# Evaluation of Environmental Noise Analysis for

# “Dairy Hills Wind Farm”

R.H. Bolton
October 16, 2006
Rev. 0

## Table of Contents

## 1.0 Introduction

Industrial wind turbine farms are proposed for the towns of Perry, Covington and Warsaw, NY that will permanently alter the towns. Large turbines create strong noise levels not only from wind through the blades but largely by the turbine mechanisms themselves. To capture the wind these turbines are to be installed on hill tops around the town and thus have significant potential to create a noise nuisance. Wind turbine noise added to the prevailing ambient background sound is an important environmental consideration when siting wind turbines since they are a permanent installation and may significantly impair resident's enjoyment of neighboring lands or even personal health. Also, relevant consideration of noise impacts and mitigation measures are a specific requirement of a NY State Environmental Quality Review procedure, required before approval of permits.

## 2.0 "Dairy Hills Wind Farm"

Dairy Hills Wind Farm, LLC has proposed a large "wind turbine farm" for the Towns of Perry, Covington and Warsaw NY. Up to 62 megawatt-scale turbines are to be erected over 24 square miles of the towns. A NYS Environmental Quality Review is required to assess and mitigate potential environmental damage associated with the project. To conform to NYS Environmental laws a comprehensive noise pollution analysis and mitigation plan must be performed for all potential affected "receptors" throughout the wind farm geography. The sponsor submitted a Draft Environmental Impact Statement that includes a noise analysis as Appendix I, by Hessler Associates (Ref. 1). Hessler chose to follow the DEC's Noise Policy (Ref. 2), designed for the Department but also useful to sponsors or other agencies in assessing and mitigating noise impacts. From Hessler:

> The primary basis for evaluating potential project noise is the Program Policy *Assessing and Mitigating Noise Impacts* issued by the New York State Department of Environmental Conservation (NYCDEC), Feb. 2001. This assessment procedure is incremental in the sense that a fairly simple "first level noise impact evaluation" is initially carried out to determine if any residential receptors *may* experience a noticeable increase in sound level. If this analysis, which compares the measured background level to very conservatively calculated potential project sound levels, shows that any houses may be impacted a further, "second level noise impact evaluation" is carried out to model project noise in a more realistic and detailed fashion.

## 2.1 Flawed Noise Analysis

The successful measurement and assessment of the complex noise potential of a large wind turbine farm project is a vital part of the environmental review and mitigation process and there are specific instructions in the DEC Policy about excessive noise:

> When a sound level evaluation indicates that receptors **may experience sound levels or characteristics that produce significant noise impacts or impairment of property use**, the Department is to require the permittee or applicant to **employ reasonable and necessary measures to either eliminate or mitigate adverse noise effects**.

(emphasis added)

Hessler however thinks that the noise study purpose is to provide evidence that the noise turbine sounds will be masked, and therefore acceptable. From their report:

> 2.0 BACKGROUND SOUND LEVEL SURVEY
> 2.1 OBJECTIVE AND MEASUREMENT QUANTITIES
> **The purpose of the survey was to determine what minimum environmental sound levels are consistently present and available at the nearest potentially sensitive receptors to mask or obscure potential noise from the project**.
>
> (emphasis added)

It is no wonder, therefore, that though the Hessler report claims to adhere to the DEC Noise Policy but is in fact severely flawed and worthless as a proper noise pollution analysis:

a) <u>All</u> potential receptors that may be affected by unreasonable noise levels must be characterized, not just at the 5 measurement sites Hessler chose to represent 20 square <u>miles</u> of impacted terrain. Unique acoustical features of the terrain may influence sound propagation and although Hessler describes the terrain and methodology there is no indication their site choices are statistically valid or to what confidence level. Yet this mathematics is quite straight forward, elementary and essential.
b) Measurements of background noise were completely inaccurate due to wind-induced microphone error and therefore do not provide a baseline for establishing noise contour maps.
c) Background sound level measurements were only taken for 20 days in late September and early October. Representative background noises are essential in determining turbine setbacks. Because of wide seasonal in vegetation presence, temperature and winds a 20 day measurement, meant to establish the 20 year lifetime noise levels is only 3/1000 the project duration and obviously woefully inadequate. A statistical analysis to establish a reasonable sample duration and confidence should be required.
d) Realistic computer modeling should conform to prevailing sound propagation results and include atmospheric refraction effects.

The Hessler noise study consists of two parts, identification of the ambient background noise and then computer modeling analysis of the expected turbine noise for various geographic noise boundaries (contours) surrounding the turbine farm. The background ambient determination is important because the new wind turbine noise emissions will be added to the ambient to provide a "limit of acceptance." The DEC Noise Policy suggests a 3 dB(A) increase over ambient for "sensitive receptors" and a generally applicable limit of 6 dB(A) increase as acceptable under most circumstances. Therefore the computer modeling of noise contours around each turbine depends exclusively on obtaining reliable ambient background noise data. Inaccurate noise contours and inaccurate background noise limits will lead to serious errors in delineating setback requirements for turbine siting. The simple mathematics of this type of sound assessment is shown in the graph, Fig. 1 below.

