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APPENDIX 8

RESOURCE SYSTEMS ENGINEERING PRESENTATION TO THE TOWN OF OAKFIELD

JULY 22, 2009

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TOWN OF OAKFIELD
WIND ENERGY WORKSHOP SESSION

JULY 22, 2009

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EVERGREEN WIND POWER II, LLC
OAKFIELD WIND PROJECT
AROOSTOOK COUNTY, MAINE
SOUND LEVEL ASSESSMENT

SOUND LEVEL PREDICTION MODEL

- METHODOLOGY
- ASSUMPTIONS
- RESULTS

POST CONSTRUCTION MONITORING

- PURPOSE
- METHODOLOGY
- RESULTS

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EVERGREEN WIND POWER II, LLC
OAKFIELD WIND PROJECT
AROOSTOOK COUNTY, MAINE

SOUND LEVEL ASSESSMENT

Prepared by:

Resource Systems Engineering
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File 080130

APRIL 2, 2009

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SOUND LEVEL PREDICTION MODEL

METHODOLOGY

- Project and Land Use Mapping
- Turbine Layout
- Topography
- CADNA/A Software Platform
- International Standards for Outdoor Sound Propagation
- International Standards for Wind Turbine Sound Level
- Model Calibration based on Wind Turbine Measurements

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MODEL INFORMATION

TOPOGRAPHY

- 3D Terrain Model based on USGS Topographic Contours
- Turbine base elevations – 910 to 1430 feet above msl
- Turbine layout – north and south cluster

LAND USE

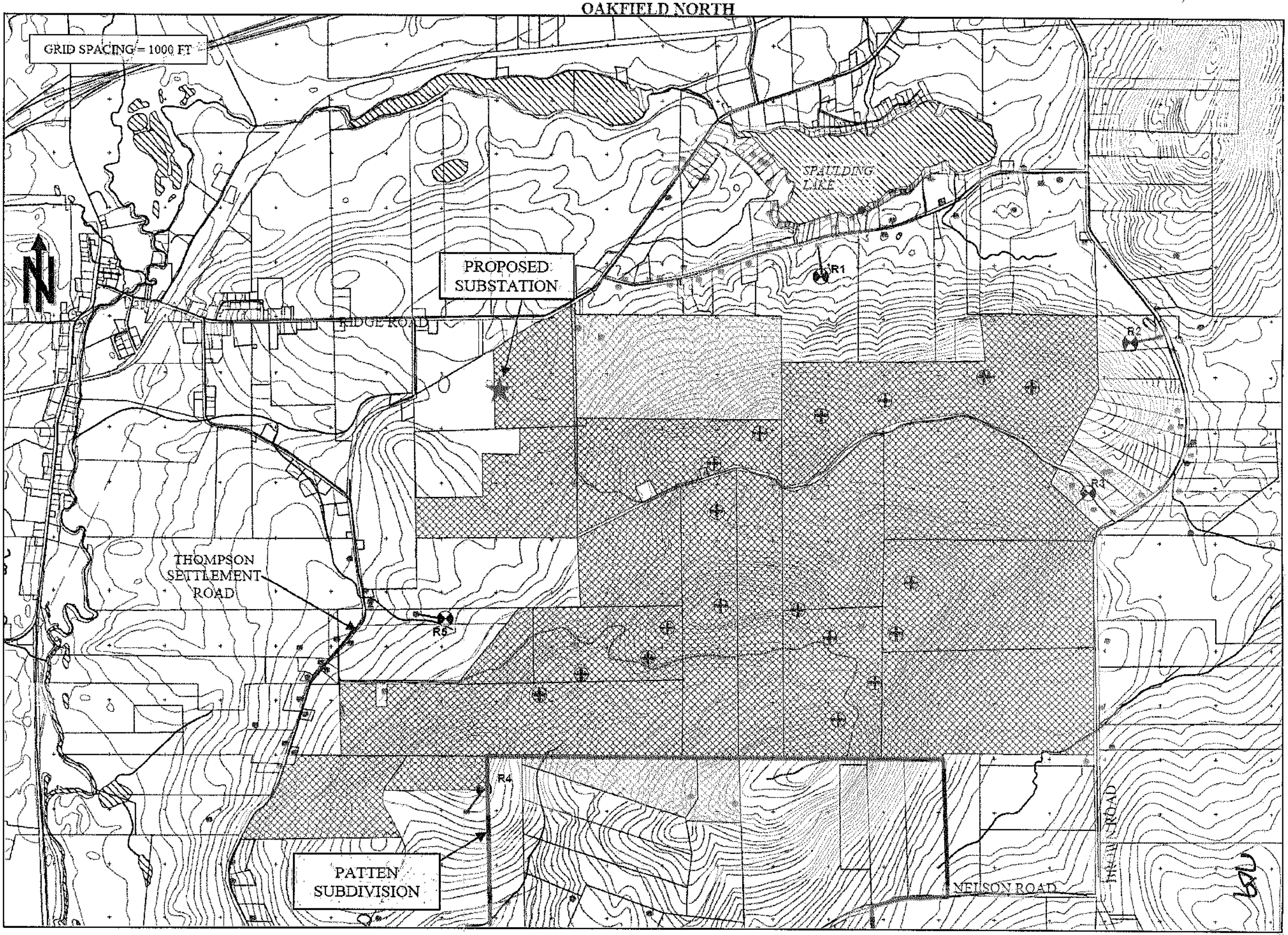
- Parcel boundaries per First Wind survey and local tax maps
- Structures per aerial photography and field verification

RECEIVER POSITIONS

- Highest predicted sound levels relative to Maine DEP nighttime limits
- Exclude parcels leased by Evergreen Wind
- Exclude parcels that require sound easements

FIGURE 3. VICIN[illegible]Y SITE PLAN (1 OF 2)

OAKFIELD NORTH



WIND TURBINE LOCATION
DWELLING LOCATION
LEASED OR PURCHASED
SOUND EASEMENT
RECEIVER POSITION

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FIGURE 3. VICIN[illegible] SITE PLAN (2 OF 2)
OAKF[illegible]LD SOUTH

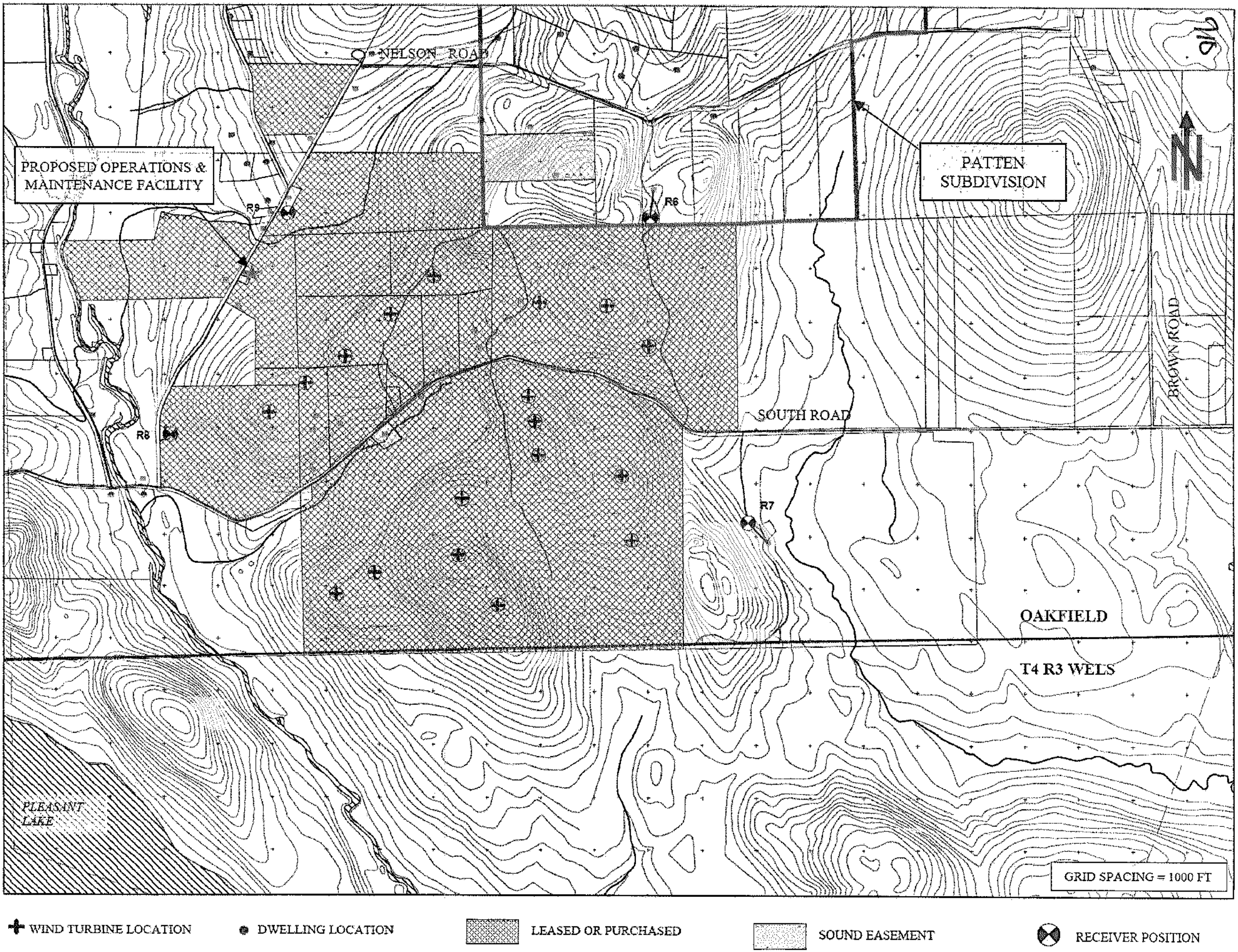

Table 1

Maine DEP Hourly Sound Level Limits (dBA)

Receiver Point[A]	Description	Distance From Nearest Wind Turbine (ft)	Maine DEP Hourly Limit (dBA) Daytime	Nighttime	Limit Basis
R1	Residential parcel off Spaulding Lake Road north of Oakfield North	2,550	55	45	Quiet limits at protected location within 500 feet of existing dwelling
R2	Residential parcel off Brown Road northeast of Oakfield North	1,950	55	45	Quiet limits at protected location within 500 feet of existing dwelling
R3	Residential parcel off Brown Road east of Oakfield North	2,160	55	45	Quiet limits at protected location within 500 feet of existing dwelling
R4	Residential parcel off Nelson Road southwest of Oakfield North	1,990	55	45	Quiet limits at protected location within 500 feet of existing dwelling
R5	Residential parcel off Thompson Settlement Road west of Oakfield North	2,200	55	45	Quiet limits at protected location within 500 feet of existing dwelling
R6	Residential parcel off Nelson Road northeast of Oakfield South	1,850	55	45	Quiet limits at protected location within 500 feet of existing dwelling
R7	Residential parcel off South Road east of Oakfield South	2,190	55	45	Quiet limits at protected location within 500 feet of existing dwelling
R8	Residential parcel off Thompson Settlement Road west of Oakfield South	1,860	55	45	Quiet limits at protected location within 500 feet of existing dwelling
R9	Residential parcel off Thompson Settlement Road northwest of Oakfield South	2,690	55	45	Quiet limits at protected location within 500 feet of existing dwelling

[A]See Figure 3, Vicinity Site Plan.

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MODEL FRAMEWORK/ASSUMPTIONS

WIND TURBINES

- GE 1.5 sle Series wind turbines – three blade rotor diameter 77 m / 253 feet
- Tower height = 80 m / 262 feet (base to rotor hub)
- Total height = 118.5 m / 389 feet base to tip of vertically extended rotor blade
- Includes 36 potential Wind Turbine sites – 34 turbines will be constructed
- Sound Power Level as a Point Source at turbine hub in accordance with IEC 61400-11: 2002
- Uncertainty /Confidence Interval = ± 2.0 dB
- Full Continuous Sound Power at Hub Height Wind Speed = 9 m/s (20.1 mph)
- Model Calculations –turbines operating at full continuous sound power on all 36 possible sites
- Rotor blade not specified and as available in 2005
- Cut-in Wind Speed = 3 m/s (6.7 mph)
- 4 dBA less at 7 m/s (15.7 mph)
- Full Electric Power Generation reached at 11.5 m/s (25.7 mph)

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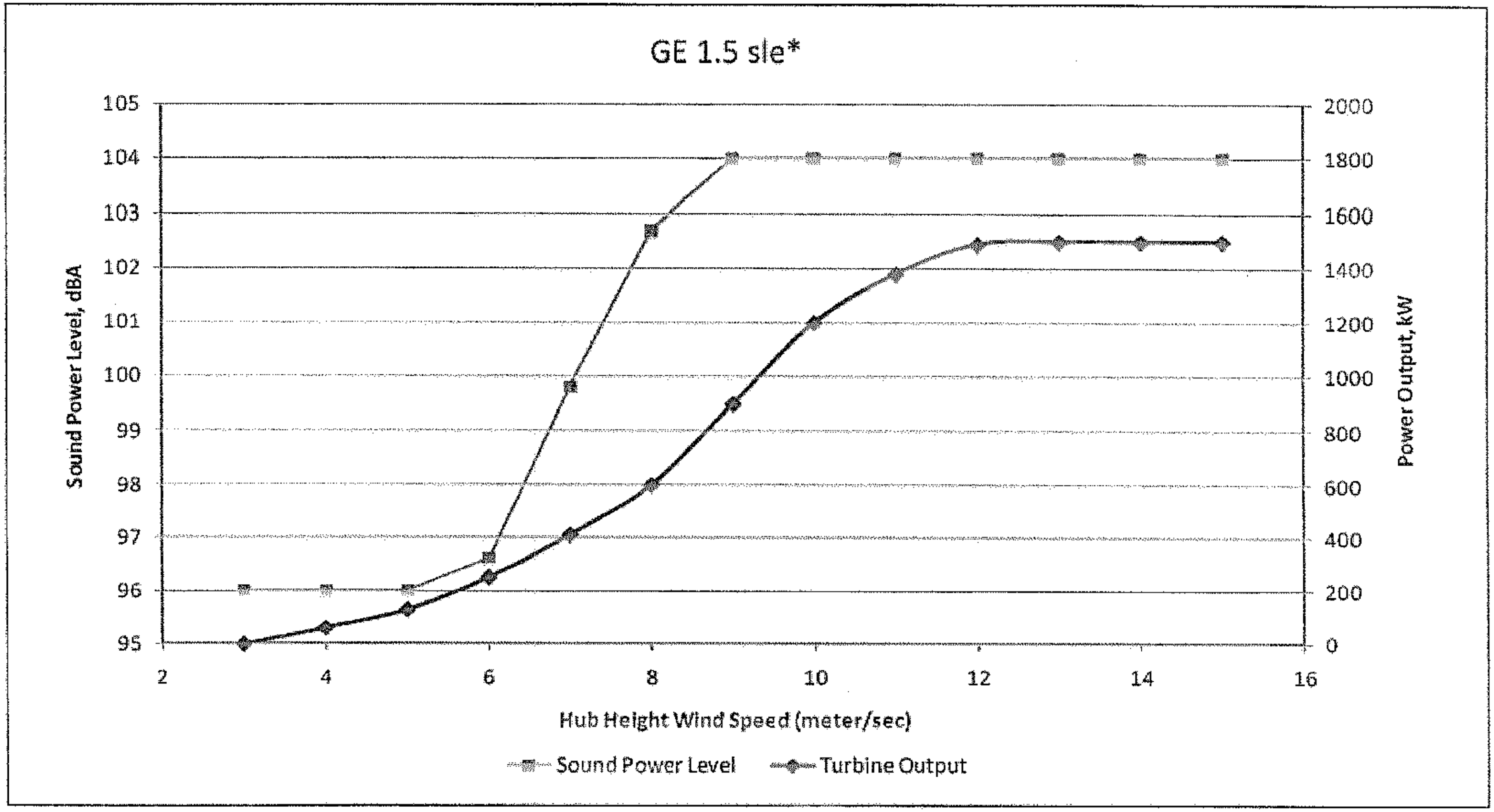
Figure 4. Sound Power Level and Power Output of GE 1.5 sle Wind Turbine in Relation to Hub Wind Speed



**Excludes Uncertaintly Factor of ± 2 dBA per GE Technical Documentation – Noise Emission Characteristics (2005) and Confidence Level of +2dBA per GE Technical Specification – Noise Emission Compliance, GE Wind Energy, May 2005.*

