likely handle the issue.

In *Rose v. Chaikin*, the defendants constructed a sixty-foot wind generator near a residential neighborhood in Brigantine, New Jersey.⁹⁴ After the turbine was completed, the plaintiffs experienced tension and stress-related symptoms, including nervousness, dizziness, loss of sleep and fatigue. The court referred to cases that established a precedent in New Jersey where projects that created noises injuriously affecting the health and comfort of ordinary people in the vicinity to an unreasonable extent were enjoined.⁹⁵ Furthermore, the court emphasized that the wind turbine's sound would be loud, constant, and particularly out of place in a residential neighborhood. Though the court enjoined the operation of the turbines, the court stressed the potentially beneficial impacts of wind turbines. The court in *Rose* reasoned that the defendants' wind turbines

⁹⁴ 187 N.J. Super. 210 (1982) 453 A.2d 1378

⁹⁵ *Id.*

served merely to conserve energy use and save on electric bills for the defendants, and therefore had little broader social utility. On policy grounds, the *Rose* decision suggests that wind turbines, if built on a non-residential location, might be found as reasonable uses of land, and will therefore reduce the likelihood of a nuisance injunction.

In *Burch v. NedPower*,⁹⁶ the defendant wind energy company intended to build a large wind farm on a site fourteen miles long and half a mile wide, containing up to two hundred turbines. The ruling in *NedPower*, therefore, may be the first published opinion on a nuisance suit against a large-scale modern wind project. In 2003, the West Virginia Public Service Commission granted NedPower a certificate of convenience and necessity for the construction of the wind project, provided the environmental conditions were met. In 2005, seven plaintiffs filed suit against NedPower, seeking a permanent injunction against the facility to prevent further nuisances due to the noise, vibrations, flicker or strobe effect of the turbines, and their belief that their property value was reduced.

The West Virginia Supreme Court decided this case, as it was dismissed at the pleading stage when the Circuit Court of Grant County held that it lacked jurisdiction to enjoin a project approved by the PSC. Ultimately, the court not only held that the plaintiffs claims for nuisance due to noise, unsightliness and reduced neighboring property value should not have been dismissed at the pleading stage, but that an injunction could have been the proper form of relief. The court remanded the suit to circuit court, and stressed that while the lower

⁹⁶ *Burch v. NedPower Mount Storm, LLC*, 647 S.E.2d 879, 885 (W.Va. 2007).

court had the power to enjoin the entire wind project, it should only grant relief that would “cause the defendant no more injury than is necessary to protect the plaintiffs rights.”⁹⁷ *NedPower* appears to have set a much lower bar for nuisance suits against wind farms than prior nuisance law might have allowed in most U.S. jurisdictions.

*Rankin v. FPL Energy*⁹⁸ had a very different outcome than *NedPower*, because the state court of appeals in Texas upheld a partial motion for summary judgment and a jury verdict in favor of a large wind development. The plaintiffs were residents in Taylor County who alleged a nuisance claim based on aesthetic impacts of the large wind farm nearby. The court refused to give weight to this claim and found that “merely characterizing the wind farm as abnormal and out of place in its surroundings [does not allow] a nuisance claim based on an emotional reaction to the sight of FPL’s wind turbines.”⁹⁹ This was based on Texas law requiring a more tangible interference with the plaintiff’s property. The court also concluded that finding for the plaintiff in such a nuisance lawsuit over changed aesthetics would give the plaintiff, “in effect, the right to zone the surrounding property.”¹⁰⁰ This case represents the courts unwillingness to disturb the common law of nuisance and is often cited to defend large wind developments from nuisance claims. However, *Rankin* stems from a direct visual complaint and it is important to note that a wind turbine’s resulting noise

⁹⁷ *Id.*

⁹⁸ *Rankin v. FPL Energy, LLC*, 266 S.W.3d 506, 513 (Tex. App. 2008).

⁹⁹ *Id.*

¹⁰⁰ *Id.*

annoyance is more often linked to the symptoms associated with Wind Turbine Syndrome than is a wind turbine's visual effects.