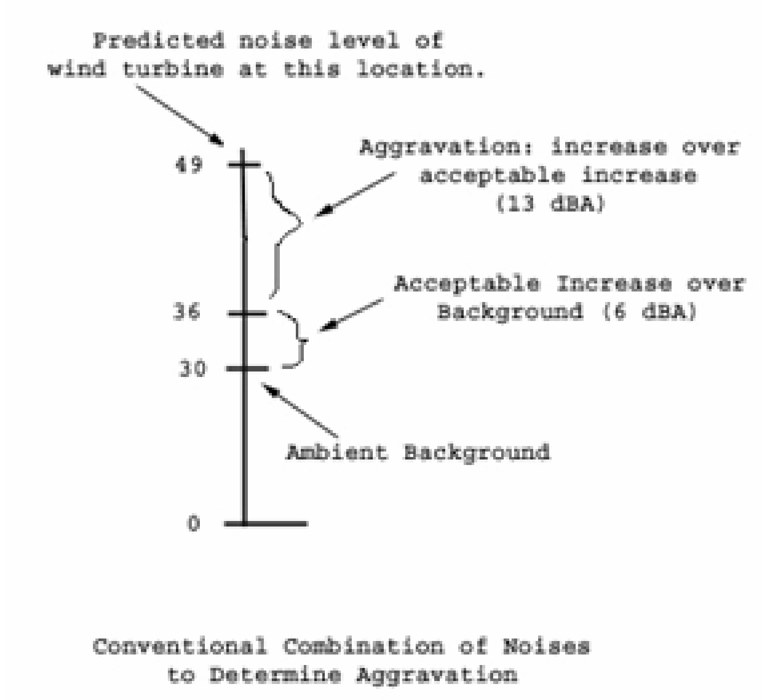


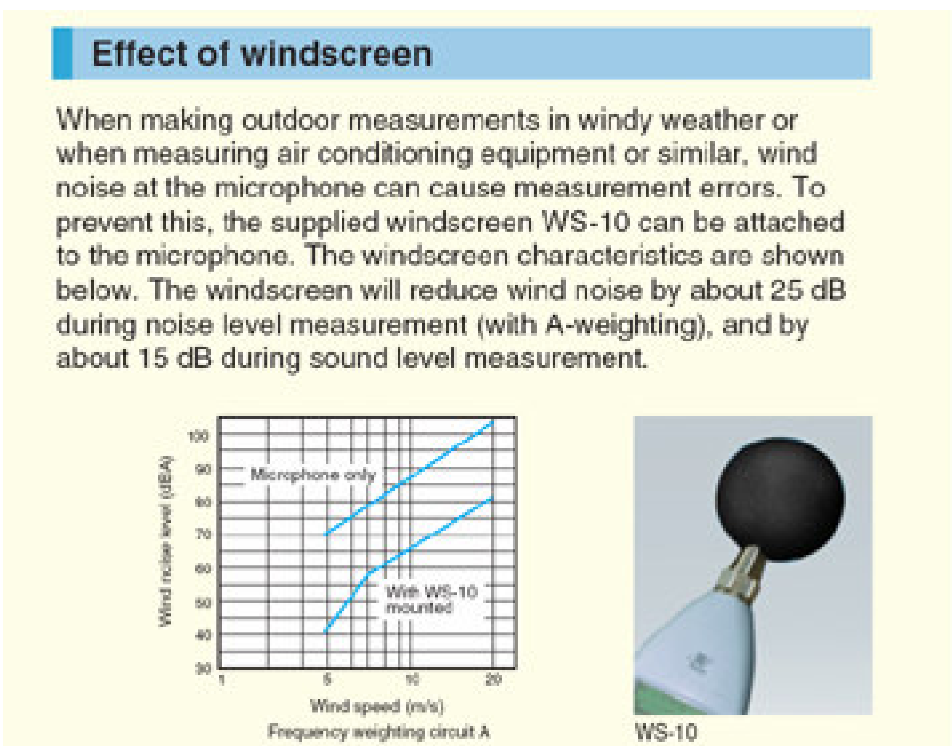

**Fig. 1: Noise Aggravation Mathematics**

Analysis of the Hessler study reveals however that the background noise levels were not reliably measured due to overwhelming contamination of measurements by the wind blowing through the meter's own microphone. To take background ambient sound measurements Hessler mounted a wideband "C" type noise monitor and an "A" weighted monitor. The standard setup uses a microphone with a spherical wind screen and weather sheath attached and is connected to recording electronics. Fig. 2 is a photo from a typical setup used by Hessler, this one from their Noise Survey, Fig 2.2.3, showing the recorder, pole and two microphone assemblies.

It is well known that wind induced microphone noise is a large source of "masking error" in any windy measurement situation. The reader may recall news broadcasts where the reporter is trying to talk despite breezes causing "wind noise" that overcomes the reporter's voice. It's the same thing here, a breeze on the microphone, even with a wind screen, will cause significant errors due to this unwanted effect. Noise meter manufacturer data clearly show the error and it has been studied theoretically by van den Berg (Ref 3), with good agreement between theory and instrumentation.

Rion, manufacturer of the "A" weighting meter provides wind-induced error curves for their instruments in varying wind conditions in their specification sheet (Fig. 3). And Fig. 4 shows a plot of wind speed vs. dBA error for the Rion as well as another manufacturer's noise meter, plus two conditions for the van den Berg theoretical model. All are in good agreement. Also shown on the graph as vertical bars are the cut-in wind speed and cut-out wind speed for the Gamesa Éolica G90 turbine, proposed as typical for the "farm". It can be seen that at the cut-in wind speed of 9 mph the noise meter error is about 35 dBA. Unless the background noise being measured is above 35 dBA it won't be

**Fig. 2: Hessler's Typical Background Sound Measurement Setup**



## Effect of windscreen

When making outdoor measurements in windy weather or when measuring air conditioning equipment or similar, wind noise at the microphone can cause measurement errors. To prevent this, the supplied windscreen WS-10 can be attached to the microphone. The windscreen characteristics are shown below. The windscreen will reduce wind noise by about 25 dB during noise level measurement (with A-weighting), and by about 15 dB during sound level measurement.



**Fig 3: Excerpt from Rion NL Series Specification Sheet**

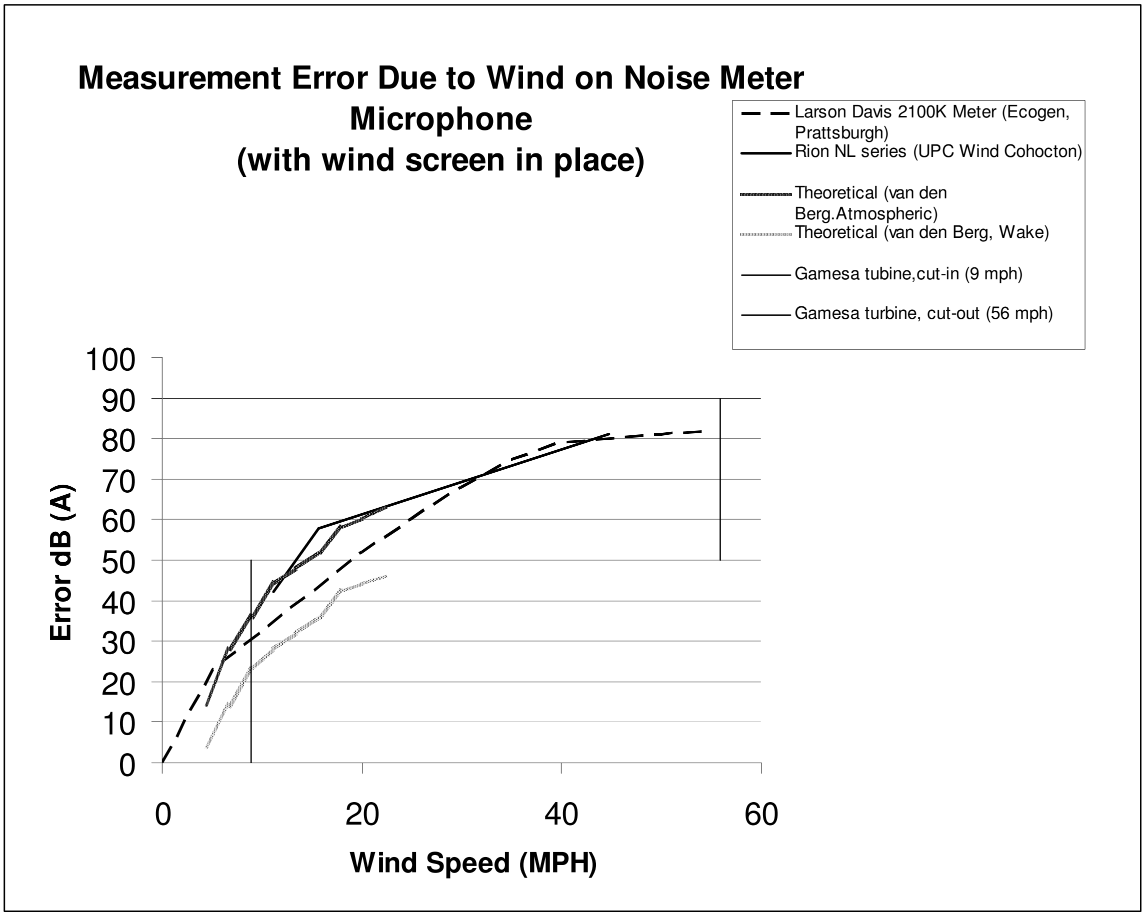



**Fig 4: Noise Meter Microphone Error (Bolton)**

registered as a true background sound because of the microphone error. Since wind itself is completely silent, it creates sound only when acting on some object causing it to react to the wind's pressure. A 9 mph wind may create an "ambient" less than 35 dBA, depending on physical conditions around the measuring site – nearby woods and vegetation, structures, and terrain. At the turbine cut-out wind speed of 56 mph the microphone error has risen to an astonishing 80 dBA. Only loud background sounds can be now be registered, once again with no way of discerning any quieter ambient. Putting a microphone on a pole with a wind screen simply does not give any kind of reliable background noise information if the wind is blowing!

Hessler states that the "microphones were protected from rain and self-induced wind noise by waterproof double windscreens." (Appendix I, section 2.3 "Instrumentation and Survey Duration") but this is merely to keep rain out and reduce the error from the "no windscreen" condition in Fig. 3. I recently (8-23-06) called Rion's US distributor, Scanteck and spoke at length with their Rick Peppin about wind screens and microphone noise error. He is aware of wind noise errors and says only a large windscreen, costing $1,800 and therefore seldom purchased, will effectively reduce this error, though its not calibrated and therefore of limited use. It was his opinion one should measure background noises without the wind blowing at all, to give the <u>most</u> conservative noise figure.

Fig. 5 shows a rough plot of the microphone error (data from Fig. 3) superimposed over the measured noise data that Hessler provides from raw hourly data in their Fig 2.5.3 “Hourly Sound Levels and Wind Speeds (10/6 to 10/11/05)”. The microphone error obviously masks the true background sounds. If the errors were small enough they could be subtracted from Hessler’s graph to provide the true background. Hessler seems delighted with their error, and oblivious to it:

> What is striking about this plot is that the sound levels at all five locations, some many miles apart, are very nearly the same and certainly follow the same overall trends, which are clearly dictated to a large extent by wind speed.