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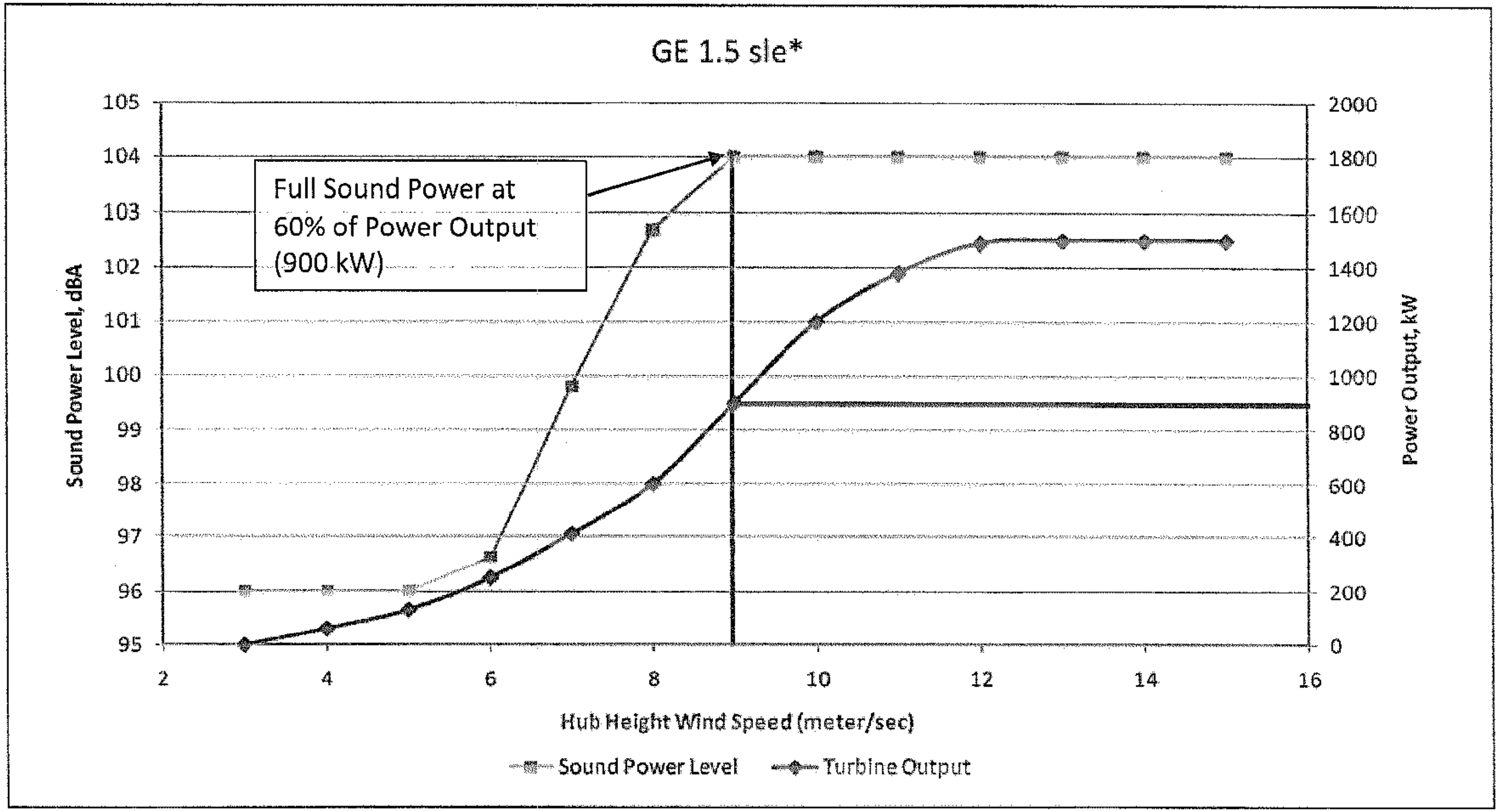
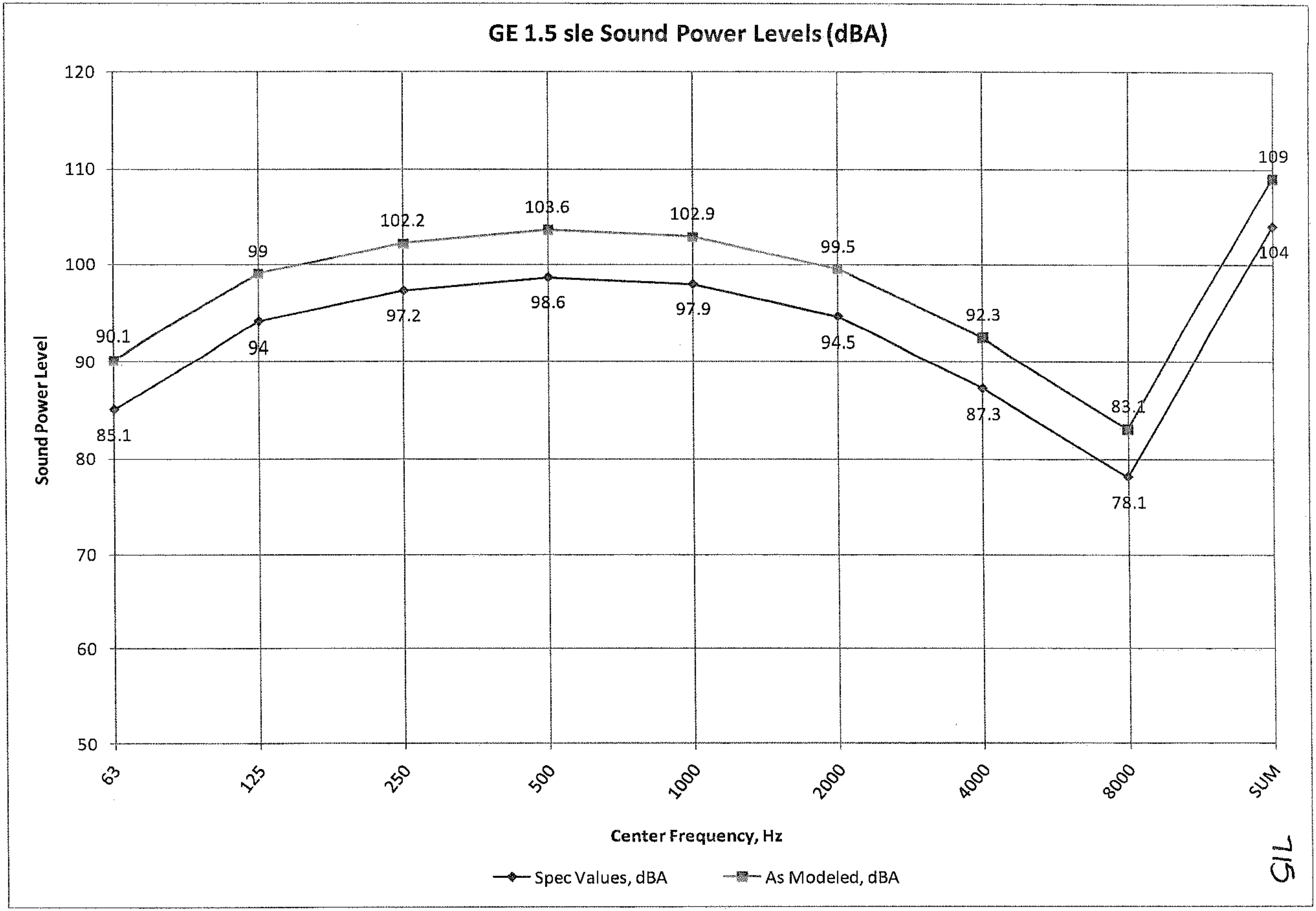
Figure 4. Sound Power Level and Power Output of GE 1.5 sle Wind Turbine in Relation to Hub Wind Speed



**Excludes Uncertaintly Factor of ± 2 dBA per GE Technical Documentation – Noise Emission Characteristics (2005) and Confidence Level of +2dBA per GE Technical Specification – Noise Emission Compliance, GE Wind Energy, May 2005.*



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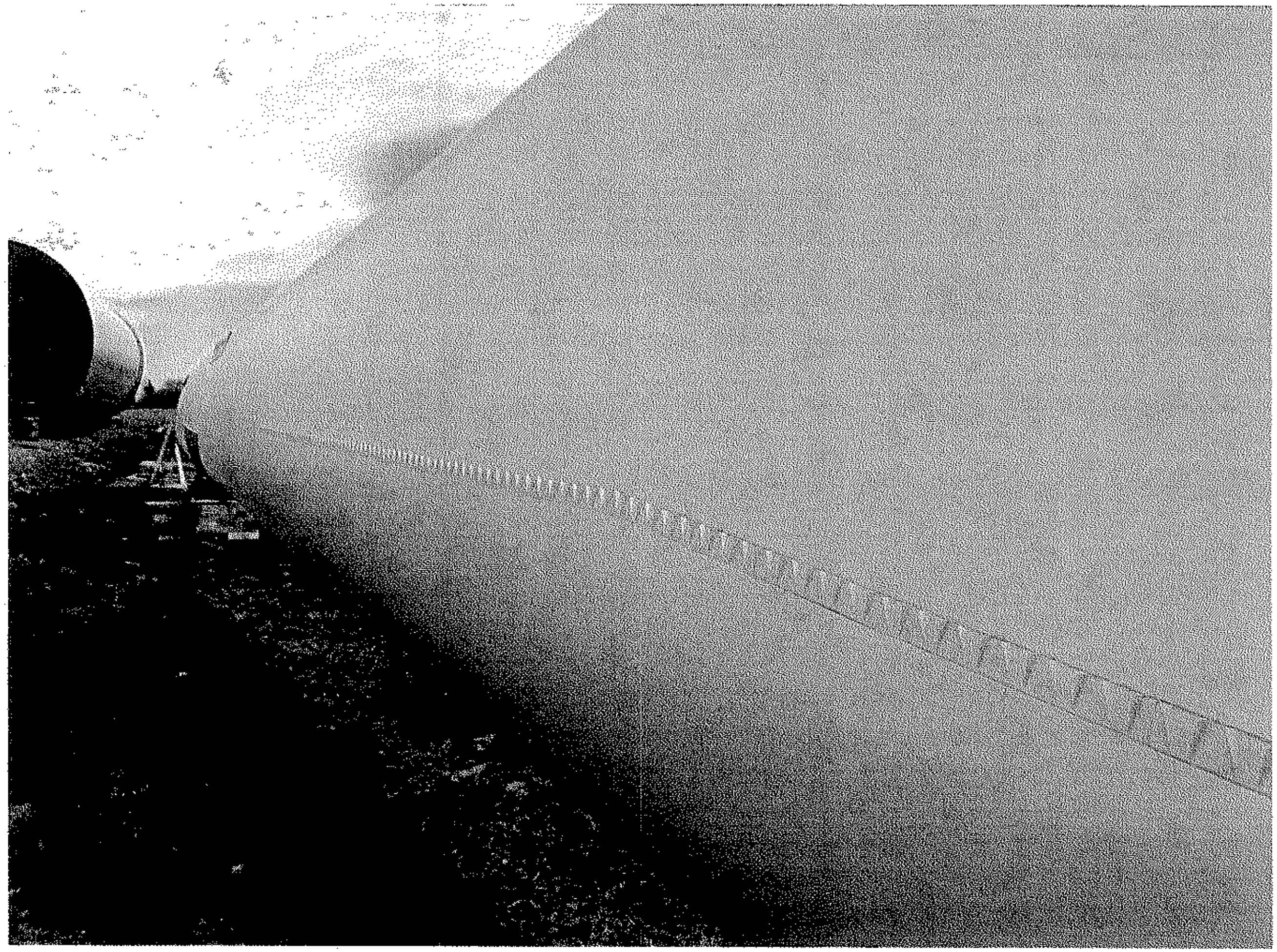
Wind Turbine Blade with Vortex Generator Strip



LM Glasfiber Model LM37.3 P2

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MODEL CALCULATIONS

GENERAL

- ISO 9613 Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation
- Wind Turbine as Point Source per IEC 61400-11
- Meteorological conditions "favorable to propagation from sources of known sound emission"
- Downwind propagation in all directions or "well-developed moderate ground-based temperature inversion"
- Stated Accuracy = $\pm$ 3 dB (ISO 9613-2 Section 9): Source/Receiver-Mean Height 5 to 30 m and Distance 100 to 1000 m

CONFIGURATION OF CALCULATION (MODEL SETTINGS)

- Spectral, All Sources – Ground Absorption G=0.5 (mix of hard and soft ground)
- Water Bodies (Lake) – G=0.0 (hard/reflective surface)
- Atmospheric Absorption - Temperature 10° C; Rel. Humidity 70 % (low range of ISO 9613-2 attenuation)
- No attenuation due to foliage/trees – intervening terrain only
- Receiver Height = 1.5m (5 feet) per Maine DEP regulation
- Grid Spacing = 20m x 20m (66 x 66 feet); Height = 1.5 m (5 feet)

MODEL CALCUATION

CALIBRATION/ADJUSTMENTS

- 5 dB added to each octave band sound power level based on Operations Testing at Mars Hill
- High end of range of measured sound levels under various site and weather conditions
- 5 dB adjustment consistent with stated uncertainties of GE Specification and ISO 9613-2

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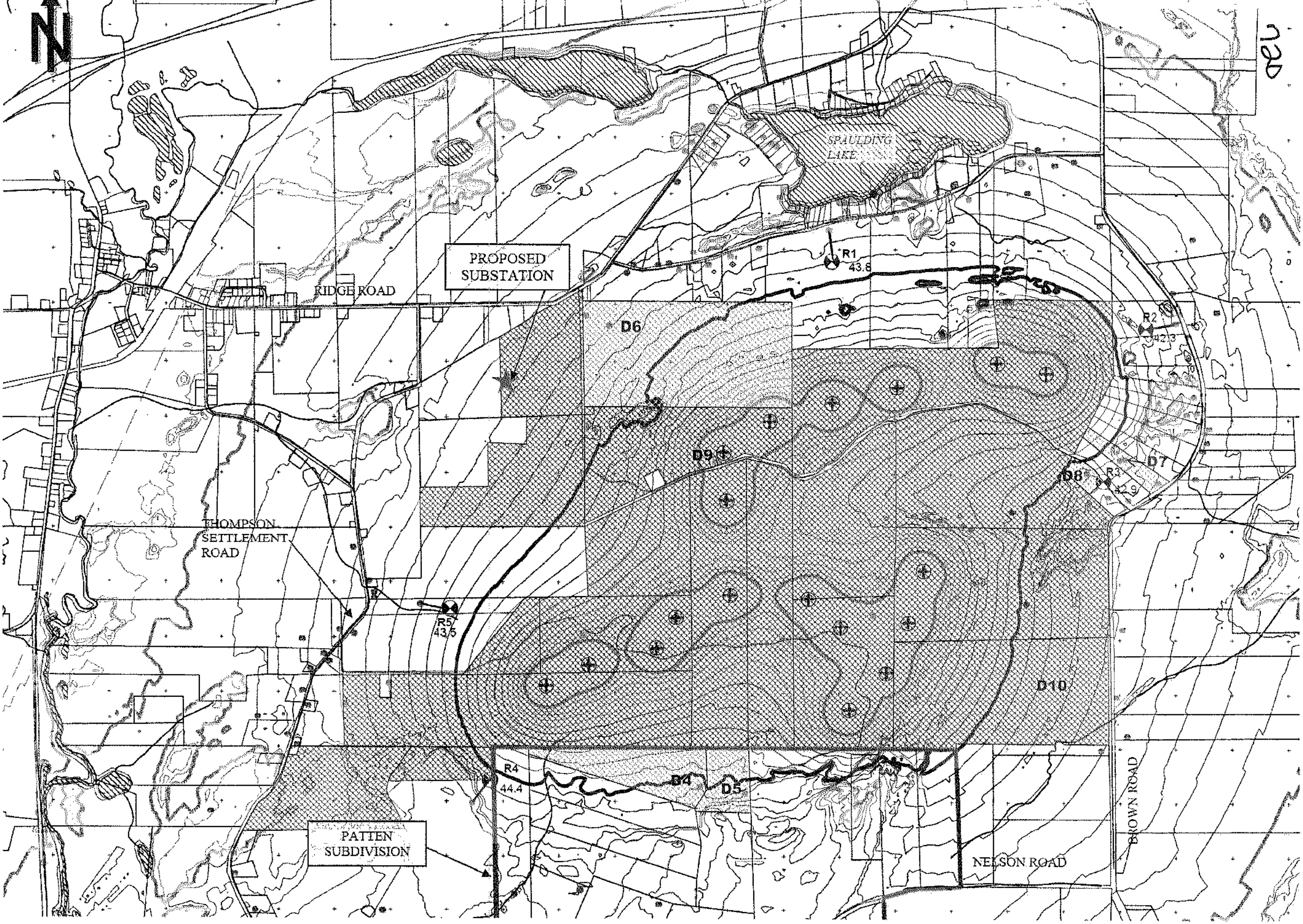
MODEL RESULTS

- Sound Pressure Level Contours - 1 dBA interval
- Estimated Sound Level at Receiver Points
- Compare results to Maine DEP nighttime limits