Stephen Harland Butler wrote a law review article on possible guidance for future courts on how to treat nuisance claims against wind power developments.¹⁰¹ He suggests that when the court is presented with a nuisance claim based on noise, a jury trial will sometimes be appropriate to weigh the precise extent of the harm, especially where the wind development is in close proximity to a residential community.¹⁰² He also warns that courts must be careful to balance the harm of the alleged nuisance against its social benefits before acting rashly to enjoin the development of a wind project that is likely to have substantial social benefits.¹⁰³ So too should the courts give due attention to the findings of state agencies and public service commissions that may have previously examined wind developments. Butler stresses that where some form of state approval was given to the wind project, courts hearing nuisance claims against wind farms should ensure that any findings of state agencies are included in the final analysis of unreasonableness.¹⁰⁴

¹⁰¹ See Generally Stephan Harland Butler, Headwinds to a Clean Energy Future : Nuisance Suits Against Wind Energy Projects in the United States, 97 Cal. L. Rev. 1337, (2009).

¹⁰² Id.

¹⁰³ Id.

¹⁰⁴ Id.

As the market for wind turbines grew considerably in the past year alone, we can expect the market to increase in the years ahead.¹⁰⁵ As a result, we are likely to see an increase in complaints from individuals living near turbines in the next coming years. Environmental issues create the perfect incubator for legal conflict and the shift to a renewable energy culture is bound to benefit some and disadvantage others. The question becomes how to best balance this conflict.¹⁰⁶ For example, even if a developer obtains all the proper approvals and permits necessary and proceeds to build a project, nuisance laws can force the project to shut down at the very end of the process. This is a very expensive and inefficient way to operate. Wind energy is expected to be the focus for many of those disputes in the near term, because it is the fastest growing renewable sector, the most visible, and one with specific concerns over health effects due to the introduction of "Wind Turbine Syndrome." To avoid these potential suits, developers and municipalities should collaborate to determine proper setback distances between dwellings and wind turbines, with a goal of minimizing noise annoyance and other symptoms associated with Wind Turbine Syndrome.

¹⁰⁵ "US Small Wind Market Grew 78% in 2008 - Renewable Energy World." *Renewable Energy World - Renewable Energy News, Jobs, Events, Companies, and more*. 3 June 2009. Web. Oct. & Nov. 2009.

¹⁰⁶ Blackwell, Richard. "Green Energy a Perfect Incubator for Legal Conflict «." *Wind Concerns Ontario*. Globe and Mail, 18 Nov. 2009. <http://windconcernsontario.wordpress.com/2009/11/18/green-energy-a-perfect-incubator-for-legal-conflict/>. Web. 2 Dec. 2009.

Conclusion

Wind turbines generate a broad spectrum of low intensity noise, but low frequency noise is the primary problem believed to affect some people that live close to wind turbines, especially at night. Low frequency noise does not have as much of an impact on people when they are surrounded by more background noise, such as in urban settings or when individuals participate in various outdoor activities.

In the various studies discussed above, the most common complaint from those living near wind turbines is annoyance, resulting in headaches and sleeplessness. Most available evidence suggests that the reported health effects are related to audible low frequency noise. These complaints occur more often from individuals who can see the wind turbines from their home, and generally increase when outside noise levels are above 35 dB(A). Low frequency noise is generally not easily perceived beyond one - half mile. However, if a turbine is subject to aerodynamic modulation because of sheer caused by terrain, such as mountains, trees, buildings, or different wind conditions through the rotator plane, turbine noise may be heard at a greater distance.

The take-away from several research papers appears to be that while significant portions of the population are affected by moderate wind farm noise, neither increasing wind farm noise nor annoyance from other sources of similar noise inevitably leads to a decrease in human health. There is an entire separate

body of research investigating various attitudinal aspects related to stress and health, which only muddy the waters as we try to interpret the direct studies on wind farm noise. Though the studies discussed above help one gain a better picture of noise annoyance and how to best mitigate complaints from wind turbines, they cannot be used to explain away either annoyance or health impacts that do take place any more than annoyance can be used as a clear indication of eventual health effects. It is clear that 35 dB – 45 dB is a range at which impacts on neighbors become far more widespread. The social question that will need to be addressed is what proportion of nearby neighbors suffering from sleep deprivation or sound annoyance will be acceptable: 5% or 20%? Where will we draw the line beyond which we consider turbine placement too close?