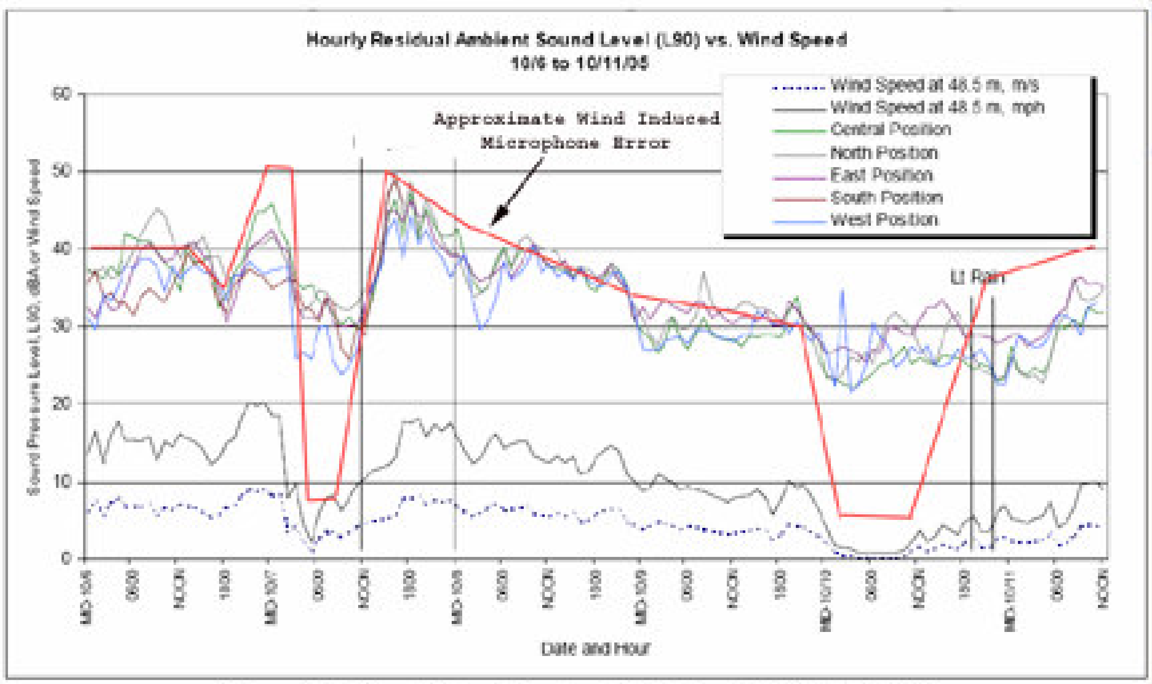



**Figure 2.5.1** *Hourly Sound Levels and Wind Speeds (10/6 to 10/11/05)*

**Fig. 5: Graph of Microphone Measurement Error Superimposed over Field Data**

We can see the source for their astonishment; the microphones are indeed only measuring the microphone wind noise, not the background noise!

A study “Noise Immission from Wind Turbines” (Ref. 4) evaluated some methods of correcting erroneous noise meter measurements:

> “The project has dealt with practical ways to reduce the influence of background noise caused by wind acting on the measuring microphone.”

The report identifies four methods to eliminate microphone error:

> 3.1.1 Reduction of Wind Induced Microphone Noise

Wind induced microphone noise is a major problem in wind turbine noise measurement during strong wind. Four techniques for reducing this so-called pseudo noise were tested in the project.

- *Two microphone cross correlation*. Noise signals from two identical microphones positioned some distance apart were analyzed applying correlation technique to suppress wind induced noise components, which are uncorrelated in the two signals[4]
- *Mounting the microphone on a vertical reflecting board.* The board reduces wind velocity at the microphone, screens the noise from any source behind the board, and causes pressure doubling (+6 dB) for sources in front of the board.
- *Directional microphone with supplementary wind shield.* A directional microphone reduces noise from directions other than that of its axis. Wind noise sensitivity of the directional microphone was reduced by mounting a supplementary wind shield.
- *Large secondary wind screen.* An extra wind screen used simultaneously with the normal wind screen reduces wind noise. The attenuation of the acoustic signal when transmitted through the secondary wind screen was measured in an anechoic room and the wind induced noise was measured in the field.

The reduction of wind-induced noise turned out to be more or less the same no matter which of the methods is used…"

None of these correction methods was employed by Hessler. As a reputed "expert" consulting company Hessler should have certainly known about the obvious problems with ambient sound measurement and should have used corrective measures such as listed above.

## 2.2 Vegetation

The Hessler study did not include summer or winter measurements, both important because of the sound absorbing characteristics of the seasons. From the DEC Noise Policy:

A. Environmental Setting and Effects on Noise Levels

4. Time of Year - **Summer time noises have the greatest potential for causing annoyance** because of open windows, outside activities, etc. During the winter people tend to spend more time indoors and have the windows closed. (emphasis added)

## 2.3 Background Measurement Sample Size

Only 5 sites were selected for background noise evaluations yet over 60 turbines are proposed, situated on 24 square miles of the Town. According to SEQR regulations each potential disturbance site should be evaluated for noise impact, not merely 5. Ideally numerous background measurements, within say a 50% attenuation range from each other, should be made around each turbine, both in circular position and also radial distance. As an estimate, approximately 20 measurements should be taken around each location for a total of 1,200 site measurements for the entire project, in order to get a thorough and completely meaningful ambient noise "map". Since this large "saturated" sample is not practical, a statistically valid smaller sample size would be nearly as accurate. However this sample size and confidence interval must be computed using standard statistical methods and will assuredly yield more than 5 sites for a project of this magnitude. Nothing is included in Hessler's report to scientifically substantiate their choices of number of sites or measurement locations.

## 2.4 Noise Predictive Modeling

Hessler discusses the noise modeling software and its application in their section 3.3 "Noise Modeling Methodology". They use the Cadna/A v 3.5 software and provide a town wide contour map of results in Graphic B (Fig. 6 below). There are three noise contours drawn, 50, 45 and 42 dBA. As drawn and according to Hessler's conclusions approximately 20 residences will be affected by the proposed turbine siting. However this contour map is not accurate and since Hessler did not provide the setup parameters for Cadna/A it is not apparent where the errors arise. An excerpt from Graphic B is shown here in Fig 6 below.