FIGURE ESTIMATED SOUND LEVEL CONTOURS – OAKFIEL NORTH



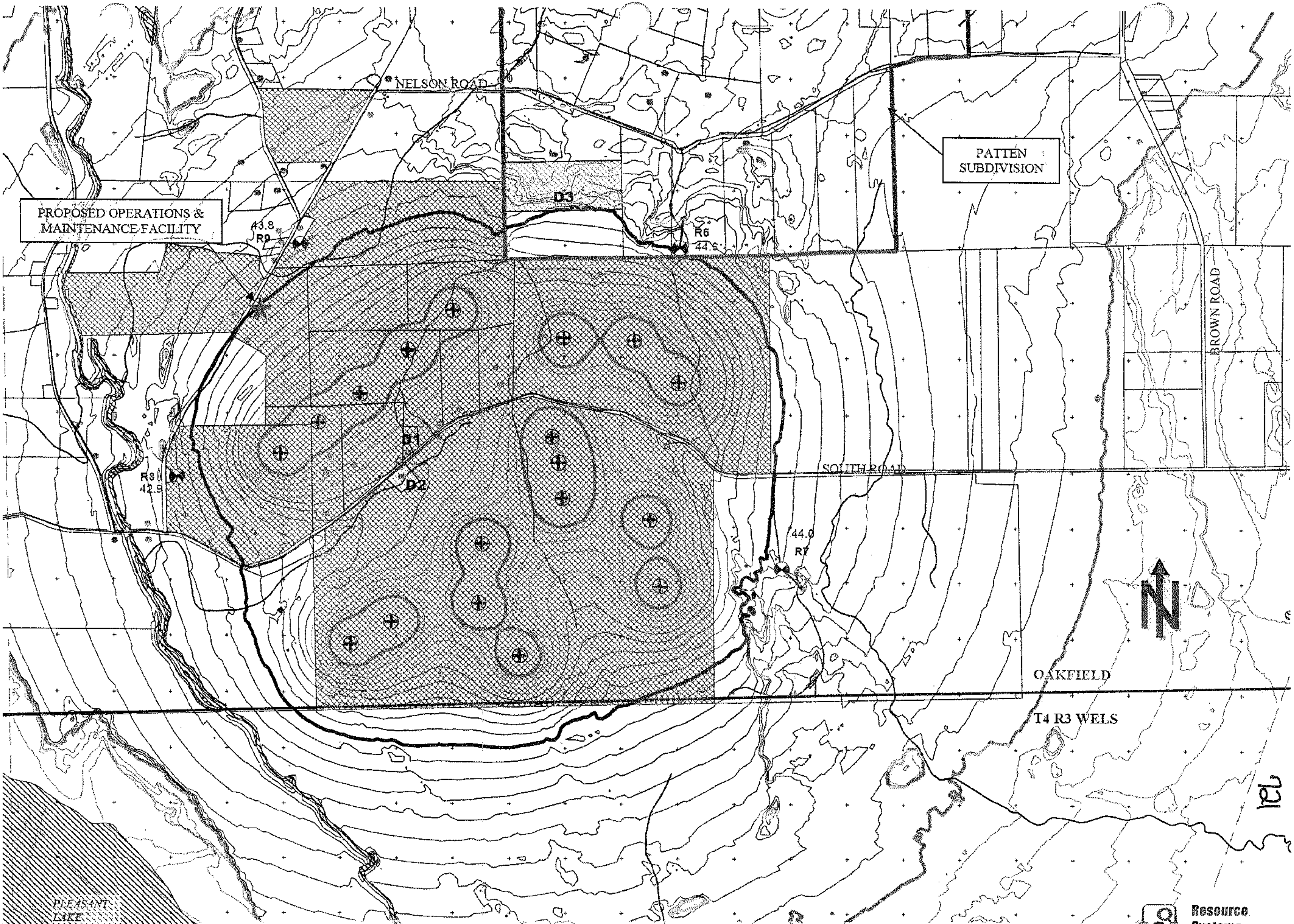


FIGURE 5 ESTIMATED SOUND LEVEL CONTOURS – OAKFIELD SOUTH

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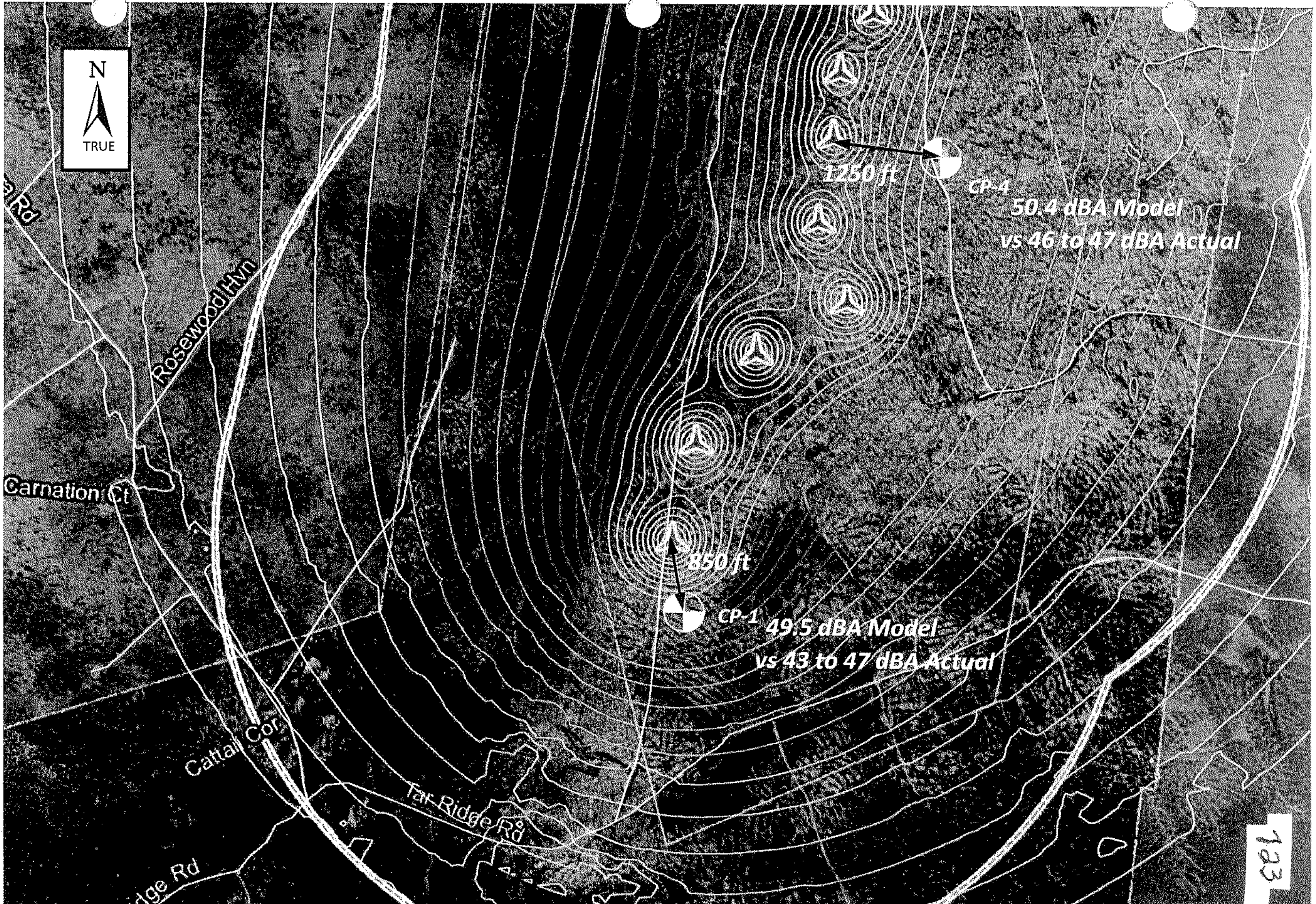
TABLE 3

ESTIMATED SOUND LEVELS FROM WIND TURBINE OPERATION

Receiver Position	Distance to Nearest Wind Turbine, Feet	Estimated Hourly Sound Level, L_{Aeq-Hr}	Maine DEP Nighttime Limit, dBA
R1	2,550	44	45
R2	1,950	42	45
R3	2,160	43	45
R4	1,990	44	45
R5	2,200	44	45
R6	1,850	45	45
R7	2,190	44	45
R8	1,860	43	45
R9	2,690	44	45



ESTIMATED vs ACTUAL SOUND LEVELS – STETSON WIND

(Based on Oakfield Wind Model Protocol)

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TOWN OF OAKFIELD
WIND ENERGY WORKSHOP SESSION

JULY 22, 2009

Prepared by:
Resource Systems Engineering

Presented by:
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POST CONSTRUCTION MONITORING

- PURPOSE
- METHODOLOGY
- RESULTS

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POST CONSTRUCTION MONITORING (OPERATIONS TESTING)

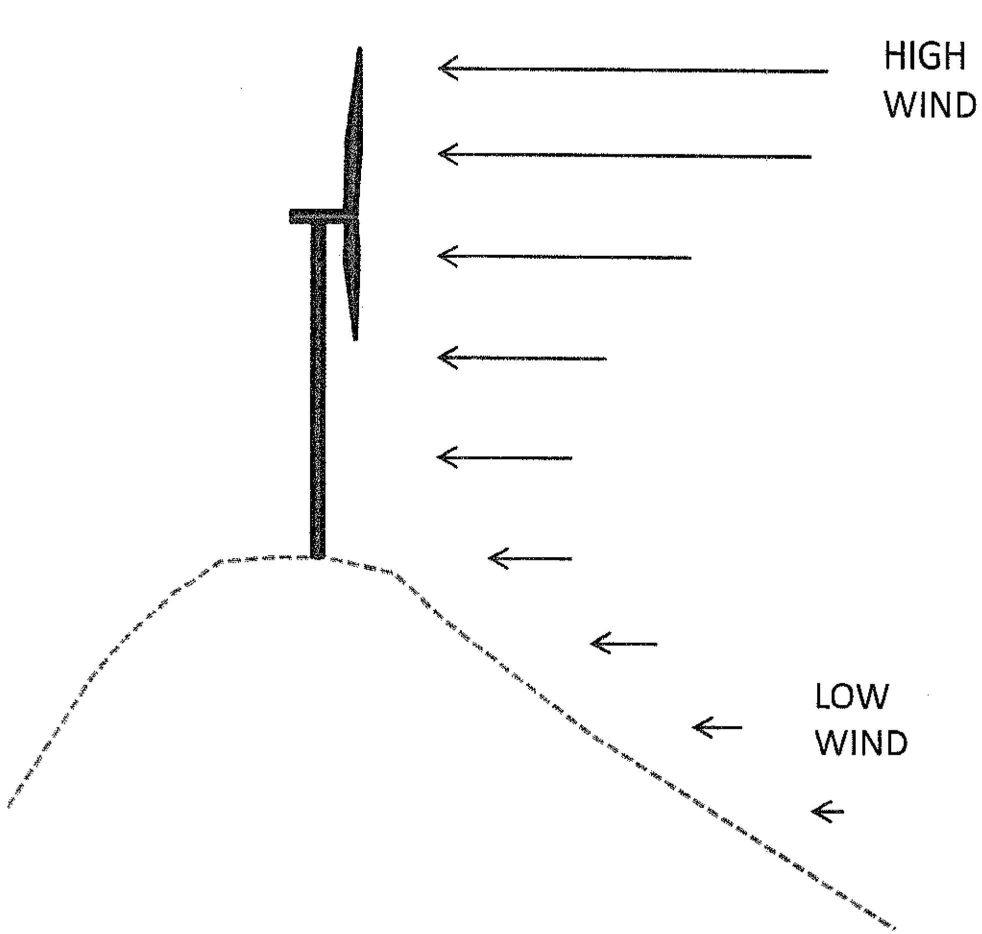
PURPOSE

- Demonstrate compliance with DEP sound level limits
- Measure wind projects under conditions when wind turbine sound is most prominent
- Extremely stringent weather and operating conditions
- Focus measurements and reporting on nighttime periods (traditionally 24 hours or more)
- Accurately account for potential tonal and short duration repetitive sounds

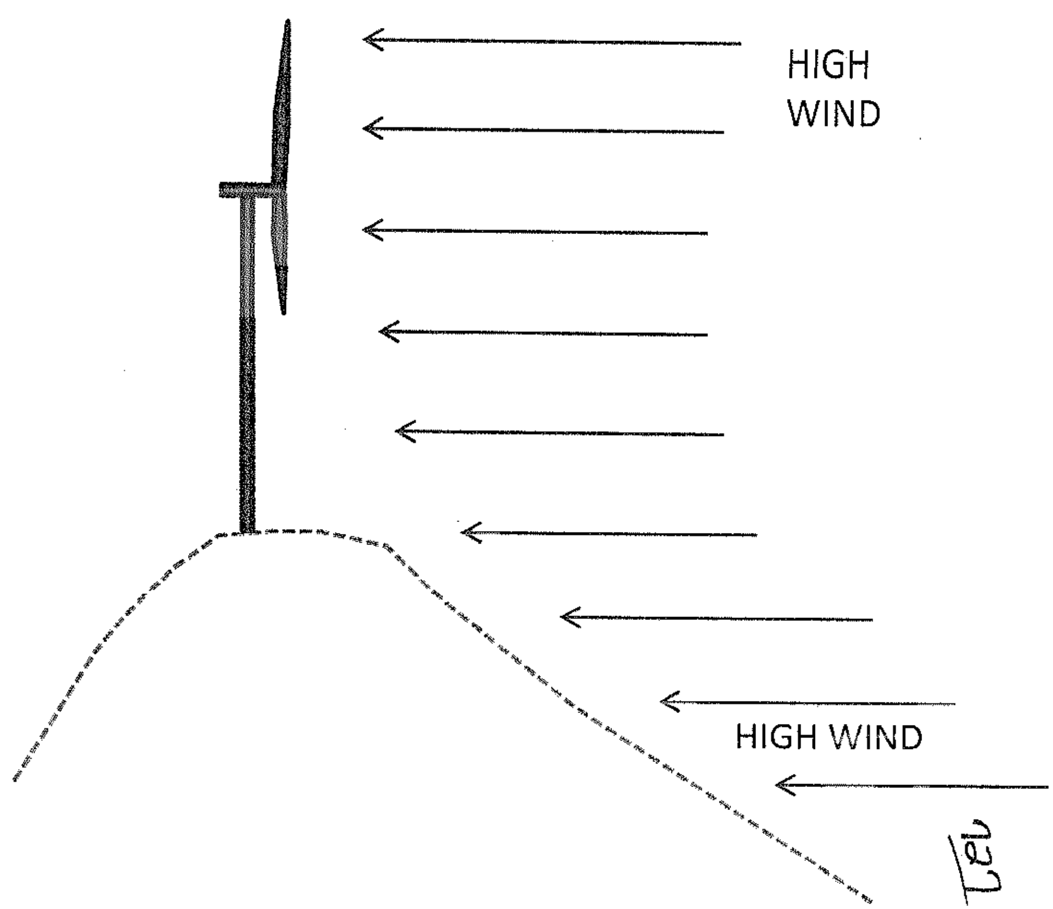
OPERATIONS TESTING

- Measure wind projects under conditions when wind turbine sound is most prominent – Full Turbine RPM & Low Ambient Sound

STABLE ATMOSPHERE – NIGHTTIME
- High Upper Winds
- Low Surface Wind



UNSTABLE ATMOSPHERE - DAYTIME
- High Upper and Surface Wind



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OPERATIONS TESTING

Measure wind projects under conditions when wind turbine sound is most prominent – Full Turbine RPM & Low Ambient Sound

STABLE ATMOSPHERE – NIGHTTIME

- High Upper Winds
- Low Surface Wind
- Wind turbine sounds most noticeable
- Low masking by wind sound
- Highest potential for amplitude modulation

BASIS

- Supported by Technical Literature (Internationally)
- Supported by experience and reports from testing in Maine

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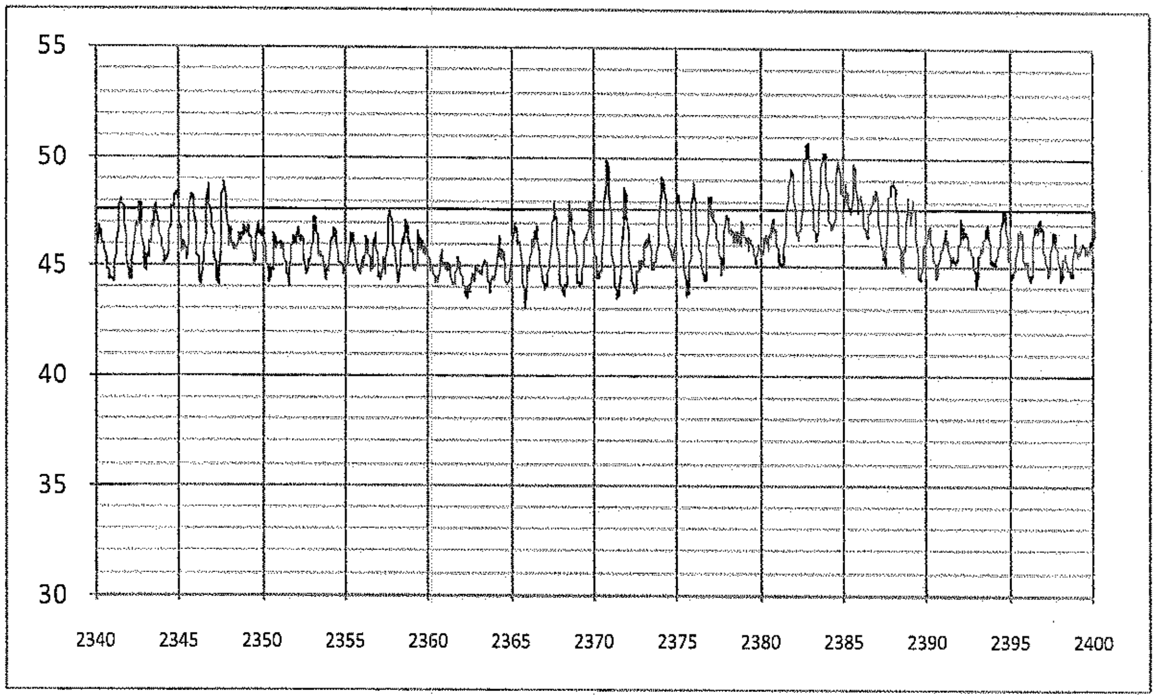
OPERATIONS TESTING

AMPLITUDE MODULATION

- Sound Level Fluctuation – Blade "whoosh"
- Occurs about once per second – blade passage rate
- Regulated by Maine DEP as Short Duration Repetitive (SDR) Sound
- Add 5 dBA when amplitude modulation 6 dBA or more