Though much is known about the possible health effects associated with living near a wind turbine, there are still many questions inherent in every study's conclusion. To overcome these ambiguities, we need to better understand how to mitigate complaints before project planning begins. Research suggests some of the best mitigation techniques include (1) improved noise modeling, including characterization of potential sources of aerodynamic modulation noise and characterization of nighttime wind conditions; (2) the visibility of the wind turbines; (3) the interests and involvement of nearby residents and community and (4) proper setbacks.

As so many residents complain of low frequency noise from wind turbines, it seems that the single A-weighted (dB(A)) noise receptor used in most jurisdictions is not adequate to predict turbine sound emissions. Therefore, good sound modeling would include dB(C) criteria, which is more predictive of perceptual loudness than dB(A), especially if low frequency sounds are significant. It is important that the developer account for ambient noise in the surrounding area, both during the day and at night, with perhaps a nighttime limit below 35 dB in both rural and urban environments. It may even be beneficial to decrease the turbine's nighttime limit to below 30 dB in rural environments, especially if the turbines are being built within one-mile of the nearest residence.¹⁰⁷

The current methods for assessing noise levels produced by wind turbines located in various terrains, such as mountainous regions and forest grounds need further development. Developers can take terrain and climate into account when predicting wind turbine noise, but it comes at a cost. The developer will have to perform numerous tests throughout the year to account for climate change and seasonal foliage. Additionally, to capture the terrain's impact on the wind turbine's emitted noise, the developer would have to perform studies that assess how wind flow and wind speed from various directions will affect nearby residents. It appears that residences living beyond one mile from a wind turbine site do not suffer as many health effects from the turbines as those who live within a mile. One possibility, therefore, may be to require that the developer perform various

¹⁰⁷ The term residence would also include facilities such as schools and hospitals

studies, as defined above, if they wish to site wind turbines within one-mile. These developers should bear all costs associated with the studies, and the costs should increase proportionally as the distance between the turbine and residence decreases. This will help deter developers from unnecessarily siting too close to residences, while ensuring the nearby residents that the developer is doing its best to mitigate the turbine's noise.

Though Wind Turbine Syndrome is more a product of the sound from wind turbines than the turbine's visual effects, developers must set proper setbacks to ensure that shadow flicker does not affect nearby roads and residences. Several studies suggest that when some residents have a visual of the turbine from their home, their stress levels are likely to increase. This can be attributed to their belief that their property is decreasing in value. Assuming that stress can lead to other ailments typical of wind turbine syndrome, the developer should perform visual studies to insure that turbines sited within one mile of a residence are as hidden as practicable.

There is a definite relationship between community involvement in the wind turbine siting process and noise complaints following the turbine's completion; the more the community is involved, the less number of complaints are voiced.¹⁰⁸ With this in mind, it is important that the developers educate and

¹⁰⁸ Pagano, Margareta. "Are Wind Farms a Health Risk? US Scientist Identifies 'wind Turbine Syndrome'" *The Independent*. 2 Aug. 2009. <http://www.independent.co.uk/environment/green-living/are-wind-farms-a-health-risk-us-scientist-identifies-wind-turbine-syndrome-1766254.html>. Web. 19 Mar. 2010.

involve the community in the siting process. Such simple steps by the developer are likely to reduce issues such as lawsuits down the road.

Though Wind Turbine Syndrome is a recent phenomenon, many institutions dedicated great time toward better understanding the issue. Due to the current lack of high-level evidence on which to base any solid conclusions, more studies are necessary. Setting aside the idea of acoustically induced symptoms, annoyance is a real issue. Developers need to take this into account when planning and developing wind installations. Annoyance is an emotionally driven judgment and differs from individual to individual; thus, the concept of Wind Turbine Syndrome on the most basic level is in the arena of debatable community-wide values. Regardless of its validity, the idea of Wind Turbine Syndrome has already created additional hurdles for developers, especially in the siting process. To best avoid these obstacles, the Wind Action Group can hold a forum and educate concerned parties on the reality of “Wind Turbine Syndrome”, highlighting that wind turbines are not the only source that emits low frequency noise. By educating surrounding communities, the Wind Action Group can help reduce any unwarranted fear that “Wind Turbine Syndrome” has attached to wind power. By working with the community and stressing the need for local participation in siting decisions, the Wind Action Group can encourage a collaborative effort between municipalities, local community members, and prospective developers so that proper noise regulations and setback distances are implemented, ensuring wind energy’s growth well into the future.