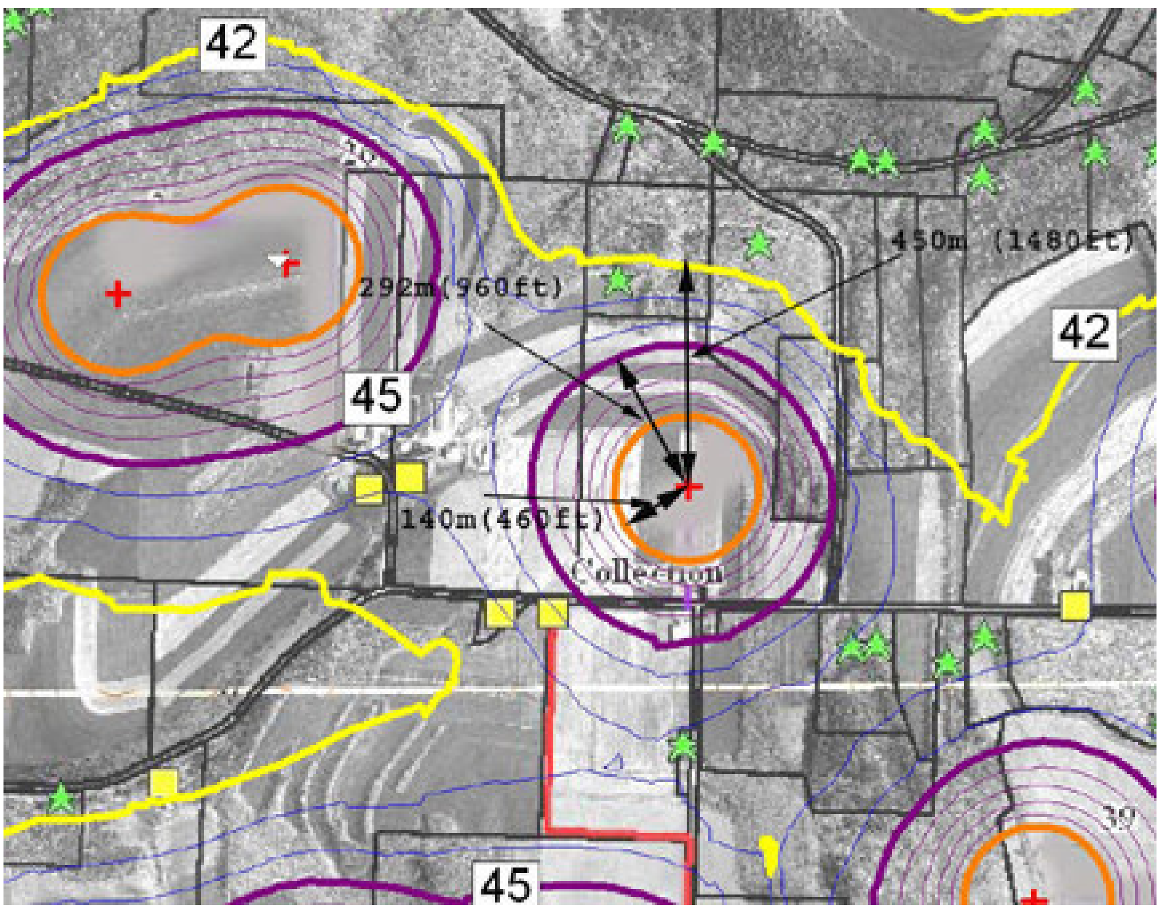



**Fig. 6: Excerpt from Graphic B**

As measured the noise attenuation falls according to the following table:

| Distance from Source (meters, feet) | dBA Noise |
|---|---|
| 0 (turbine) | 105 (Gamesa data sheet) |
| 140 m (460 ft) | 50 |
| 292 (960) | 45 |
| 450 (1480) | 42 |

As will be examined later in this report (Section 3.5 "NASA") these attenuations are far too great and a 105 dBA source is not expected to decline to the 42 dBA range for nearly 1 mile ( 1609 m), not 450 m as indicated by Hessler. This is a very substantial difference of 400%.

If the Graphic B map is approximated with a realistic larger contour displacement for both attenuation distance and a lower dBA "acceptance" limit it is apparent now that over 120 residents will be affected!

## 3.0 Associated Noise Studies from other Regions and Agencies

In the study of complex phenomena or in the manufacture of electrically operated equipment it is common for analysts and manufacturers to use information, studies and standards developed in other countries as a guide. The beneficial sharing builds the knowledge base, prevents undesirable effects and enhances public comfort and safety.

For example with consumer electrical equipment it will often bear a Underwriter's Laboratory (UL) label certification of design and manufacturing safety for U.S. products and also a Canadian Standard's Association (CSA) certification for products sold in Canada since the electrical supply is identical, though the safety measurements and standards are slightly different.

Likewise for wind turbine noise, the noise emanations are similar, turbines are manufactured internationally, and noise measurement methods and reporting units are identical. It is therefore useful to assess other analyses to survey their conclusions, rationale and compare these to the Hessler analysis.

Several other reports identify rural, country ambient sounds as about 30 dBA, or frequently quieter, and that quieter noise levels in the 30 dBA range should be used as opposed to urban environments that frequently allow 50 dBA limits. For example, wind turbines in Europe are more widely established and noise studies there indicate that in terrain similar to many areas of Perry, low noise backgrounds are to be expected, that the wind turbines noises are therefore much more objectionable, and that setbacks up to 1 mile, or more, are needed.

## 3.1 Federal EPA Noise Study

Early in the EPA's founding, circa 1971, it conducted a comprehensive analysis of noise pollution. (Ref 5). Modern urbanization has significantly increased noise pollution in urban areas due to the post-WW II presence of passenger jets and the proliferation of expressways and automobiles. This study includes a variety of sound assessment methods, measurements of noises, receptor acceptance levels and statistical analysis of data. Today the EPA findings are the general underpinning of the NYS DEC's Noise Policy guidance about tolerable noise levels and measurement methods.

From the EPA:

> 3.1 Variation of Outdoor Noise Environment with Location
>
> The range of daytime outdoor noise levels at the 18 locations is presented in Figure 7. The locations are listed from top to bottom of the figure in descending order of their daytime residual noise levels (Lg0). The noisiest location which is outside of a 3rd floor apartment overlooking an 8-lane freeway is at the top of the list with its daytime residual noise level of 77 dB(A). **The rural farm is next to the bottom of the list with its daytime residual noise level of 33 dB(A)**.
> This difference of 44 dB in the residual noise levels of these two locations constitutes a large range in noise climate. Its magnitude clearly implies that all citizens do not enjoy the same "quality" in their noise environment. In fact, the owner of the 3rd floor apartment near the freeway has trouble keeping the apartment rented for more than a month to any one tenant. His problem is not surprising since the outdoor noise level is sufficiently high to render normal speech communication difficult indoors even when the windows are closed.

(emphasis added)

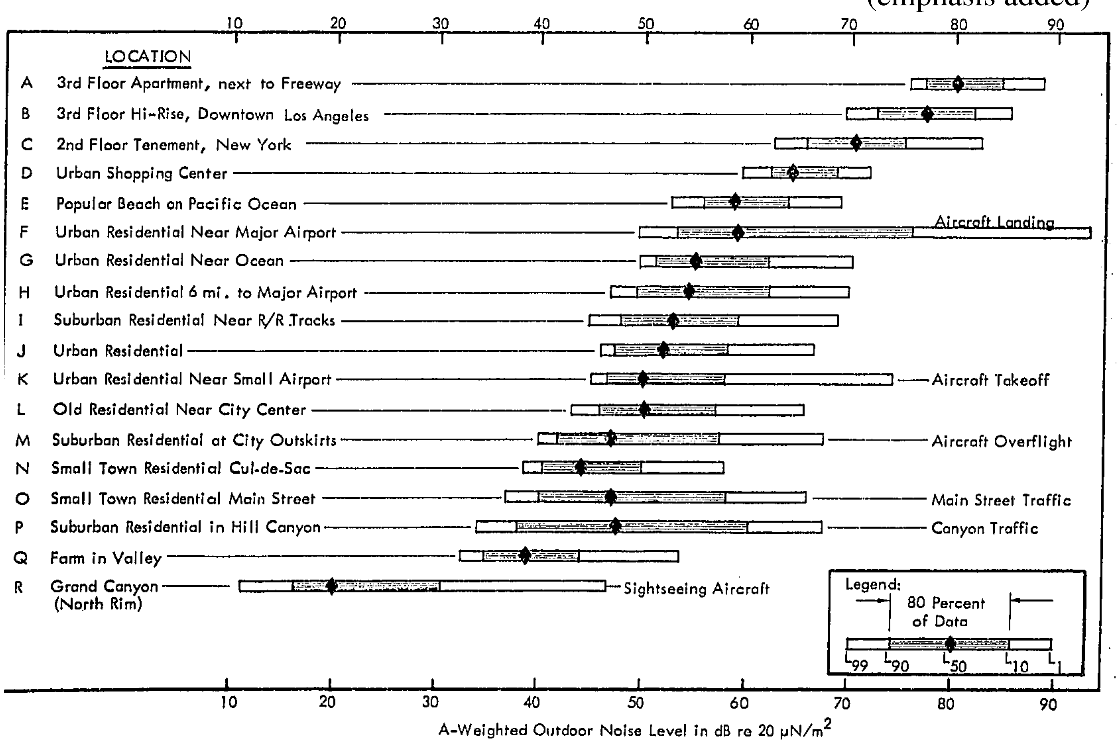



**Fig 7 of EPA Report, Daytime Noise**

From the noise table above we see clearly that a daytime "farm in valley" noise level is less than 40 dBA half the day. At night, from the EPA's Fig 9 table (below) the "farm in valley" is now quieter than 33 dBA half the night and is only above 36 dBA for 10% of the night. The L(90) limit (appropriately used by Hessler as a "most conservative" level) is 29 dBA. The details of the "farm in valley" location are not explicit and it is unknown how closely this site may mimic a Perry site. Perhaps parts of the Dairy Hills Wind Farm site are even quieter at certain times, like the "Grand Canyon (North Rim)" location, showing a mean of 25 dBA and a L(90) of only 21 dBA.