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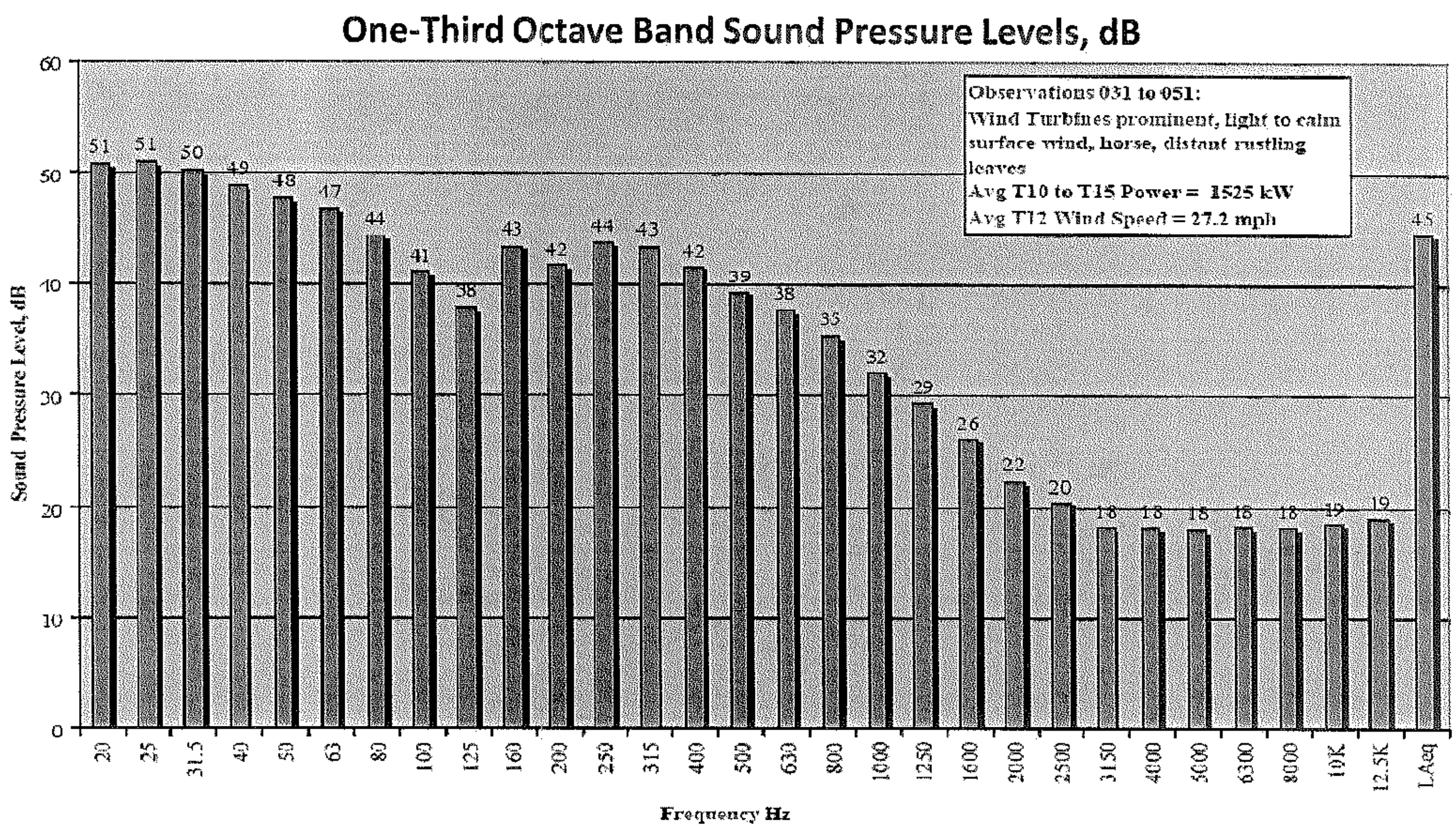
OPERATIONS TESTING

TONALITY (TONAL SOUND)

- Sound level at one frequency well above adjacent frequencies
- Assessed as part of IEC measurement procedure for wind turbines
- IEC 61400-11 Wind turbine generator systems – Acoustic noise measurement techniques
- Maine DEP adds 5 dBA to tonal sounds if present at a protected location



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Rollins Wind Project
Wind Turbine Sound Compliance Assessment Plan

Submitted by
Evergreen Wind Power III, LLC

Final Revised April 6, 2009

This wind turbine sound compliance assessment plan was developed jointly by Evergreen and Maine DEP with the advice and guidance of their respective acoustical consultants. Recommendations for testing protocols were drafted by EnRad Consulting of Old Town, Maine on behalf of Maine DEP, and further refined in consultation with Evergreen and Resource Systems Engineering (RSE) of Brunswick, Maine.

The sound compliance assessment for the Rollins Wind Project requires carefully specified measurement conditions, monitoring specifications and reporting requirements to characterize and consistently quantify wind turbine sound levels. RSE has developed this compliance assessment plan in consultation with the Department and development compliance for the project will be demonstrated when the following outlined conditions have been met for 12, 10-minute measurement intervals per monitoring location meeting 06-096 CMR 375.10 requirements.

Extraneous sounds could potentially or do complicate routine operation compliance assessment. If the applicant must adjust for such sounds, background ambient monitoring will be necessary. If background ambient monitoring is proposed, locations and times will be determined with concurrence from the MEDEP.

a. Compliance will be demonstrated when the required operating/test conditions have been met for twelve 10-minute measurement intervals at each monitoring location.

b. Measurements will be obtained during weather conditions when wind turbine sound is most clearly noticeable, i.e. when the measurement location is downwind of the development and maximum surface wind speeds ≤6 mph with concurrent turbine hub-elevation wind speeds sufficient to generate the maximum continuous rated sound power from the five nearest wind turbines to the measurement location. [Note: These conditions occur during inversion periods usually between 11pm-5am.] Measurement intervals affected by increased biological activities, leaf rustling, traffic, high water flow or other extraneous ambient noise sources that affect the ability to demonstrate compliance will be excluded from reported data. The intent is to obtain 10-minute measurement intervals that entirely meet the specified criteria. A downwind location is defined as within 45° of the direction between a specific measurement location and the acoustic center of the five nearest wind turbines.

c. Sensitive receiver sound monitoring locations will be positioned to most closely reflect the representative protected locations for purposes of demonstrating compliance with applicable sound level limits, subject to permission from the respective property owner(s). Selection of monitoring locations will require concurrence from Maine DEP.

d. Meteorological measurements of wind speed and direction will be collected using anemometers at a 10-meter height above ground at the center of large unobstructed areas and generally correlated with sound level measurement locations. Results will be reported, based on 1-second integration intervals, and be reported synchronously with hub level and sound level measurements at 10 minute intervals. The wind speed average and maximum will be reported from surface stations. Maine DEP concurrence on meteorological site selection is required.

e. Sound level parameters reported for each 10-minute measurement period will include A-weighted equivalent sound level, 10/90% exceedance levels and ten 1-minute 1/3 octave band linear equivalent sound levels (dB). Short duration repetitive events will be characterized by event duration and amplitude. Event frequency is defined as the average event frequency +/- 1SD and amplitude is defined as the peak event amplitude minus the average minima sound levels immediately before and after the event, as measured at an interval of 50 ms or less, A-weighted and fast time response, i.e. 125 ms. For each 10-minute measurement period short duration repetitive sound events will be reported by percentage of 50 ms or less intervals for each observed amplitude integer above 4 dBA. Reported measurement results will be confirmed to be free of extraneous noise in the respective measurement intervals to the extent possible and in accordance with (b.).

f. Compliance locations will be determined in consultation with the Department.

g. Compliance data collected in accordance with the assessment methods outlined above for representative locations selected in accordance with this protocol will be submitted to the Department for review and approval prior to the end of the first year of facility operation. Compliance data for each location will be gathered and submitted to the Department at the earliest possible opportunity after the commencement of operation, with consideration for the required weather, operations, and seasonal constraints.

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OPERATIONS TESTING - SOUND LEVEL ASSESSMENT

Part of Rollins Wind Site Permit – Oakfield Pending

MEASUREMENT CONDITIONS

- Periods when wind turbine sound most noticeable
- Measurement location downwind (within 45°)
- Maximum surface wind at or below 6 mph
- Winds at turbines hubs sufficient to generate maximum continuous rated sound power from five nearest wind turbines
- Extraneous Sounds - Adjustments for ambient/extraneous sound level will require background ambient monitoring
- Locations and times for ambient monitoring require concurrence from Maine DEP

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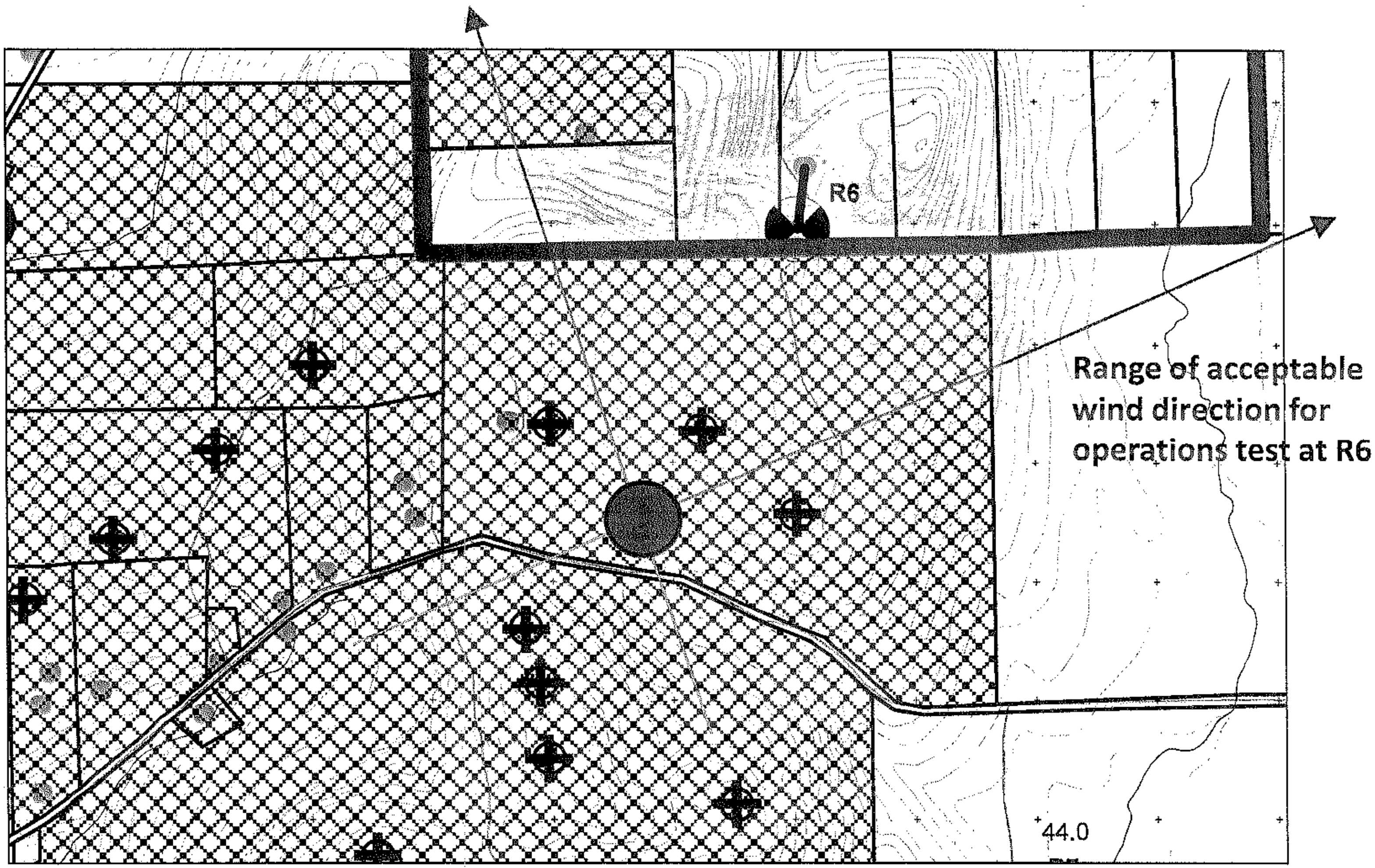
OPERATIONS TESTING - SOUND LEVEL ASSESSMENT

MEASUREMENT LOCATIONS

- Represent protected locations with most restrictive sound limits for purposes of demonstrating compliance
- Selection of locations requires concurrence from Maine DEP
- Permission from respective property owner



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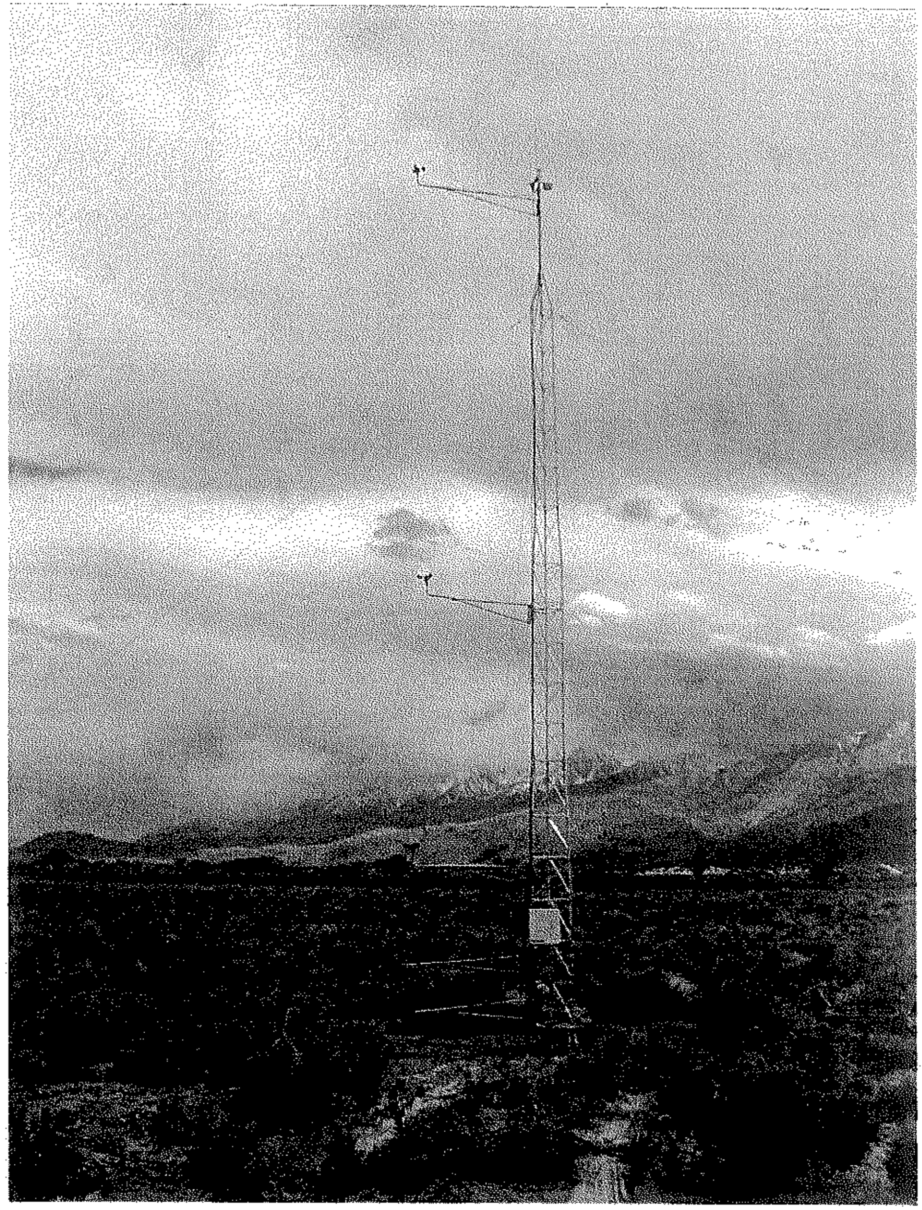
OPERATIONS TESTING - SOUND LEVEL ASSESSMENT

METEOROLOGICAL MEASUREMENTS

- Wind speed and direction using anemometers at height of 10 m above ground
- Center of large, unobstructed areas correlated with sound level measurement locations
- Locations require concurrence from Maine DEP
- Results based on 1-second intervals
- Report average and maximum wind speed for each 10-minute measurement interval meeting protocol criteria



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OPERATIONS TESTING - SOUND LEVEL ASSESSMENT

SOUND LEVEL MEASUREMENT DATA

- Reported for each 10-minute measurement period
- A-weighted equivalent sound level, 10/90% exceedance levels
- Ten 1-minute 1/3 octave band linear equivalent sound levels (dB)
- Short duration repetitive (SDR) events characterized by event duration and amplitude
- Amplitude is the peak event sound level minus the average minima sound levels immediately before and after the event
- Measured at interval of 50 ms or less, A-weighted and fast time response, i.e. 125 ms
- SDR events reported by duration of amplitude by integer above 4 dBA
    - Time when amplitude change exceeded 4 dBA, 5 dBA, 6 dBA, 7 dBA etc

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OPERATIONS TESTING - SOUND LEVEL ASSESSMENT

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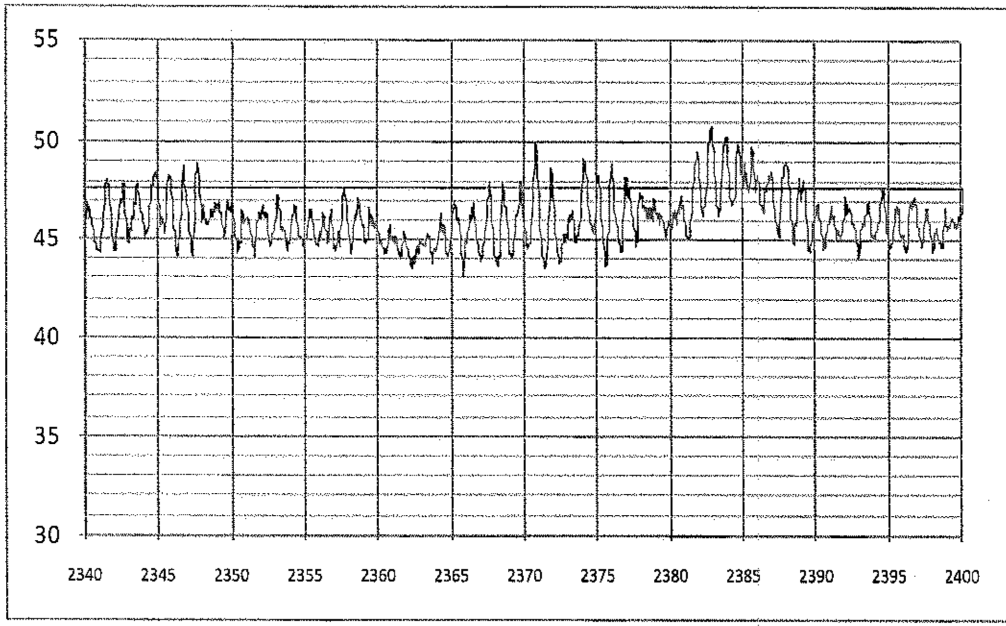
COMPLIANCE DEMONSTRATION