Table 1.0 - Industrial Wind Turbine Setback Recommendations from Residential Properties

AUTHORITY	NOTES	YEAR	RECOMMENDATION IN MILES
Frey & Hadden	Scientists. Turbines >2MW	2007	>1.24
Frey & Hadden	Scientists. Turbines <2MW	2007	1.24
Harry	UK Physician	2007	1.5
Pierpont	US Physician	2008	1.5 in flat terrain 2.2 in mountainous terrain
Welsh Affairs Select Committee	Recommendation for smaller turbines	1994	.93
Scottish Executive	The setbacks here were set for more visual reasons	2007	1.24
Adams	US Lawyer	2008	1.55
Bowdler	UK Noise Engineer	2007	1.24
French National Academy of Medicine	French Physicians	2006	.93
The Noise Association	UK Scientist	2006	1
Kamperman & James	US Noise Engineers	2008	>.62
Bannett	NZ Scientist	2008	>.93
Acoustic Ecology Institute	US Noise Engineers	2009	.93
National Wind Watch		2007	1.0
CRSC report for Congress,	US Specialists in	2008	.62

Jeffery Logan and Stan Mark Kaplan	energy Policy		
Dr. Robyn Phipps, Ph.D.	New Zealand	2007	Found wind farm noise has significant effect on people that extend beyond 3.1 miles from the site of the turbines.
Majorlaine Villey-Migrane	France Physicians	2001	>3.1 miles
Champaign, IL Planning commission		2009	2.5 miles
Karmen Krogh	Ontario, Pharmacist		.93 to 2.17

Table 2.0 - Current Noise Regulations and Setback Distances

Jurisdiction	Turbine Distance from Property	Turbine Distance from Nearest Structure	Noise Standard-Distance from Property Line	Noise Standard-Distance from Nearest Structure
Kansas				
(1) Butler County	No turbines shall be located closer than 500 feet or the total height of the turbine plus 50 feet, whichever is greater, from the property lines of any property not included in the Conditional Use Permit	No turbine shall be located closer than 1000 feet from a residential structure. Turbines shall be located no closer than the total height of the turbine plus 5 feet from a common agricultural/residential accessory structure		
(2) Greary County		1500 – foot (0.284 miles) minimum setback from residential structures	The noise level measured at the property line of the project property shall not exceed 55 dB at any time (A or C weighted).	Commercial wind energy conversion systems should be located in areas where there are adequate setbacks from residential and rural homes so that noise from the turbine is not an intrusion.

Jurisdiction	Turbine Distance from Property	Turbine Distance from Nearest Structure	Noise Standard- Distance from Property Line	Noise Standard- Distance from Nearest Structure
(3) Riley County	1.5 T		SPL shall not exceed 65 dB(A) when measured at five feet above ground level at the property line and shall not exceed 50 dB(c) if it is determined that a pure tone noise is generated by the project.	
Massachusetts Division of Energy Resources- Model Ordinance	Wind Turbines shall be set back 1000 feet (0.189 miles) from the nearest property line and private or public way.	Wind Turbines shall be setback a distance equal to 1.5 times the overall blade tip height of the turbine from the nearest existing residential or commercial structure		The wind facility shall conform with the DEP's noise regulations. Facilities cannot increase the broadband sound level by more than 10 dB(A) above ambient levels.