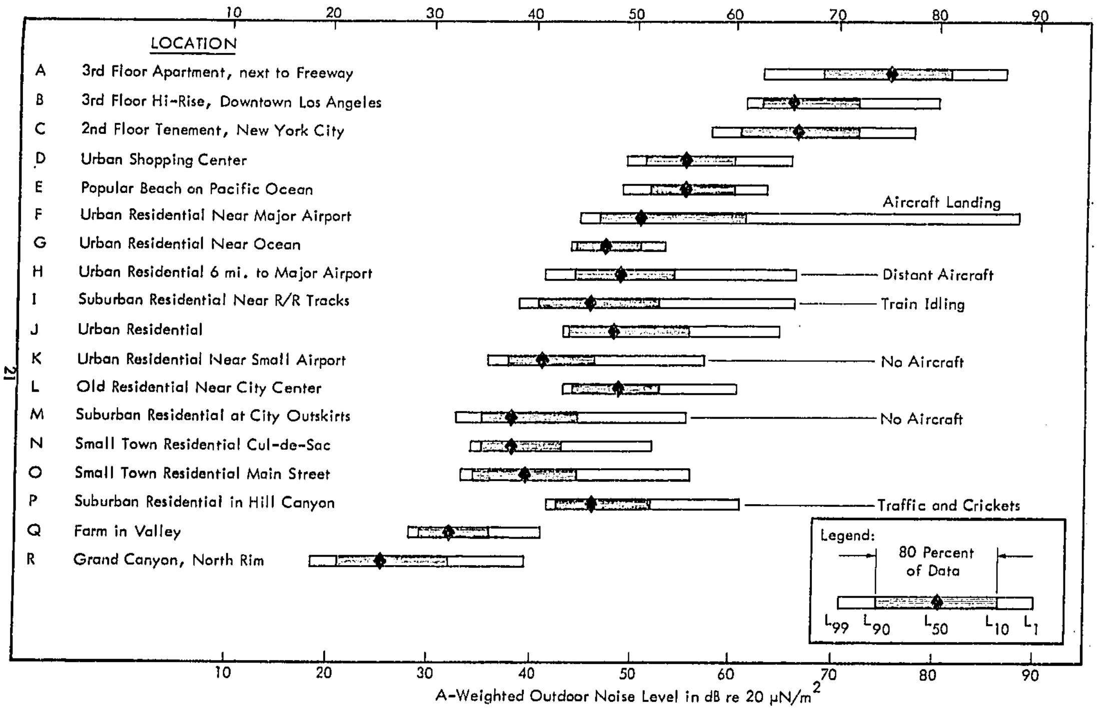



Figure 9. Nighttime Outdoor Noise Levels Found in 18 Locations Ranging Between the Wilderness and the Downtown City, with Significant Intruding Sources Noted. Data are Arithmetic Averages of the 9 Hourly Values in the Nighttime Period (10:00 p.m. - 7:00 a.m.) of the Levels Which are Exceeded 99, 90, 50, 10 and 1 Percent of the Time

**Fig 9 of EPA Report, Nightime Noise**

### 3.2 Canadian Requirements

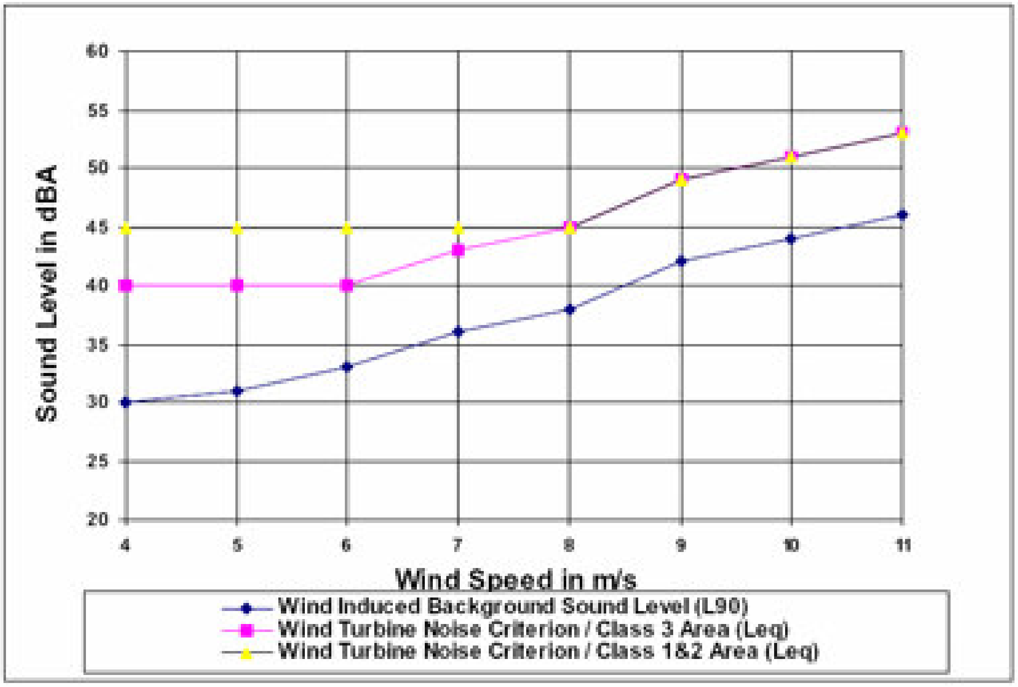
The Ontario Canada Ministry of the Environment has evaluated noise requirement for siting of wind turbines in Ontario Canada (Ref. 6). They publish a graph for various environments with a weighted increase for increasing winds, see Fig. 7 below. The project sponsor identifies predicted noise emissions at a location and compares it with the values in the graph to identify nonconformance. For rural settings the noise limit is 40 dBA over a range of turbine speeds rising to 52 dBA in higher winds.

### 3.3 United Kingdom

The UK Noise Association has extensively studied turbine noise issues. From *Location, Location, Location, An investigation into wind farms and noise by the Noise Association,* by John Stewart (Ref 6):

Wind Farm Noise – the impact on areas of low background noise:
Mid Wales -a land of hills and valleys. A place where the wind blows frequently and the population tends to be thinly spread. Ideal for wind farms. And, not surprisingly, many are planned. The best place very often for the turbines to catch the wind is close to the top of a hill. It means that the wind turbines can be at their most productive. But it also means that the noise may cascade down the surrounding valleys. To makes matters worse, many of the scattered hamlets within the valleys snuggle into corners protected by the hills and the mountains where the background noise level is very low indeed. **You only need to visit these areas to hear the 'swish, swish, swish' of the turbines – particularly downwind – over a mile away from the wind farm.**

(emphasis added)




"Class 3 Area" means a rural area with an acoustical environment that is dominated by natural sounds having little or no road traffic, such as the following:

i. a small community with less than 1000 population;
ii. agricultural area;
iii. a rural recreational area such as a cottage or a resort area; or a wilderness area.

**Fig. 7: Ontario Canada Turbine Noise Acceptance Chart**

The description of Mid Wales above describes portions of the wind farm siting area. The prevailing (urban) UK national guidelines for noise limits are (from Stewart)

• Daytime noise levels outside the properties nearest the turbines should not exceed 35-40dB(A) or 5dB(A) above the prevailing background, whichever is the greater.
• Night noise limits outside the nearest property should not exceed 43dB(A) or 5dB(A) above the prevailing background, whichever is the greater.

But in areas like Mid Wales, the guidelines are deemed by the UK Noise Association to give noise levels **too high**. Likewise, a lower noise threshold in the 35 dBA range is to be anticipated for the Dairy Hills Wind Farm area. The DEC Noise Policy gives acceptable noise levels about 6 dBA higher than the prevailing background, 3 dBA for sensitive persons. The background must be accurately measured however.