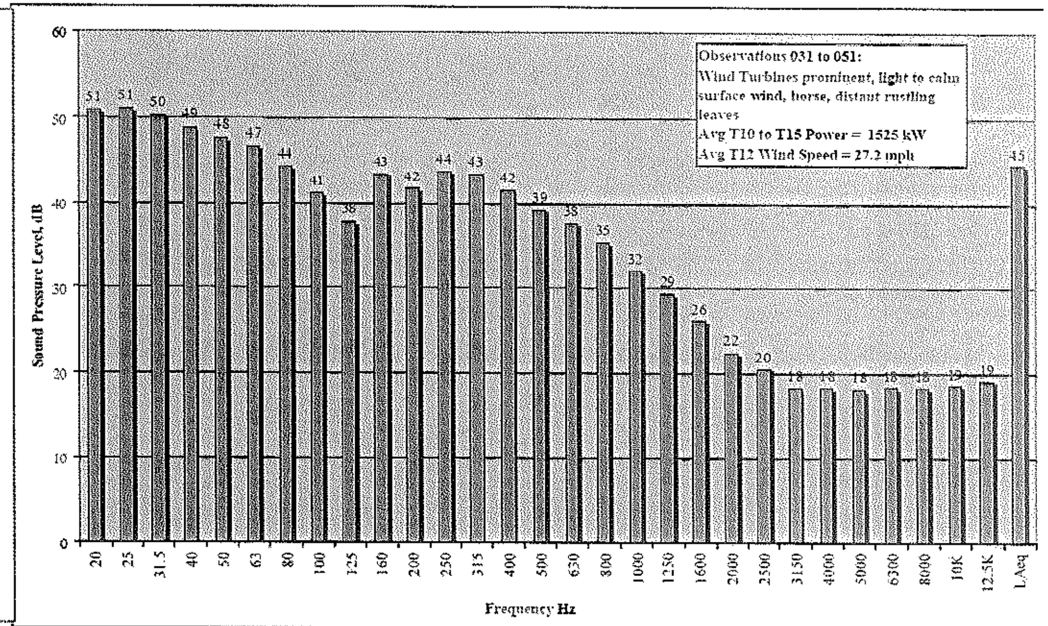
- Required for 12, 10-minute measurement intervals per monitoring location
- Measurement conditions per Compliance Protocol and DEP Chapter 375.10 requirements
- May require several days and rounds of measurements to capture the required conditions
- Within first year of operation

OPERATIONS TESTING - SOUND LEVEL ASSESSMENT

TONAL & SDR ASSESSMENT

- 5 dBA added to sound levels of Tonal & SDR sounds
- 5 dBA added to sound level of each tonal frequency
- 5 dBA added to SDR events based on amplitude and duration
- SDR events requires amplitude modulation of 6 dBA or more for 5 dBA "penalty" to be applied





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OPERATIONS TESTING - SOUND LEVEL ASSESSMENT

SDR ASSESSMENT – OBJECTIVE

- Determine total duration of SDR events for each 10-minute test period
- Determine equivalent (average) sound level of SDR events
- Apply + 5 dBA "penalty" to total duration of SDR events
- Calculate adjustment to 10-minute equivalent sound level

ASSESSMENTS FOR SHORT DURATION REPETITIVE SOUND EVENTS

10-Min LAeq	SDR LAeq	SDR Time (sec)	SDR with 5 dBA	Adjusted 10-Min LAeq	Net Change
45	50	5	55	45.2	0.2
45	50	10	55	45.5	0.5
45	50	20	55	45.9	0.9
45	50	40	55	46.6	1.6
45	50	60	55	47.3	2.3
45	48	15	53	45.4	0.4
45	50	15	55	45.7	0.7
45	52	15	57	46.0	1.0
45	54	15	59	46.6	1.6
45	56	15	61	47.3	2.3

TONAL ASSESSMENT

- Similar Method except 5 dBA applied to Tonal Frequency

OPERATIONS TESTING - SOUND LEVEL ASSESSMENT

RESULTS

- Determine 10-minute equivalent sound level (L_{Aeq}) with required tonal and SDR adjustments
- If resulting sound level is 45 dBA or less = compliance with Maine DEP nighttime limits
- If resulting sound level above 45 dBA – evaluate mitigation options to achieve compliance
- Non-compliance unlikely due to conservative model assumptions used for Oakfield Wind
- Results submitted to Maine DEP for review and approval
- Report includes detailed measurement data per Sound Level Assessment requirements

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TOWN OF OAKFIELD
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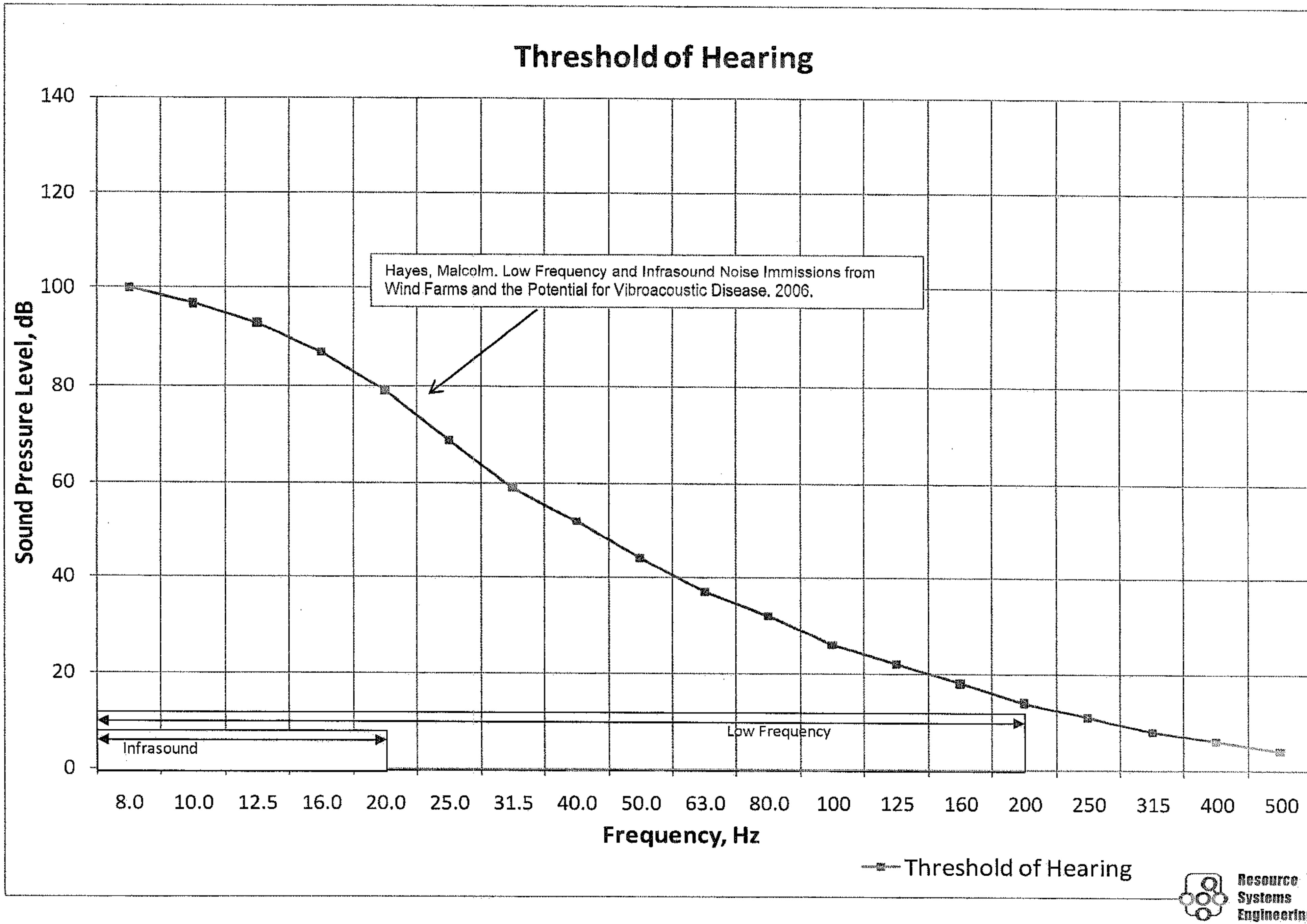
LOW FR QUENCY AND INFRASOUND



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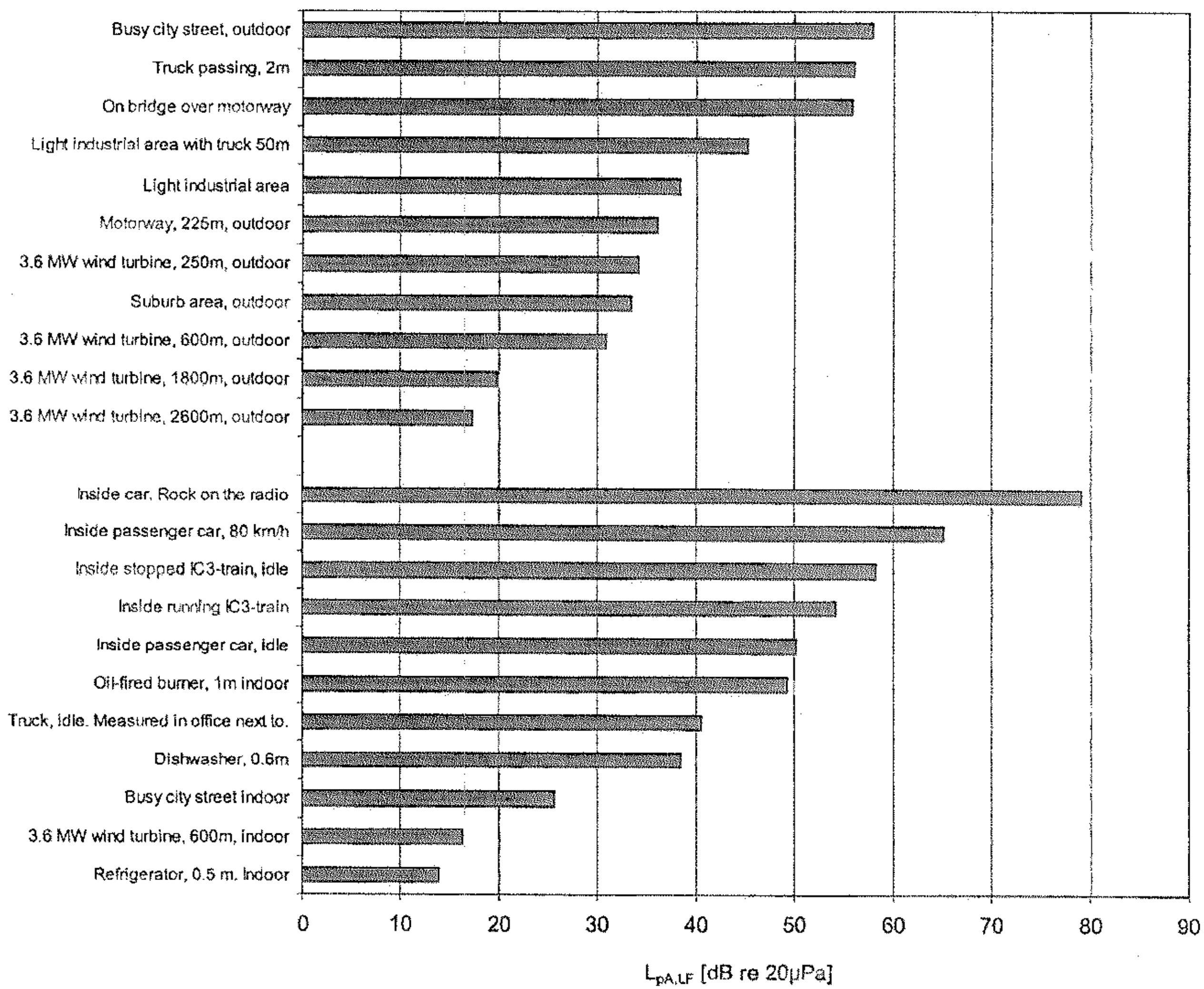
12. Low frequency content compared to other sources

Like many other noise sources wind turbines emit low frequency noise to some extent as we have seen. Figure 50 shows the magnitude of the $L_{pA, LF}$ levels from a number of sources compared to a typical 3.6 MW wind turbine.



LOW FREQUENCY AND INFRASOUND

13.1 Characteristics of Wind Turbine Noise

The noise from modern large wind turbines is dominated by the aerodynamic noise from the blades rotating in the air. As the blades pass through different wind speeds (and maybe also because of (distance differences and Doppler effects) the mid and high frequency aerodynamic noise is modulated by the low blade passage frequency. This low frequency modulation (1 Hz) may have caused some confusion about infrasound.

There seem to be solid evidence and general agreement among researchers and technicians that wind turbines do not emit audible infrasound. The levels are far below the hearing threshold.

DELTA AV 1098/08

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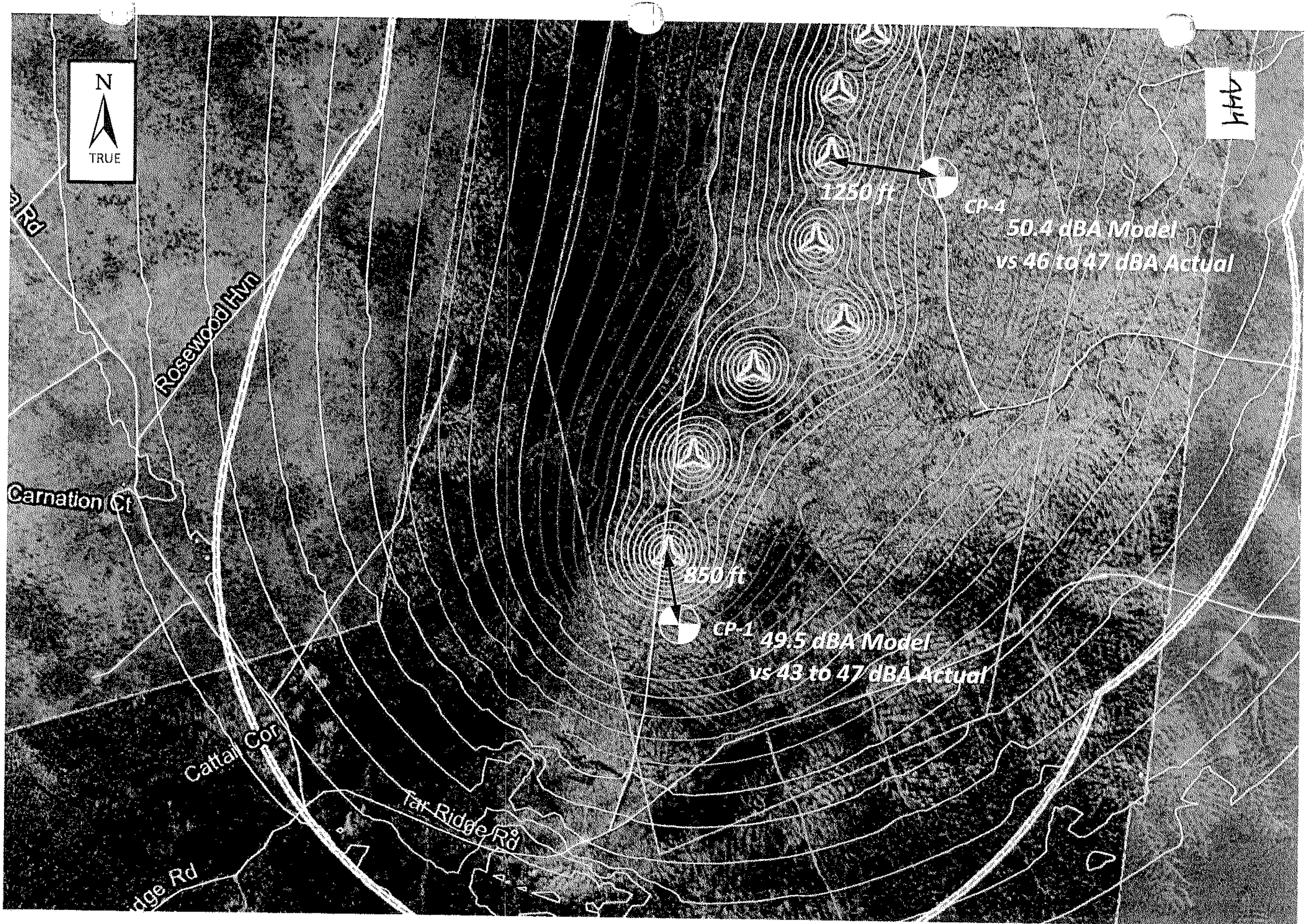

ESTIMATED vs ACTUAL SOUND LEVELS – STETSON WIND

(Based on Oakfield Wind Model Protocol)