Jurisdiction	Turbine Distance from Property	Turbine Distance from Nearest Structure	Noise Standard- Distance from Property Line	Noise Standard- Distance from Nearest Structure
<p>Michigan- Energy Office, Dept. of Labor and Economic Growth</p>	<p>The distance between the wind energy system and the property line shall be at least the height of the wind turbine tower including the top of the blade in its vertical position. The distance between an on site use wind energy system and the owners property line shall be at least 1.5 times the height of the wind energy system tower, including the top of the blade in its vertical position.</p>		<p>The SPL shall not exceed 55 db(A) measured at the property lines between leased and non-leased property. The SPL shall not be exceeded for more than 3 minutes in any hour of the day. if the ambient SPL exceeds 55 dB(A), the standard shall be ambient dB(A) plus 5 dB(A).</p>	

Jurisdiction	Turbine Distance from Property	Turbine Distance from Nearest Structure	Noise Standard-Distance from Property Line	Noise Standard-Distance from Nearest Structure
NYS Energy Research & Development Authority Model Ordinance.	Variable distances from 50 feet to 1.5 times the sum of the proposed structure height plus the rotor radius	Variable distances from 1.5 times the proposed structure height to 1500 feet (0.284 miles).	Noise shall not exceed 55 dB(A) measured at the site property line.	Audible noise shall not exceed 50 db(A) for any period of time, when measured at any residence, school, hospital, church, or public library existing on the date of approval of the wind energy facility.
(1) Hartsville, NY		2460 feet (0.466 miles) from a dwelling		
(2) Allegany, NY		2500-foot (0.473 miles) setback from residential property		
North Carolina, Currituck County	1.5 times wind turbine height	2.5 times wind turbine height		1.5 - 2.5 times wind turbine height.

Jurisdiction	Turbine Distance from Property	Turbine Distance from Nearest Structure	Noise Standard- Distance from Property Line	Noise Standard- Distance from Nearest Structure
Pennsylvania Municipalities Planning Code Model Ordinance	All wind turbines shall be set back from the nearest property line a distance of not less than the greater of the maximum setback requirements for that zoning classification where the turbine is located or 1.1 times the turbine height, whichever is greater.	For non-participating landowners property, a setback distance of not less than 5 times the hub height should be established.		Audible sound from a wind energy facility shall not exceed 55 dB(A), as measured at the exterior of any occupied building on a non-participating landowner's property.
(1) Potter County		2900- foot (0.549 miles) setback from residential property lines		

Jurisdiction	Turbine Distance from Property	Turbine Distance from Nearest Structure	Noise Standard-Distance from Property Line	Noise Standard-Distance from Nearest Structure
Wisconsin Model Ordinance	Each turbine shall be set back from the nearest property line a distance no less than 1.1 times its total height, unless appropriate easements are secured from adjacent property owners, or other acceptable mitigation is approved by the Committee.	Each wind turbine shall be set back from the nearest residence, school, hospital, church or public library a distance no less than the greater of (a) two times its total height or (b) 1000 feet (0.189 miles)	Audible sound shall not exceed 50 dB(A) for any period of time when measured at the property line of any residence, school, hospital, church, or public library. A pure tone, such as a whine, screech or hum, audible sound due to wind energy facility operations shall not exceed 45 db(A)	
(1) Calumet County	1800 feet (0.340 miles)			Turbine noise shall not exceed 5 db over the current background sound levels during the quietest part of the day or night. Excessive low frequency noise at any nearby residence will require shutdown of the offending turbine.
(2) Blair County		2500 feet (0.473 miles)		

Jurisdiction	Turbine Distance from Property	Turbine Distance from Nearest Structure	Noise Standard-Distance from Property Line	Noise Standard-Distance from Nearest Structure
(3) Dorr County	1.1 times the total height of the wind turbine	Not less than twice the total height of the turbine or 1000 feet (0.189 miles) or whichever is greater from an inhabited structure.		50 dB near any residential or related areas. If an audible sound can be heard in the area, the limit is 45 dB.
(4) Rock County		2650 feet (0.5 miles)		

Table 3.0 - Proposed Setbacks For Land-Based Wind Projects,

Content for the Renewable Energy Approval Regulation under the Environmental Protection Act

Number of Wind Turbines	Setback in metres (m) from closest Point of Reception corresponding to wind turbine Sound Power Levels in decibels (dBA)				
	102 dBA	103 - 104 dBA	105 dBA	106 - 107 dBA	> 107 dBA
1 – 5 turbines	550 m	600 m	850 m	950 m	Noise study required
6 - 10 turbines	650 m	700 m	1000 m	1200 m	
11 - 25 turbines	750 m	850 m	1250 m	1500 m	
26+ turbines	Noise study required				