Further corroboration pertaining to Scotland siting comes from Dick Bowdler, "a noise and acoustic consultant for more than 30 years and most of my current work is dealing with the assessment of environmental noise as it affects residential properties. I work equally for those potentially creating noise and those affected by it. I have been a supporter of wind energy and other forms of renewable energy for some 35 years. " (Ref. 8) Continuing, he says:

> In practice, in most rural areas, my rule of thumb is that the nearest turbine needs to be at least 1¼ **miles from any house**. However, these are areas where the background noise level can be 20dBA at night**. You suggest that your background noise level could be 30-32dB. This seems a likely figure if you have 350 houses in the area, though I suspect it could be a bit lower than this**. On this basis, **noise from the wind farm should not exceed 35dBA**. If the developers are suggesting that 55 decibels is acceptable, this is quite outrageous. 55dBA is more than four times as loud as your background noise.
>
> Most of the Scottish wind farms that have recently been approved have no housing closer than about 1 mile, except where the house belongs to the landowner of the wind farm site. There are a few applications with houses as close as about 2000 feet but these have all either been turned down or withdrawn by the developer.
>
> I am not familiar with the GE turbines, but I suspect that they have a sound power level of about 105dBA. In this case, the noise level would be between 45 and 50dBA at 1400 feet in neutral weather conditions and if the nearest turbines were in full view. (emphasis added)

### 3.4 Sweden

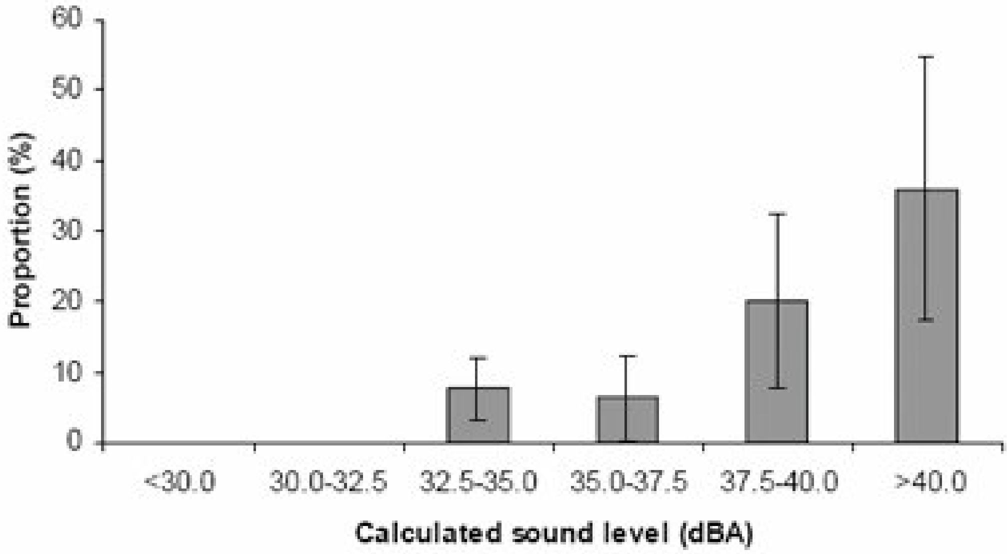
The Swedish Environmental Protection Agency (SEPA) published a report "Noise Annoyance from Wind Turbines – a review" (Ref. 9). This report "reviews the present knowledge on perception and annoyance of noise from wind turbines in residential areas as well as in recreational areas."

The study relates information useful for two criteria: perception and objection.
Each receptor location, turbine location, vegetation and terrain may have a marked impact on turbine noise perception. This is particularly important in geographies having many undulating hills. From the study:

> Topographical conditions at site have importance for the degrees to which the noises from wind turbines are masked by the wind. Dwellings that are positioned within deep valleys or **are sheltered from the wind in other ways may be exposed to low levels of background noise, even though the wind is strong at the position of the wind turbine** [Hayes 1996]. The noise from the turbine may on these conditions be perceived at lower sound pressure levels then expected. Current recommendation state that measures and sound propagation calculations should be based on a wind speed of 8 m/s at 10 meter above the ground, down wind conditions, creating a "worst case" scenario. This recommendation does not consider the case described above.
>
> (emphasis added)

Also the objection to noise was categorized by a well composed, statistically valid survey of a variety of residents near a moderate-power (600 KW/unit) wind turbine installation. The study setup parameters are given below, followed by Fig. 8, a "chart of annoyance" from the report summarizing the results.

SWEDISH ENVIRONMENTAL PROTECTION AGENCY Report 5308
Noise annoyance from wind turbines – a review




The proportions very annoyed by noise outdoors from wind turbines (95%CI) at different A-weighted sound pressure levels [Pedersen and Persson Waye 2002].

**Fig. 8: Chart of Very Annoyed Respondents**

The Swedish study was performed in Laholm during May-June 2000. The areas chosen comprised in total 16 wind turbines thereof 14 had a power of 600 kW. The study base comprised one randomly selected subject between the ages of 18 and 75 in each household living within a calculated wind turbine sound pressure level of 25 to 40 dBA (n=518).

The annoyance was measured using a questionnaire. The purpose of the study was masked and among questions on living conditions in the countryside, questions directly related to wind turbines were included. Annoyance from several outdoor sources was asked for regarding the degree of annoyance both outdoor and indoor. Annoyance was measured with a 5-graded verbal scale ranging from “do not notice” to “very annoyed”. The same scale was used for measuring annoyance from wind turbines specifically (noise, shadows, reflections, changed view and psycho-acoustical characters). The respondents’ attitude of the impact of wind turbines on the landscape scenery and the attitude to wind power in general were also measured with a 5-graded verbal scale, ranging from “very positive” to “very negative”. Questions regarding living conditions, health, sensitivity to noise and employment were also included. A total of 356 respondents answered the questionnaire, which gave a total response-rate of 69%.

For each respondent calculated A-weighted sound pressure level as well as distance and direction to the nearest wind turbine were obtained. Sound pressure levels (dBA) were calculated at 2.5-decibel intervals for each household. The calculations were done in accordance with [Naturvårdsveket 2001] and reflect downwind conditions. Data of distance between the dwelling of the respondent and the nearest wind turbine, as well as the direction, was obtained from maps.

The correlation between noise annoyance from wind turbines and sound pressure level was statistically significant (rs=0.399; n=341; p<0.001). **The annoyance increased with increasing sound pressure level at sound pressure levels exceeding 35 dBA**. No respondent stated them selves very annoyed at sound pressure levels below 32.5 dBA (Fig. 1). **At sound pressure levels in the range of 37.5 to 40.0 dBA, 20% were very annoyed and above 40 dBA 36%.** The confidence intervals were though wide; see Figure 1.

(emphasis added)

Note that about 40% of the participants find turbine sounds above 40 dBA "very objectionable". Even 32.5-35 dBA are "very objectionable" to 10 % of respondents. This study should serve as a direct warning that residents will strongly object to the Dairy Hills Wind Farm project if sited as planned, or other wind farms sited according to the Perry town law, discussed below. After turbine farms are operational, with finality and permanence, resident "receptors" will have no recourse for any mitigation other than to physically move away. What price will they receive for their real estate when prospective buyers find that the seller is moving because they can't tolerate the noise?

Also of interest from the Swedish EPA study are comments relating to wilderness areas pertaining to parts of the Dairy Hills Wind Farm site.

3.3 Perception of noise from wind turbines in wilderness recreational areas

The special soundscape of wilderness recreational areas has been described by a number of authors, e.g. [Miller 2001, Dickinson 2002]. **The soundscape differs from site to site and can be very quiet in remote areas, especially when vegetation is sparse** (as in the Swedish bare mountain region). In a comparison between different outdoor settings in USA, it was found that the sound pressure level in a suburban area at nighttime was above 40 **dBA**, along a river in Grand Canyon 30-40 dBA and **at a remote trail in the same park 10-20 dBA** [Miller, 2002]. **The effect of intruding sound should be judged in relation to the natural ambient soundscape. The sound pressure level of the intruding sound must be compared to the sound pressure levels of the background noise**. The durability of audibility is another variable of importance for understanding visitors' reactions to noise [Miller 2001].