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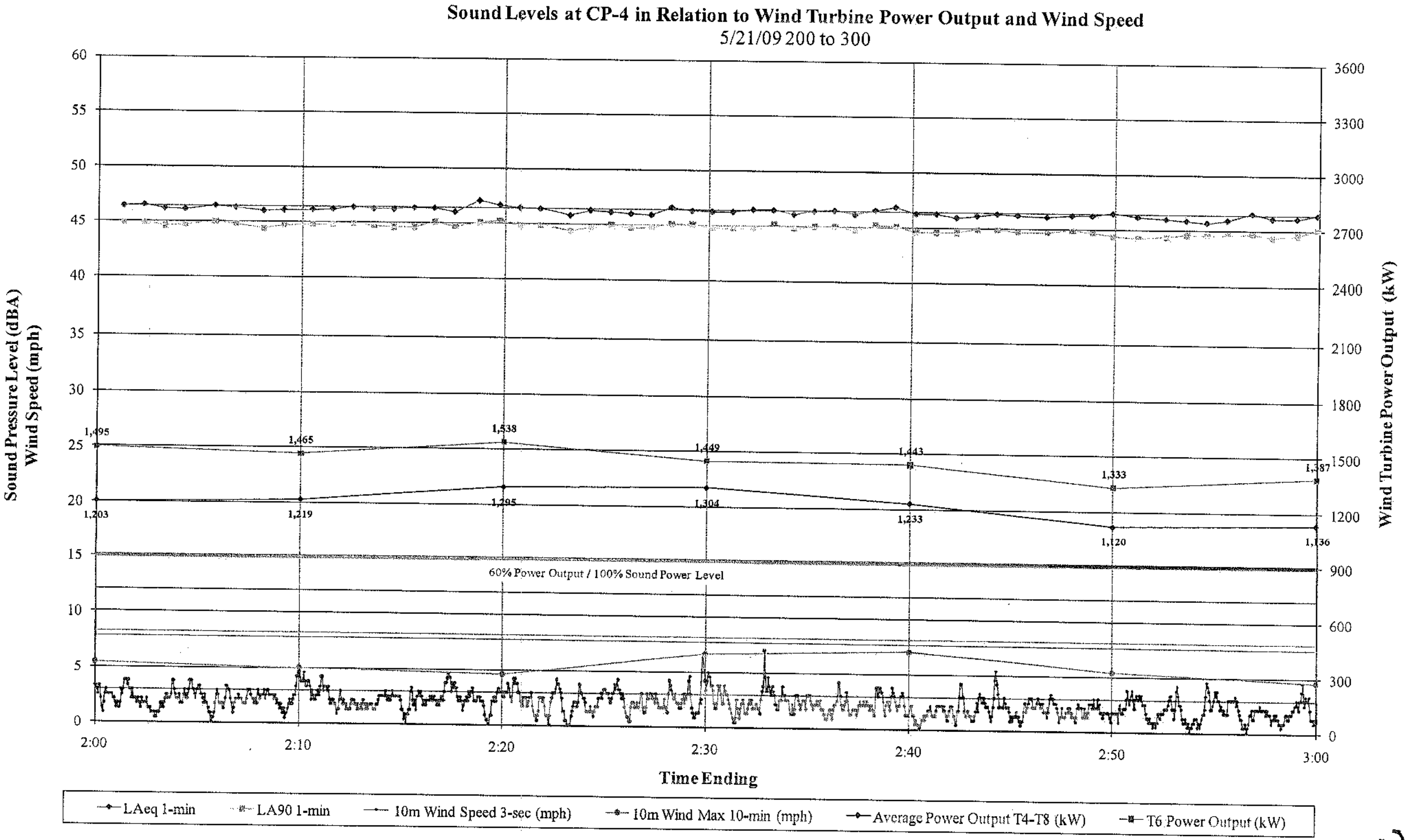
Sound Levels at CP-4 in Relation to Wind Turbine Power Output and Wind Speed
5/21/09 200 to 300
Sound Pressure Level (dBA)
Wind Speed (mph)
Wind Turbine Power Output (kW)
Time Ending
60% Power Output / 100% Sound Power Level
1,495
1,465
1,538
1,449
1,443
1,333
1,387
1,203
1,219
1,295
1,304
1,233
1,120
1,136
LAeq 1-min
LA90 1-min
10m Wind Speed 3-sec (mph)
10m Wind Max 10-min (mph)
Average Power Output T4-T8 (kW)
T6 Power Output (kW)

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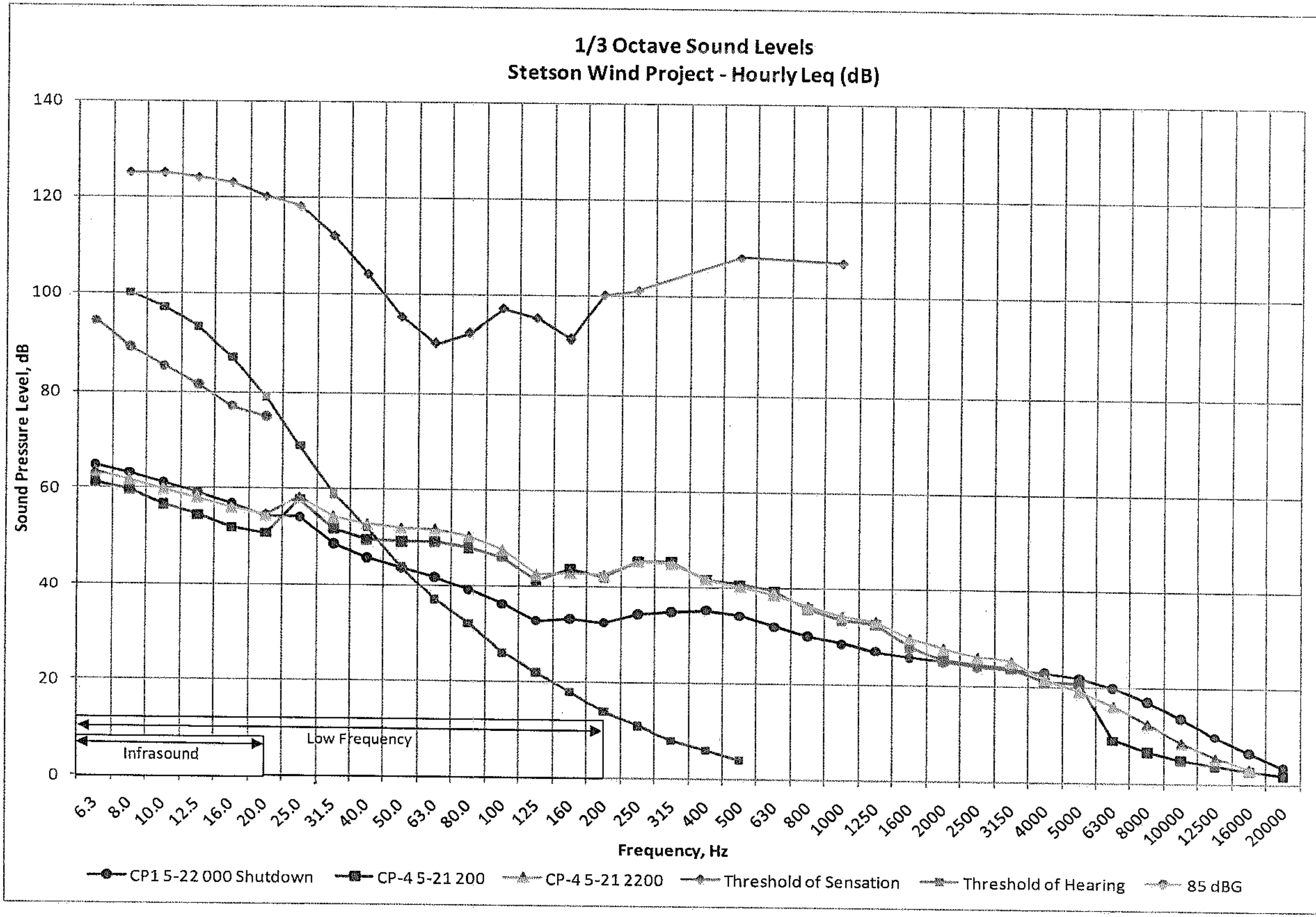
LOW FREQUENCY AND INFRASOUND



Source: Threshold of Hearing. Hayes, Malcolm. Low Frequency and Infrasound Noise Immissions from Wind Farms and the Potential for Vibroacoustic Disease. 2006.
Threshold of Sensation. Shinji, Yamada. Body Sensation of Low Frequency Noise of Ordinary persons and Profoundly Deaf Persons. 1983.

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MEASUREMENT RESULTS

- Highest infrasound and high frequency sound levels when nearest turbine was shutdown
- Infrasound more than 20 dB below hearing threshold and 15 dB below Denmark EPA infrasound standard (85 dBG)
- Low frequency sound more than 40 dB below average threshold of feeling
- Lower sound levels expected at Oakfield due to larger distance to turbines

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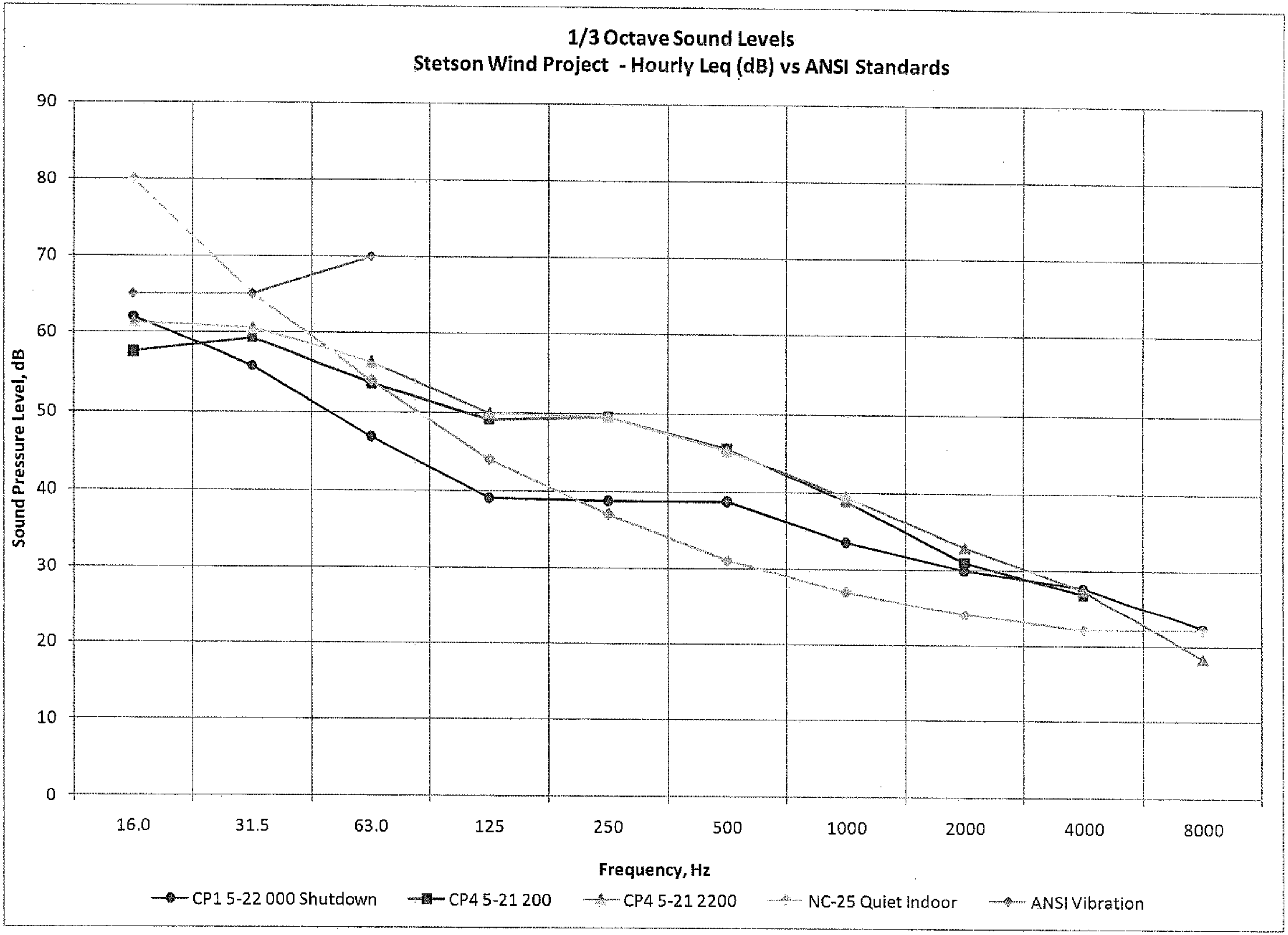

Resource Systems Engineering

MEASUREMENT RESULTS

- Outdoor sound levels at frequencies of 63 Hz or lower at or below ANSI indoor quiet criteria (NC-25) for bedrooms of private residences
- With minimum transmission loss from structure sound levels below NC-25 for all low frequencies
- Measured sound levels 6 dB or more below ANSI guidelines for structural vibration
- Expect lower sound levels at Oakfield where nearest receiver is 600 feet farther away and 500 feet from residence

Resource Systems Engineering

Published literature reviewed by Maine DEP and Maine Center for Disease Control (reference Wind Turbine Neuro-Acoustical Issues, D.A. Mills, MD, MPH Maine CDC/DHHS, March 2009):

- Eja Pedersen, Noise Annoyance from Wind Turbines, Swedish Environmental Protection Agency (2003) ("There is no scientific evidence that noise at levels created by wind turbines could cause health problems other than annoyance.")
- Health Assessment Section, Bureau of Environmental Health, Ohio Department of Health, Literature Search on the Potential Impacts Associated with Wind-to-Energy Turbine Operations, (2008) ("No evidence was found to indicate adverse health impacts in humans caused by infrasound levels generated by modern wind turbines")
- Danish Electronics, Light and Acoustics, Low Frequency Noise from Large Wind Turbines: A Procedure for Evaluation of the Audibility for Low Frequency Sound and Literature Study (2008) ("Low frequency is one of the two lowest ranking sound characteristic descriptors in relation to annoyance.")
- Geoff Leventhall, Infrasound from Wind Turbines – Fact, Fiction or Deception, Canadian Acoustics, Vol. 34 No. 2, at 29 (2006) ("[T]here is insignificant infrasound from wind turbines and . . . there is normally little low frequency noise.")

CONCLUSIONS

- "Frequencies below 100 to 200 Hz … is not considered to be problematic" [G.P. van den Berg, *The Sounds of High Winds*]
- The Maine DEP and Dora Anne Mills, MD, MCDC Director, reviewed a considerable body of scientific, peer-reviewed evidence and concluded that low frequency and infrasound from wind turbines does not pose a measurable health risk for projects that comply with Maine DEP limits
- Mr. Warren Brown of EnRad, DEP's independent 3rd party peer reviewer has similar conclusions as Dr. Mills in his reports on wind energy projects in Maine
- Acoustic Researchers & Internationally Recognized Wind Turbine Noise Experts, Geoff Leventhal, PhD, Ramani Ramakrishman, PhD and Malcolm Hayes derive similar conclusions in their publications.

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APPENDIX 9

E-MAIL FROM BO SONDERGAARD (DELTA) to RICK JAMES (E-COUSTICS)

OCTOBER 26, 2009

Bo Søndergaard/DELTA

26/10/2009 13:33 To rickjames@e-coustic.com
cc geoff@activenoise.co.uk

Subject Comments on WEPCO application and Docket:6630-CE-302

Dear Mr James

I have been made aware of the attached document made by you.

I can see that you reference some of the work I and DELTA have made on low frequency noise from wind turbines. Unfortunately it seem that you have not understood the data and therefore misinterpreted the results of the investigation. I especially think about figure 5 in the document and the text referring to this figure.

First of all this is not the original figure from our reports and there should be some explanation on how it is achieved. Secondly you infer a conclusion from our work stating that the noise increases by 5 dB for every MW the power increases. We have never made any conclusion like that neither form the specific work on low frequency noise or from any other work and it is certainly not what we see.

Could you please explain why you have chosen to put this conclusion in as if it was taken from our investigation.

Venlig hilsen/Vänliga hälsningar/Best regards

Bo Søndergaard

Specialist, Acoustics

DELTA Acoustics & Electronics

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PSC REF#:121105

Public Service Commission of Wisconsin
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EXHIBIT 808

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Comments on WEPCO's Glacier Hills Application and Supporting Documents Regarding Wind Turbine Noise and Its Impact on the Community

Oct. 5, 2009

Please accept the following commentary and recommendations on behalf of the Coalition for Wisconsin Environmental Stewardship (CWESt) in support of the following assertions:

1) Wind turbine noise is distinctively annoying and the documents submitted to the Wisconsin Public Service Commission (WPSC) under Docket No: 6630-CE-302 do not correctly or adequately describe the impact of the proposed project on the host community and the residents whose homes and properties are close to or within the footprint of the project,
2) Background sound levels submitted on behalf of WEPCO which include a 'wind noise' component were obtained using a methodology that has been shown to result in a biased assessment of background sound levels. Further, the original and revised Background Sound studies do not adequately define the background sound levels and characteristics of wind turbine noise for purposes of making decisions on location with respect to homes and properties.
3) Computer model estimates of operational sound levels from the proposed projects understate the impact of the turbines on the community.
4) That information provided supplemental to the background sound and computer modeling studies by Dr. Geoff Leventhal, and others asserting that there is no research supporting a causal link between wind turbine sound immissions at receiving properties and homes and health effects do not reflect current understanding of thresholds of perception and mechanisms whereby such perception can occur.
5) That information provided supplemental to the background sound and computer modeling studies by Dr. Geoff Leventhal, asserting that there are errors in the manuscript titled: "The 'How to' Guide To Siting Wind Turbines to Prevent Health Risks from Sound" Version 2.1[1], does not reflect a proper understanding of the goals and criteria proposed in that document.
6) The combination of the above negative factors related to wind turbine noise emissions will result in sleep disturbance for a significant fraction of those who live within a mile away and chronic sleep disturbance results in serious health effects."

The result of these technical flaws along with an outdated understanding of how the human body responds to acoustical energy previously considered to be below the threshold of perception leads to a conclusion that if the WEPCO project, as proposed, is approved, it will, with a high degree of certainty, have negative noise impacts that are "significant."

In preparation for this report, the materials provided on the WPSC website for Docket 6630 - CE - 302 have been reviewed. This includes the background noise study and computer model estimates of operating sound levels prepared by Mr. George Hessler Jr., P.E., INCE Board

[1] Kamperman, George and Richard R. James (2008). Simple guidelines for siting wind turbines to prevent health risks, The Institute of Noise Control Engineering of the USA, 117 Proceedings of NOISE-CON 2008 1122-1128, Dearborn, Michigan, available at <http://www.inceusa.org/

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Certified, submitted October 8, 2008 and its subsequent revisions; and the supplemental materials by Dr. Leventhal and others.

There is considerable similarity between WEPCO's documents, and similar documents filed in other states on behalf of wind utility developers requesting permits for their projects. The arguments presented in these documents appear on the surface to be well-crafted technical statements regarding wind turbine noise, community and land-use compatibility, and public health risks. However, despite the similarities in presentation, methodologies, and conclusions between the various authors in these documents there are serious flaws in the arguments and information used to support those conclusions. These studies present clearly one-sided information to support the development of wind utilities in locations where people will be expected to live within 1000 to 1500 feet of industrial scale wind turbines.