No studies on noise from wind turbines in wilderness areas have to my knowledge been carried out, but the effect of noise from other sources has been discussed in a few articles. A larger study on noise annoyance from aircraft over-flights on wilderness recreationists was performed in three wilderness areas in USA [Fidell et al 1996]. (emphasis added)

**3.5 NASA**

Noises carry greater distances from elevated noise sources like wind turbines and this has been reported by NASA in a study *Wind Turbine Acoustics* by Hubbard and Shepherd (Ref. 10) From the Introduction:

Wind turbine generators… are producing electricity both singly and in wind power stations that encompass hundreds of machines. Many installations are in uninhabited areas far from established residences, and therefore there are no apparent environmental impacts in terms of noise. There is, however, **the potential for situations in which the radiated noise can be heard by residents of adjacent neighborhoods, particularly those neighborhoods with low ambient noise levels**. …

(emphasis added)

This report contains detailed noise analyses of various wind turbine styles – upwind rotors vs. downwind rotors, blade shape, rotational speed etc. And it includes a detailed sound propagation analysis. Sound “bends” (refracts) in the atmosphere much like light refracts in striking a lens. A graph of the effect, from the report, is shown in Fig. 9 below.

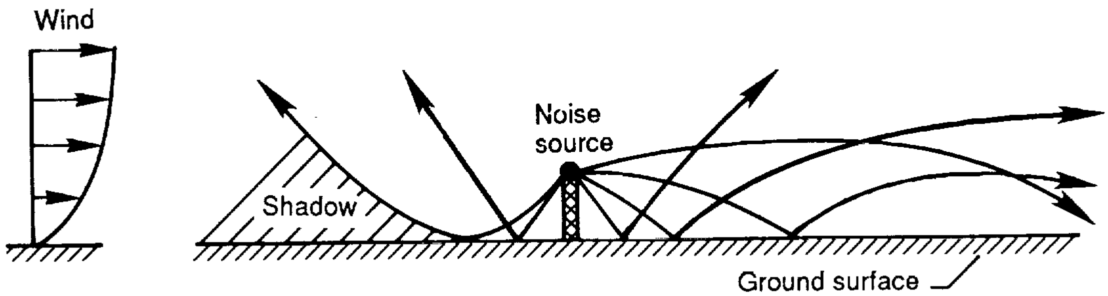



**Figure 7-20. Effects of wind-induced refraction on acoustic rays radiating from an elevated point source** [Shepherd and Hubbard 1985]

**<u>Fig. 9: Sound Refraction Effects (NASA Fig 7-20)</u>**

The “Shadow” zone in the figure may explain the observed “quietness” experienced by observers when taken to stand near wind farm turbines such as the Fenner wind farm. The noises are masked unless the observer is 4x the tower height distance. And it underscores the necessity of comprehensive and accurate engineering studies of complex phenomena. Merely relying on anecdotal “I don’t hear anything” knee jerk responses to a turbine visit is misleading and hardly equivalent to living year round as a saturated “receptor”.

Recall from the Mid Wales description above that turbine sounds carry one mile. This is shown in the NASA study as well, Fig. 10 below, for a single “point source” turbine. The sounds carry further for a “line” of turbines and many wind farms do have linear clusters of turbines along a hill ridge making the situation 6 dB worse.

From Fig. 10 it can be seen that the sound drops about 30 dB (for 1000 Hz, the most sensitive to human hearing) at 1,000 meters (about 3,000 ft). The Gamesa wind turbine spec sheet lists about a 100 dBA noise level at the turbine. (Ref 1, Table 3.3.2) and therefore at 3,000 ft the noise is 100-30 = 70 dB. At one mile (5280 ft = 1609 meter) the chart, which has a logarithmic scale, gives about a 60 dB drop, or 40 dB remaining (100 - 60 = 40). The 40 dB figure is about what the Europeans use for their noise boundary, with a1 mile setback too. Notice that for low-frequency sounds, such as the blade-support tower induced “whosh” (250 Hz on the graph), that the sound carries much further, out to 2 miles.

To confirm the reasonableness of the NASA report one can look again at the DEC Noise Policy (Table C, “Projected Noise Levels”) and find for example a Hitachi earth moving shovel starting at 92 dBA then falling to 56.5 dBA at 3,000 ft, a decline of 35 dBA. Comparing with Fig. 10 again we find NASA predicts a 35 dB drop at 1,000 m (3,000 ft), in good agreement with the DEC. Therefore we can easily conclude that reasonable setbacks for wind turbines should be in the neighborhood of **1 mile**, far in excess of the Hessler conclusions.

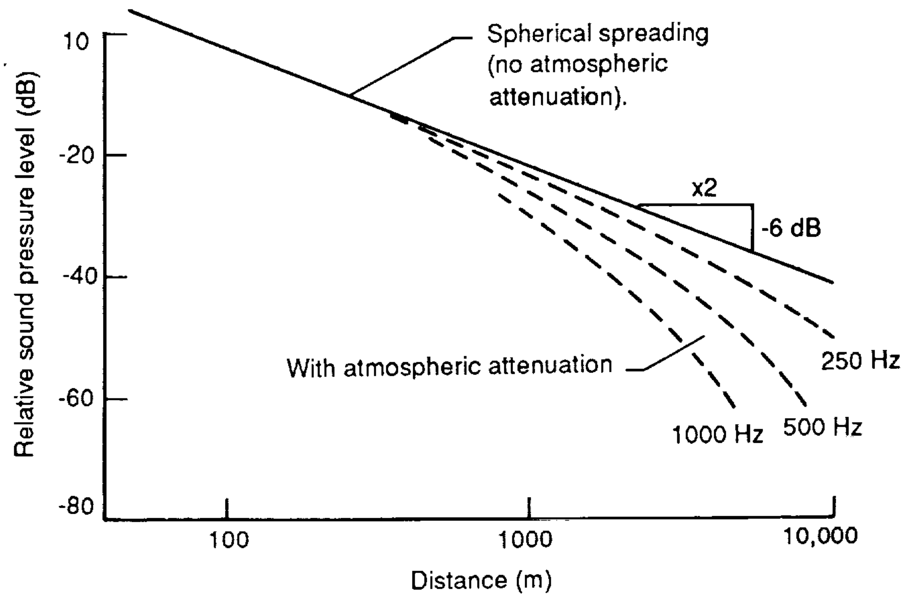



**Figure 7-18. Decrease in sound pressure levels of pure tones as a function of distance from a point source** [ANSI 1978]

**Fig. 10: From NASA "Wind Turbine Acoustics" (Ref 6)**

### 3.6 WHO Sound Levels for Night Sleeping

The World Health Organization (Ref. 11) has begun conducting comprehensive analysis of the health impairment due to night time noises and disturbance to sleep. Though targeting the effects from aircraft and highway noises the conclusions can be associated with wind turbines, since those studies have not yet begun.

The WHO conclusions to date should serve as a guide and warning.

> Conclusions:
>
> 8. **There was unanimous agreement that disturbed sleep had serious health** effects – solid evidence existed in sleep medicine, the insomnia model would be used as a proxy and its causes and effects described on the final document.
>
> 9. The analysis of the evidence suggested **that Lnight outdoor>42 dB(A) induced sleep disturbances.**
>
> 18. The NOAEL for Myocardial Infarction was Lday = 60–65 dB outdoors **and Lnight outdoors = 50 – 55 dB** for road traffic. (see footnote 1)[1] (emphasis added)

---

[1] As the report discusses there is an association between long term noise exposure and heart attack (myocardial infraction or MI):

## 4.0 Perry Town Law

Hessler refers to a new Perry wind farm siting law:

> 3.1.1 REGULATORY NOISE LIMITS
> It is our understanding that a local (Town of Perry) noise ordinance is being, or has recently been, established that limits noise from any wind energy conversion facility to a maximum of 50 dBA at any residential structure "on parcels not owned by persons having a lease or noise easement with the project owner or developer".

The Town of Perry did enact a local law (Ref. 12) that includes a noise limit:

> Section 7- Noise.
> Wind Energy Conversion Facilities shall be operated so that the noise produced during operation will no t exceed fifty (50) dBA, measured at residential structures on parcels owned by persons not having a lease or noise easement with the project developer or owner.

Referring back to the EPA's Daytime graph it can be seen that 50 dBA corresponds heavily to noises from a wide variety of urban settings, not rural farmland.

Enactment of a Town Law changing allowable land uses requires a SEQR review prior to enactment. I spoke today with Mr. Nelson today, of Dadd and Nelson, the Perry town attorney's for this project. Mr. Nelson stated that no SEQR review was conducted for the town law. This is clearly contrary to NYS CRRR Part 617 laws:

> § 617.2 DEFINITIONS.
> As used in this Part, unless the context otherwise requires:
> (a) Act means article 8 of the Environmental Conservation Law (SEQR).
> (b) **Actions** include:
> (1) projects or physical activities, such as construction or other activities that may affect the environment by changing the use, appearance or condition of any natural resource or structure, that:
> (i) are directly undertaken by an agency; or
> (ii) involve funding by an agency; or
> (iii) require one or more new or modified approvals from an agency or agencies;

---

(1) continued **Sufficient evidence existed for an association between community noise and ischaemic heart diseases;** limited/sufficient evidence existed for an association between community noise and hypertension. Most information came from road traffic noise studies but there was normally little information regarding night noise in particular. But **night time values could be extrapolated from day time results.**
Below 60 dB(A) for Lday there was no noticeable increase in MI risk to be detected. Therefore for the time-being, Lday = 60 dB(A) could be set as the NOAEL ("no observed adverse effect level") for road traffic noise and myocardial infarction (Babisch, 2002). For noise levels greater than 60 dB(A), the MI risk increased continuously, and was greater than 1.2 for noise levels of 70 dB(A).
*Discussion*
**Normally CVD effects manifested themselves after 10 years living in a noisy area**.
(emphasis added)

> (2) agency planning and policy making activities that may affect the environment and commit the agency to a definite course of future decisions;
> (3) **adoption of agency rules, regulations and procedures, including local laws, codes, ordinances, executive orders and resolutions that may affect the environment**; and
> (4) any combinations of the above.

§ 617.3 GENERAL RULES

> **(a) No agency involved in an action may undertake, fund or approve the action until it has complied with the provisions of SEQR**
>
> (emphasis added)

Also this is a Type I action since it involves more than 25 acres of the Town and therefore the SEQR process generally requires preparation by the Town of an EIS. That EIS preparation requires public hearings. All SEQR documents are required to be readily available for public review and inspection (NYCRR Part 617.12) and findings are required to be published through the DEC's Environmental Notices Bulletin.

As part of the SEQR review the establishment of the 50 dBA noise limit needs a rationale justification, the number can't be pulled out of thin air or from other town's ordinances. This is corroborated by the DEC Noise Policy:

> Where activities may be undertaken as a "right of use", it is presumed that noise has been addressed in establishing the zoning.

Hessler attempts to show in its results that there are no residences exceeding the Town law:

> Project noise will not exceed the local ordinance limit of 50 dBA at any residence.

SEQR rules do not permit adherence to an unsubstantiated and improperly enacted local law, or one that is less protective of the environment.

## 5.0 Conclusion

Occupying 24 square miles of the towns, the Dairy Hills Wind Farm project is very large and has a potentially large "noise footprint". Hessler tries to conclude, by a variety of methods, that "the project is unlikely to constitute a significant adverse community impact." Also:

> At an 8 m/s wind speed, measured at the standard reference height of 10 m above ground level, the Gamesa G87 (or G90) wind turbine produces the maximum amount of noise. At this wind speed the mean background residual (L90) sound level was found to be **44 dBA**, meaning that such a sound level is consistently present and available to mask potential turbine noise.

However using its flawed background analysis Hessler derives a 44 dBA "ambient", far above the expected, attenuates the noises in its modeling far more than expected and tries to avoid required mitigation measures required for <u>each</u> affected resident, not the project's noise impact on the community at large.

An accurate and comprehensive noise analysis is essential but clearly the Hessler study must be repeated with far better analysis in terms of a) reasonably accurate background levels b) inclusion of summer vegetation and winter snow c) statistically valid measurement sites that comprehensively represent the likely intrusion on non-leaseholder lands and dwellings and d) reasonable computer modeling to show noise contours encompassing likely atmospheric effects.

These requirements must be satisfied to conform to the Noise Policy and SEQR rules:

> In circumstances where noise effects cannot readily be reduced to a level of no significance by project design or operational features in the application, the applicant **must evaluate alternatives and mitigation measures in an environmental impact statement to avoid or reduce impacts to the maximum extent practicable** per the requirements of the State Environmental Quality Review Act.

Many sites may be found to be unsuitable for use due to unacceptably high noise levels <u>requiring</u> higher setbacks, with 1 mile an expected outcome from a genuine study. Mitigation suggestions from the DEC Noise Policy include "increasing the setback distance". It is entirely likely that other turbine locations must be sought, or the scale of the wind farm must be reduced.

Richard H. Bolton , CV in Appendix 1

**References**


1. *Environmental Sound Survey and Noise Impact Assessment*, Dairy Hills Wind Farm Project, Perry NY, Hessler Associates, Inc., Report No. 1761-110305-C, May 3, 2006

2. *Assessing and Mitigating Noise Impacts,* New York State Department of Environmental Conservation Program Policy, Department ID: DEP 00-01, Rev: Feb 2, 2001

3. *The sound of high winds: the effect of atmospheric stability on wind turbine sound and microphone noise,* Godefridus Petrus van den Berg, Rijksuniversiteit, Groningen Netherlands, May 2006, Chapter 8, “Rumbling Wind: wind induced sound in a screened microphone”

4. *Noise Immission from Wind Turbines* , United Kingdom’s Energy Technology Support Unit , Feb 10, 1999

5. *Community Noise,* US EPA Office of Noise Abatement and Control, by Wyle Laboratories under Contract 68-04-0046, Dec. 31, 1971.

6. *Interpretation for Applying More NPC Technical Publications to Wind Turbine Generators* **,** Ministry of the Environment, Ontario Canada**,** Version 1.0, July 6, 2004

7. *Location, Location, Location, An investigation into wind farms and noise by the Noise Association,* by John Stewart, UK Noise Association, London, July 2006.

8. Private communication from Dick Bowdler, New Acoustics Co., Scotland, U.K., to Sue Sliwinski, Oct. 16, 2002, used with permission.

9. *Noise Annoyance from Wind Turbines – a review*, by E. Pedersen and H. Halmstad, Naturvårdsverket, Report 5308, Swedish Environmental Protection Agency, ISBN 91-620-5308-6.pdf, August 2003.

10. *Wind Turbine Acoustics* NASA Technical Paper 3057, H. Hubbard and K.Shepherd ,1990

11. *Report on the third meeting on night noise guidelines,* WHO European Centre for Environment and Health, Bonn Office Lisbon, Portugal, 26–28 April 2005

12. *Town of Perry Wind Energy Conversion Facilities Siting Law*, Local Law Number 1 for 2006, filed January 31, 2006.

## Appendix 1

Richard Bolton
264 East Lake Road
Rushville, NY 14544
Tel 585 554 3809
Email: barehill@aol.com

I graduated from the University of Rochester in 1975 with a B.S. in Physics and subsequently took graduate courses in optics there.

From 1975 to my retirement in 1998 I was a Project Engineer at Eastman Kodak and receive 5 US Patents. Always working in new product research, engineering and development I was often involved in "due diligence" engineering analysis for new product proposals throughout the corporation. This involved considerations of manufacturability, reliability, ergonomics, customer acceptance, and design methodology. My work was cross-disciplinary because of my physics background and my exposure within Kodak to many other scientists and engineers. I often worked in engineering disciplines of optical design, mechanical design, systems design, and product software.

From 1976 to 1986 I had the position of Adjunct Faculty, Rochester Institute of Technology, Physics Laboratory.

From 2005 to present I have been a Technician at Hobart and William Smith Colleges' Physics Department, where I am responsible for laboratory setup, physics equipment parts manufacture, and devising new demonstrations.

I am President of Bare Hill Software Company that develops engineering software for Macintosh and Microsoft personal computers. In that capacity I served as consultant engineer to Eastman Kodak, Corning Glass, and Xerox on various equipment projects.

I am President of the Environmental Compliance Alliance founded to promote public and government agency awareness of New York State and Federal environmental regulations, and promoting agency compliance with those regulations.

In my professional experience I have learned to examine and analyze technical reports, especially with regard to methodological, technical and statistical errors. I recently consulted on a wind turbine project slated for Clinton County in upstate NY. My noise analysis is being used in a proceeding there.

###