It is the goal and focus of this report to present the other side of this argument, and to provide the WPSC with the foundation research, papers, and presentations needed to understand that what is not disclosed in the wind utility application reports and supporting documents is critical. Given the opportunity for the WPSC to review the information provided in this report and its attached references, it is hoped that the WPSC will understand why wind utility projects from Iowa to Maine, Ontario to West Virginia are now the locus of numerous complaints and lawsuits. These complaints and lawsuits detail the complaint's problems with wind turbines causing sleep disturbance, adverse health effects, and other related problems. Yet, it must be remembered that at the time of the permit application, the developer for each of these projects assured the permitting agency that none of these problems would occur. This report is intended to provide information such that the WPSC will not find itself permitting similar situations.

The Glacier Hills Wind project will result in a large number of residences being within 1000 feet of one of more wind turbines. Figure 1 illustrates the extent to which the proposed footprint of the wind utility will encroach on residential homes.

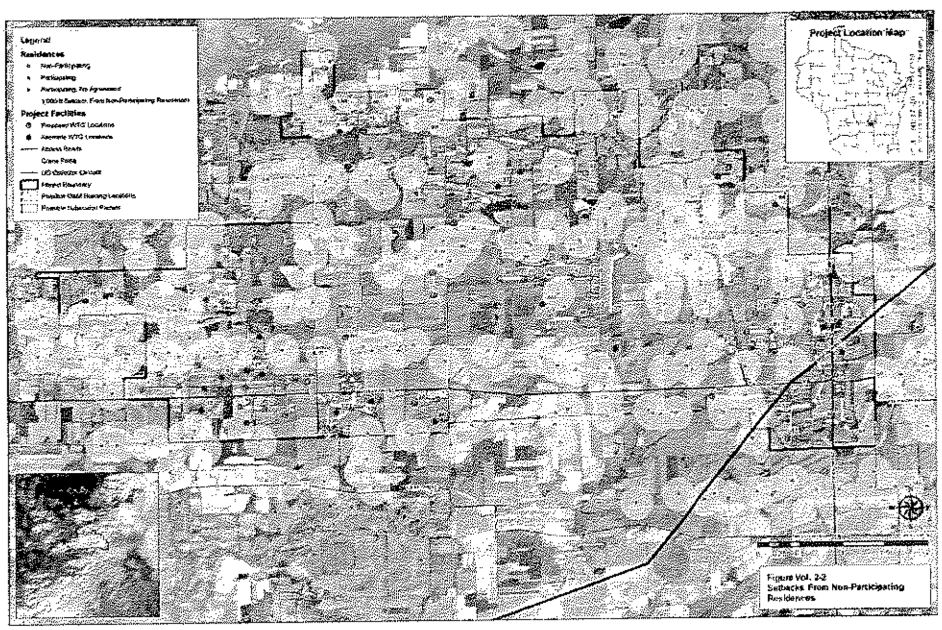

Figure 1-1000 foot setbacks from homes

It is common for people to look at wind turbines as a new type of noise source. However, some of the problems associated with them are easier to understand if we view wind turbines as a special case of large industrial fans. For example, if we take a look at the spectrum from a fan, as shown in Figure 2, there are certain characteristics that all fans have in common. There is maximum energy at the blade passage frequency, tones above the blade passage frequency, and broadband noise. The harmonics of that tone have somewhat lower energy content. The broadband spectrum starts above the range where the tones longer dominate. The energy is highest at the blade passage frequency and drops off as frequency increases.

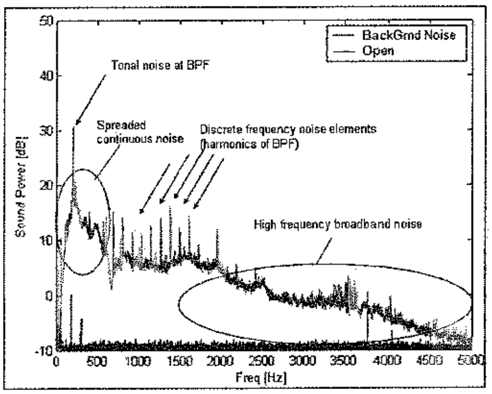

Figure 2-Typical Fan Noise Spectrum

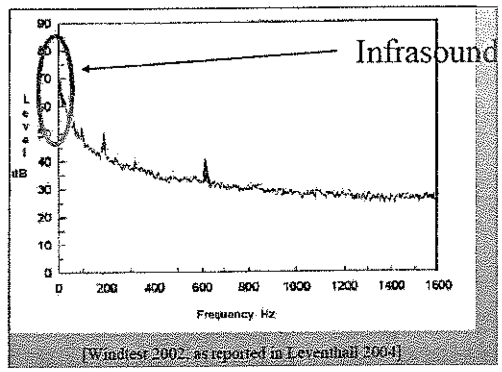

Figure 3-Vestas V-52 Spectrum (From NREL Presentation)

Figure 3, the wind turbine spectrum for a Vestas V-52, shows some of the same spectral characteristics. For a wind turbine the blade passage frequency is usually between 1 and 2 Hz and the harmonics occur usually below 10 Hz. Because this is a difficult range of frequencies to measure, especially in field test situations, most information about the spectral characteristics do not show the infrasound range (0-20Hz) sound pressure levels (SPL). This is further obscured by the practice of wind industry acoustical consultants to present data using of A-weighting (dBA). The practice masks the spectrum shape by creating a visual impression of minimal low-frequency sound content. Even when octave band (1/1 or 1/3) SPLs are presented the reports normally ignore frequencies below 31. 5 or 63 Hz. The wind industry and its consultants often say that there is no infra or low frequency content. If that is true then the customary reporting practices are understandable. But, if those assumptions are not accurate, then these practices mask a potential source of significant problems.

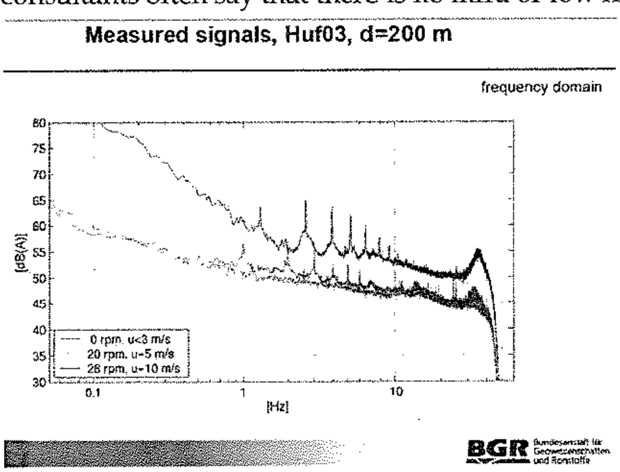

Figure 4-Wind Turbine Infrasound

The graphic to the left (Figure 4) shows a wind turbine's spectrum for the frequency range of 0-10 Hz. Note the tones and harmonics and the correlation of the frequency of the tones to rotational speed. This graph is from a study conducted by the Federal Institute for Geosciences and Natural Resources, Hannover, Germany, titled: "The Inaudible Noise of Wind

Turbines" presented at the Infrasound work shop in 2005 (Tahiti).

Are the sound emission characteristics similar or different for different models and makes of wind turbines? Figure 5 shows the general spectrum shape of 37 modern upwind turbines of the type and sizes being located in the Midwest. This graph shows the sound power data after normalizing the data for each turbine to 1 MW of power output.[2] It is clear that there is little deviation in spectral shape between any of the various models that is not related to power produced. In fact, the study concluded that for each increase of 1 MW in power output the graph would shift upward by approximately 5 dB.

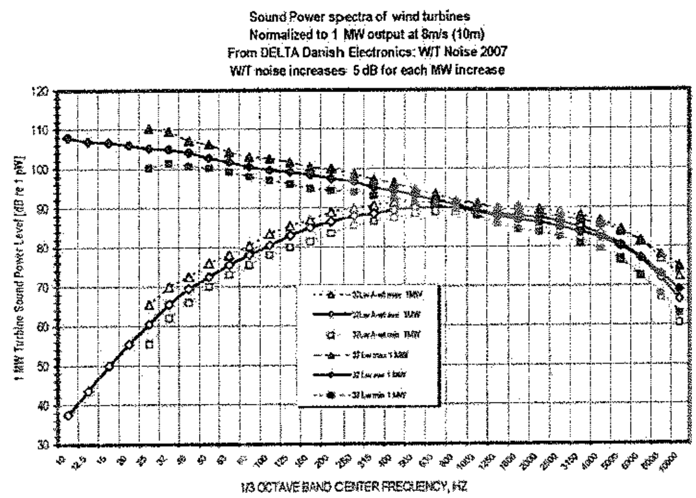

Figure 5-Sound Power Level of 37 Turbines Normalized to 1MW

Given that power to sound level relationship and the constant increase in the power rating of turbines being installed we could see the wind turbine sound levels increase another 25 dB by the time 5 MW turbines are commercially available.

1) Wind turbine noise is distinctively annoying

There have been several studies, primarily conducted in European countries with a long history of wind turbines, showing that at the same sound pressure (decibel) level or less, wind turbine noise is experienced as more annoying than airport, truck traffic or railroad noise[3,4,5]. There are several reasons why people respond more negatively to wind turbine noise that are directly a result of the character of the noise more than the absolute level of the sounds received.

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2 DELTA, Danish Electronics, Light & Acoustics, "EFP-06 Project, Low Frequency Noise from Large Wind Turbines, Summary and Conclusions on Measurements and Methods," April 30, 2008

3 Pedersen, E., Waye, K. P., "Human response to wind turbine noise – annoyance and moderating factors", Proceedings of the First international Meeting on Wind Turbine Noise: Perspectives for Control, Berlin, October 17-18, 2005.

4 E. Pedersen and K. Persson Waye, "Perception and annoyance due to wind turbine noise: a dose–response relationship," J. Acoust. Soc. Am. 116, 3460–3470 (2004).
K. Persson Waye and E. Ohrstrom, "Psycho-acoustic characters of relevance for annoyance of wind turbine noise," Journal of Sound and Vibration 250(1), 65-73 (2002).
K. Persson Waye, E. Ohrstrom and M. Bjorkman, "Sounds from wind turbines – can they be made more pleasant?" In: N. Carter and R. F. S. Job (eds), 7th International congress on noise as a public health problem, pp 531-534 (22-26 Nov, Sydney, Australia 1998).
K. Persson Waye, A. Agge and M. Bjorkman, "Pleasant and unpleasant characteristics in wind turbine sounds," In: D. Cassereau (eds), Inter-Noise 2000, (August 27-30, Nice, France 2000).
K. Persson Waye and A. Agge, "Experimental quantification of annoyance unpleasant and pleasant wind turbine sounds," In: D. Cassereau (eds), Inter-Noise 2000, (August 27-30, Nice, France 2000).

5 Vandenberg, G., Pedersen, E., Bouma. J., Bakker, R. "WINDFARMperception Visual and acoustic impact of wind turbine farms on residents" Final Report, June 3, 2008.

Amplitude Modulation (Audible Blade Swish)

It is not clear whether the distinctive **rhythmic, impulsive or modulating character of wind turbine noise** (all synonyms for "thump" or "swoosh" or "beating" sounds), its characteristic low frequency energy (both audible and inaudible, and also impulsive), health effects of chronic exposure to wind turbine noise (especially at night), in-phase modulation among several turbines in a wind farm (this can triple the impulse sound level when impulses of three or more turbines become synchronized), or some combination of all of these factors best explains the annoyance. One or more of these characteristics are likely present depending on atmospheric and topographic conditions, (especially at night)[6] as is the individual susceptibility of each person to them.

Nevertheless, reports based on surveys of those living near wind farms consistently find that, compared to surveys of those living near other sources of industrial noise, annoyance is significantly higher for comparable sound levels among wind utility footprint residents. In most cases, where relationships between sound level and annoyance have been determined, annoyance starts at sound levels 10 dBA or more <u>below the sound level</u> that would cause equivalent annoyance from the other common community noise sources. Whereas one would expect that people would be annoyed by 45 dBA nighttime sound levels outside their homes in an urban area, rural residents are equally annoyed by wind turbines when the sound levels are 35 dBA independent of the time of day. Given that wind turbine utilities are often permitted to cause sound levels of 40 to 50 dBA at the outside of homes adjacent to or inside the footprint of wind utilities in the states east of the Mississippi the negative reactions to wind turbines from many of those people is understandable. Their reactions provide objective evidence in support of an expectation that a substantial number of people who live near the Glacier Hills Wind project will complain that the noise level they experience is both causing nighttime sleep disturbance and creating other problems once operation commences.[7] [8]

Although there remain differences in opinions about what causes the amplitude modulation of audible wind turbine noise most of the explanations involve **air turbulence around the turbine blades**[9]. There are a number of explanations and more than one may apply at any specific wind farm site. For example, eddies in the wind, wind shear (different wind speeds at the higher reach of the blades compared to the lower reach), slightly different wind directions across the plane of the blades, and interaction among turbines, have each been identified as causes of modulating wind turbine noise from modern upwind turbines.[10]

It is noted that consultants for wind utility developers often claim that wind turbine sound emissions inside and adjacent to the project footprint estimated by the sound propagation model's represent worst-case conditions. However, it is only true that the input data used for the turbine's acoustic energy represents the turbine's sound emissions at or above its nominal operating wind speeds under standardized weather and wind conditions. That is reasonable

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[6] G.P. Van den Berg, "The beat is getting stronger: The effect of atmospheric stability on low frequency modulated sound on wind turbines," Noise notes 4(4), 15-40 (2005) and "The sound of high winds: the effect of atmospheric stability on wind turbine sound and microphone noise" Thesis (2006)

[7] Pedersen (2007); Kamperman and James (2008); James (2009b); Minnesota Department of Health (2009), pp. 19-20.

[8] Bajdek, Christopher J. (2007). *Communicating the Noise Effects of Wind Farms to Stakeholders*, Proceedings of NOISE-CON (Reno, Nevada), available at <u>http://www.hmmh.com/cmsdocuments/ Bajdek_NC07.pdf</u>

[9] Van den Berg (2006, pp. 35-36); Bowdler (2008), Palmer (2009) and Oerlemans/Schepers (2009).

[10] Bowdler (2008)

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given that the purpose of these tests is to produce standardized data to permit a prospective buyer of turbines to compare the sound emissions from various makes and models. This needs to be understood as being similar to the US EPA's standardized gasoline mileage tests. You do not get the mileage posted on the vehicle sticker since your driving habits are different. The same is true for wind turbines and the environments in which they operate. The IEC test data does not account for the increased noise from turbulence or other weather conditions that cause higher sound emissions. A review of the IEC 61400-11, Wind Turbine Systems-Part 11: Acoustic Noise Measurement Techniques' assumptions in the body and appendices (esp. Appendix A) show that the IEC test data reported to turbine manufacturers is not 'worst case' for real world operations. Independent of the effect of weather and wind on the turbine's noise emissions, ANSI standards for outdoor noise caution that turbulence in the air can increase the downwind sound levels by 6-7 dB or more. It should be clear that any assertions by the acoustical modeler that the models represent worst case sound level estimates rely on careful phrasing and ignorance of the underlying standards and methods by the reviewers.

Impulsive sound was considered more problematic for older turbines that had rotors mounted downwind from the tower[11]. The sound was reduced by mounting the rotor upwind of the tower, common now on all modern turbines[12]. Initially, many presumed that the change from downwind to upwind turbine blades would eliminate amplitude modulated sounds (whooshes and thumps) being received on adjacent properties. However, in a landmark study by G. P. van den Berg now referred to in all serious discussions of wind turbine noise[13], it was shown that the impulsive swishing sound increases with size because larger modern turbines have blades located at higher elevations where they are subject to higher levels of "wind shear" during times of ground level "atmospheric stability." This results in sound fluctuating 3-5 dBA between beats under moderate conditions and 10 dBA or more during periods of higher turbulence[14].

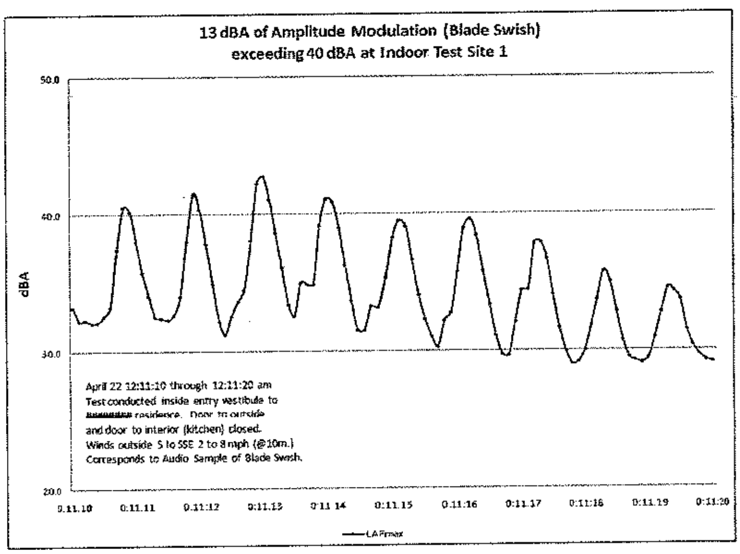

Figure 6-Audible Blade Swish inside home from New York -Wind Utility

This author has confirmed amplitude modulation (blade swish) at every wind project he has investigated. During periods of high turbulence he has measured levels of blade swish of 10-13 dBA. Figure 6's graph shows the rise and fall of the A-weighted sound levels from blade swish measured inside a closed entry vestibule to a home. This test site is approximately 1500 feet from two (2) turbines with sound emission characteristics similar to the turbines proposed for the

[11] Rogers (2006, p. 10)
[12] *Id.*, pp. 13, 16; Van den Berg (2006), p. 36.
[13] Van den Berg (2006, p. 36)
[14] *Id.*,

WEPCO project. It should be noted that the sound levels exceed 40 dBA inside the home in the rooms facing the turbines with a window partly open.

To compensate for the added annoyance of fluctuating or impulsive sound, the convention is to add a penalty of 5 dBA to computer model estimates of average sound levels to account for the increased annoyance from sort term flucuations in sound levels.[15] In the Kamperman/James criteria, this penalty is already included in its recommendation for a maximum allowable sound level at the receiving property of 35 dBA.

Frequency of Conditions that Cause Blade Swish

The phenomenon of wind shear coupled with ground level atmospheric stability refers to the boundary between calm air at ground level and turbulent air at a higher altitude. *"A high wind shear at night is very common and must be regarded a standard feature of the night time atmosphere in the temperate zone and over land."*[16] A recent paper presented at the 2009 Institute of Noise Control Engineers, Noise-Con 2009 conference in Ottawa, Canada on background noise assessment in New York's rural areas noted: *"Stable conditions occurred in 67% of nights and in 30% of those nights, wind velocities represented worst-case conditions where ground level winds were less than 2 m/s and hub-height winds were greater than wind turbine cut-in speed, 4 m/s."*[17]

Based on a full year of measurements every half-hour at a wind farm in Germany, Van den Berg found:

> *"the wind velocity at 10 m[eters] follows the popular notion that wind picks up after sunrise and abates after sundown. This is obviously a 'near-ground' notion as the reverse is true at altitudes above 80 m. . . . after sunrise low altitude winds are coupled to high altitude winds due to the vertical air movements caused by the developing thermal turbulence. As a result low altitude winds are accelerated by high altitude winds that in turn are slowed down. At sunset this process is reversed.*[18]"

In other words, when ground-level wind speed calms after sunset, wind speed at typical hub height for large wind turbines (80 meters, or 262 feet) commonly increases. As a result, turbines can be expected to operate, generating noise, while there is no masking effect from wind-related noise where people live. *"The contrast between wind turbine and ambient sound levels is therefore at night more pronounced.*[19]*"* As the turbine's blades sweep from top to bottom under such conditions the blade encounters slightly different wind velocities creating unexpected turbulence that results in rhythmic swishing noise[20]. Such calm or stable atmosphere at near-ground altitude accompanied by wind shear near turbine hub height occurred in the Van den Berg measurements 47% of the time over the course a year on average, and most often at night[21].

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[15] Van den Berg (2006), p. 106; Minnesota Department of Public Health (2009), p. 21. *See also* Pedersen (2007, p. 24) ("Amplitude-modulated sound has also been found to be more annoying than sound without modulations."

[16] Van den Berg (2006, p. 104). *See also* Cummings (2009)

[17] Schneider, C. "Measuring background noise with an attended, mobile survey during nights with stable atmospheric conditions" Noise-Con 2009

[18] (Van den Berg 2006, p. 90)

[19] *Id.*, p. 60

[20] *Id.*, p. 61. *Cf. also* Minnesota Department of Public Health (2009), pp. 12-13 and Fig. 5.

[21] Van den Berg 2006, p. 96

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Infra and Low Frequency Sounds

The level of annoyance produced by noise also increases substantially for **low frequency sound,** once it is perceived, than the more readily audible mid-frequency sounds. Sound measured as dBA is biased toward 1,000 Hz, the center of the most audible frequency range of sound pressure. Low frequency sound is in the range below 200 Hz and is more appropriately measured as dBC or using instrumentation that can provide 1/3 octave band resolution of the spectrum sound pressure levels. Sound below 20 Hz, termed **infrasound,** is generally presumed to not be audible to most people. *See* Leventhall (2003, pp. 31-37); Minnesota Department of Public Health (2009, p. 10); Kamperman and James (2008, pp. 23-24). For many years it has been presumed that only infra and low frequency sounds that reached the threshold of audibility for people posed any health risks. Many acoustical engineers were taught that if you cannot hear a sound, it cannot harm you.

Recent research has shown that the human body is more sensitive to infra and low frequency noise (ILFN) and that the organs of balance (vestibular) and cardio-vascular systems respond at levels of sound significantly lower than the thresholds of audibility. [22] Dr. Nina Pierpont has conducted a peer reviewed study of the effects of infra and low frequency sound on the organs of balance that establishes the causal link between wind turbine ILFN and medical pathologies. The new research is not from the traditional fields that have provided guidance for acoustical engineers and others when assessing compatibility of new noise sources and existing communities. This research is coming from the field of medical research into how our bodies respond to external energies at the cellular level. Numerous studies are now available showing how the body responds to extremely low levels of energy not through the traditional organs of auditory and balance, but at the level of cell activity.

To get a idea of just how outdated our understanding is of the way our bodies interact with the energies and forces around us I would like to share a short piece that was sent to me by Eileen Mulvihill, a genetic biologist who received her Ph.D. in Molecular Biology from the Université Louis Pasteur, Strasbourg, France. She holds six patents for discoveries she made during her career. Her point is to demonstrate how our body's cells and molecules function as sensory receptors that augment the sensory organs, like our auditory and vestibular organs. Most of us learned that we have primary sensory organs and they perform all the needed functions for sensing the world around us (especially those who have not remained current with research in the field of molecular and cellular biology). It is this, now outdated view-point that leads some of the wind industry acoustical experts to still claim that 'If you can't hear it, it can't hurt you." In other words, they believe that because our auditory function (outer, middle, and inner ear) is not as sensitive to infra and low frequency sounds (rumble) as it is to mid and high frequency sounds (where speech occurs); and, that the infra and low frequency sounds from wind turbines are not loud enough to be heard by <u>most</u> people, there is no potential for adverse health effects. She recently provided a good example of research that shows how our body can sense external forces. In other words, she describes other ways we sense acoustic energy, like low frequency

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[22] Alves-Pereira, Marianna and Nuno A. A. Branco (2007a). *Vibroacoustic disease: Biological effects of infrasound and low-frequency noise explained by mechanotransduction cellular signalling*, 93 PROGRESS IN BIOPHYSICS AND MOLECULAR BIOLOGY 256–279, available at http://www.ncbi.nlm.nih.gov/ pubmed/17014895><
and, Alves-Pereira, Marianna and Nuno A. A. Branco (2007b). *Public health and noise exposure: the importance of low frequency noise*, Institute of Acoustics, Proceedings of INTER-NOISE 2007,

sounds, through cellular level mechanisms not related to dedicated sensory organs. She offered the following example using a paper by Dr. D. Ingber:

> "Anyone who is skilled in the art of physical therapy knows that the mechanical properties, behavior and movement of our bodies are as important for human health as chemicals and genes. However, only recently have scientists and physicians begun to appreciate the key role which mechanical forces play in biological control at the molecular and cellular levels.
>
> "An article by Dr. D. Ingber, who first described the model of tensegrity, describes what his team has learned over the past 30 years as a result of their research focused on the molecular mechanisms by which cells sense mechanical forces and convert them into changes in intracellular biochemistry and gene expression-a process called "mechanotransduction".
>
> "Ingbers Prog Biophys Mol Biol. 2008 Jun-Jul;97(2-3):163-79. Epub 2008 Feb 13 work has revealed that molecules, cells, tissues, organs, and our entire bodies use "tensegrity" architecture to mechanically stabilize their shape, and to seamlessly integrate structure and function at all size scales. Through the use of this tension-dependent building system, mechanical forces applied at the macroscale produce changes in biochemistry and gene expression within individual living cells.
>
> **"This structure-based system provides a mechanistic basis to explain how application of physical impacts, such as low frequency sound, influences cell and tissue physiology."** (Emphasis added)

What she is describing is the process by which low levels of energy can affect hormone production which by their actions result in adverse health effects. There are many more and smaller receptors for sensory input that than just our dedicated organs. Because these receptors are so small they may be far more sensitive to low amplitude, low frequency sound than the studies conducted focusing on the auditory and vestibular organs only would reveal. Also, remember that low frequency sound penetrates into our body with little attenuation in the same way that it passes through the walls and roofs of our homes.

We are also finding that new research tools not available to the researchers who are frequently quoted by wind developers in their defense are showing that our auditory and vestibular organs themselves are more sensitive than previously known. In Dr. Pierpont's forthcoming study, Wind Turbine Syndrome, she cites the research of Drs. Todd, Rosengrenm, and Colebatch in their paper "Tuning and sensitivity of the human vestibular system to low-frequency vibration" published in Neuroscience Letters 444 (2008) 36–41. In this paper they present the findings of a study in the abstract as:

> "Mechanoreceptive hair-cells of the vertebrate inner ear have a remarkable sensitivity to displacement, whether excited by sound, whole-body acceleration or substrate-borne vibration. In response to seismic or substrate-borne vibration, thresholds for vestibular afferent fibre activation have been reported in anamniotes (fish and frogs) in the range −120 to −90 dB re 1 g. In this article, we demonstrate for the first time that **the human vestibular system is also extremely sensitive to low-frequency and infrasound vibrations** by making use of a new technique for measuring vestibular activation, via the vestibulo-ocular reflex (VOR). We found a highly tuned response to whole-head vibration in the transmastoid plane with a best frequency of about 100 Hz. At the best frequency we obtained VOR responses at intensities of less than −70 dB re 1 g, which

was **15 dB lower than the threshold of hearing** for bone-conducted sound in humans at this frequency. Given the likely synaptic attenuation of the VOR pathway, human receptor sensitivity is probably an order of magnitude lower, thus approaching the seismic sensitivity of the frog ear. These results extend our knowledge of vibration-sensitivity of vestibular afferents but also are remarkable as they indicate that the **seismic sensitivity of the human vestibular system exceeds that of the cochlea for low-frequencies.**" (Emphasis added)

These examples are provided to demonstrate that there is sufficient evidence to present a causal link between ILFN and adverse health effects. The typical acoustician has not caught up on these new understandings of how our bodies respond to infra and low frequency sound levels. These levels were only a few years ago considered too low to cause any physical response. Once we understand that what you cannot hear, can hurt you; we will be in a better position to develop the procedures and criteria to use wind turbines as a renewable energy resource but until the time when the necessary studies have been completed it is appropriate to follow the precautionary principle and not expose the public to a potential health risk.

Wind turbine noise includes a significant low-frequency component, including inaudible infrasound as shown in Figures 3 through 5. For example, according to the manufacturer, under ideal test conditions at a distance of 200 meters (656 feet), a single 2.5 MW Nordex N80 wind turbine generates 95 decibels at 10 Hz[23]. This is at the threshold of human hearing for the average person and above the threshold for the most sensitive individuals.[24] The Nordex study also showed that sound pressure levels were highest at the blade passage frequency (between 1 and 2 Hz) and dropped off with increasing frequency. Thus, we can expect that below 10Hz sound pressure levels were higher than 95 dB.

Although low frequency sound is in the less-audible or inaudible range, it is often felt rather than heard. Unlike the A-weighted component, the low-frequency component of wind turbine noise *"can penetrate the home's walls and roof with very little low frequency noise reduction.*[25]*"* Acoustic modeling for low frequency sound emissions of ten 2.5 MW turbines indicated *"that the one mile low frequency results are only 6.3 dB below the 1,000 foot one turbine example.*[26]*"* This makes the infra and low frequency sound immissions from wind turbines a potential problem over an even larger area than the audible sounds, such as, blade swish and other wind turbine noises in the mid to high frequency range.

2) Background Sound Levels

Apart from the distinctive characteristics of wind turbine noise, including its low frequency component, the quiet soundscapes found in rural and semi-wilderness areas accentuate the perceived annoyance and potential for sleep disturbance. The WPSC has procedures for how to assess the pre-operational background sound levels that were designed for the types of communities in which the more traditional power generating utilities are located. Whether these are adequate for wind utilities located in quiet communities remains to be determined. It is not in the scope of this report to anticipate any needed changes, but the discussion above relative to the potential issues related to infra and low frequency sound does

[23] Nordex (2004, p. 4).
[24] Rogers et al. (2006, p. 9, table 5)
[25] Kamperman and James (2008), p. 3.
[26] *Id.*, p. 12

imply that some method of assessing and controlling the lower frequency sounds is warranted.

The first background sound assessment that was submitted was flawed by instrumentation setup errors. These errors were observed and reported by George Kamperman when he conducted an independent assessment of background sound levels.[27] Mr. Kamperman reported background sound levels at the four test sites ranging from 20 to 31 dBA (L_{A90}) and L_{A50} ranging from 23 to 35 dBA. The revised background sound study by Mr. Hessler (Aug. 9, 2009) reports the background sound levels as being between 28 and 35 L_{A90} and 51 to 60 L_{A50}. It is difficult to understand why there is such a discrepancy between the L_{A50} values if sites and conditions were equivalent.

In discussions with Mr. Kamperman regarding these differences it was noted that the Hessler test sites were not at the residents' homes, but instead, were located near wind monitors. Mr. Kamperman summarized his observations as follows:

> "Rick:
>
> "Your note reminded me of Hessler's four measurement locations at Glacier Hills. He did not select any locations near residents. He stated in his report that his measurements were near wind monitors. His measurements were on public roads near wind monitors and always on a hilltop. "Near" means approximate. Monitor A and B appeared to be about 1/4 mile (my guess not measured) east of the N-S road. Monitor A appeared to be equal distance from SR-33 and the N-S road to the west. Monitors C and D are a couple hundred feet west of Mon. 4 and 3 respectively. No Hessler microphone measurement locations appeared to be near residents except possibly Mon. 1. Traffic noise from SR-33 is the primary environment noise source in the Glacier Hills area.
>
> "I visited Glacier two consecutive evenings in June to measure background noise level at the Hessler Mon. 1-4 locations. The first evening had to be scrubbed because of high surface winds. Although a local resident farmer confirmed the Ethanol plant was operating normally I could barely hear the plant operation either night at position Mon. 1. Traffic noise from SR-33 (1/2 mile south) was dominant.

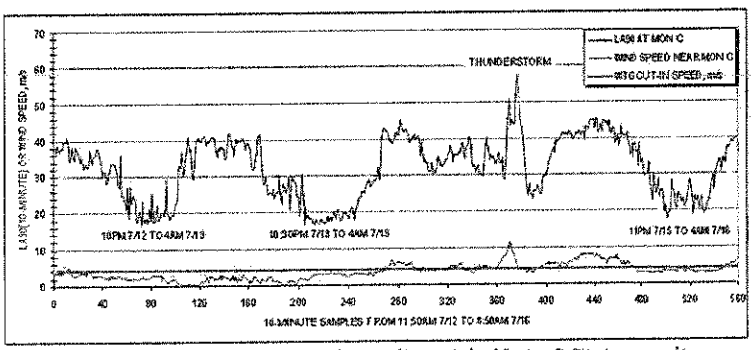

Figure 3: Continuous LA90 sound level over a 4-day sampling period at Monitor C, Site 4 compared to measured wind speed at a height of 10 meters.

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> "First look at the Glacier Hills new background noise data from Hessler. Figure 3 shows the background noise level 1/4 mile south of SR-33 with line-of-sight between the Mon 4 microphone and a long section of the highway. Here we see the lowest L_{A90} levels are about 17 dBA on three of the four nights. ANSI Std. integrating sound level meters

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[27] Kamperman, G. W., P.E., INCE Bd. cert., "Critique of background sound measurements reported by Hessler Associates, Inc. "Noise Assessment Glacier Hills Wind Park" October 2008," Dated June 15, 2009

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typically exhibit a noise floor between 15 dBA and 17 dBA. Therefore I can presume the actual minimum ten minute L90 background noise level to be 14 dBA, or less, next to SR-33. When nighttime traffic noise is this quiet I would expect the nearest resident near Mon. 1 northeast (3/4 miles) of the Ethanol plant can clearly hear normal plant operations.

"If we assume from Figure 3 daytime SR-33 traffic noise elevates the background to 40 dBA during daytime at Mon. 4 (C) 1/4 mile south we should expect the same traffic noise to be about 37 dBA at the near farmhouse 1/2 mile north near Mon. 1 (A). So our farmhouse may experience a daytime/nighttime ten minute background noise level of 37dBA/14 dBA a 23 dBA day/night variation. Now try to imagine the noise impact with the introduction of 50 dBA wind turbine noise 24/7."

Is this the explanation for the differences between the two 2009 studies? It may be that Mr. Hessler selects his test sites with the intention of biasing the test results. This is something that has been observed in other tests he and his firm have conducted for wind developers. The background sound study Hessler and Associates conducted for a wind developer in the upper New York area near Cape Vincent was questioned by members of that community. They commissioned an independent Study by Dr. Paul Schomer, who is the Chair of the Acoustical Society of America's Standards Committee and is highly respected for impeccable work by his peers.[28] Dr. Schomer concluded that:

"Hessler's BP study for the Cape Vincent Wind Power Facility appears to have selected the noisiest sites, the noisiest time of year, and the noisiest positions at each measurement site. Collectively, these choices resulted in a substantial overestimate of the a-weighted ambient sound level, 45-50 dB according to Hessler."

The complete Cape Vincent study is provided with the references. If should be reviewed by the WPSC to determine if the WEPCO sound study was free from similar bias.

Other studies of background sound levels in rural communities confirm the results of Mr. Kamperman's study. For example, similarly low background sound levels were also reported in the study by Mr. Clifford Schneider[29]. Schneider reported that the median L_{A90} sound level for approximately 20 test locations in northern New York was 25.5 to 26.7 dBA. This reviewer has also found that in rural areas background sound levels are typically less than 30 L_{A90}. When sampling is conducted during the evening hours when community activities are at a minimum the L_{Aeq} and the L_{A90} are usually within 5 dB of each other. It is during this time that the sounds from the wind turbines will be most apparent and it is against those low background sound levels that land-use compatibility should be assessed.

While on the topic of nighttime sound levels it should be noted that the World Health Organization (WHO) revised its guidelines for nighttime noise in 2007. The revised guidelines supersede the guidelines commonly referenced from 1999 and before.[30] These guidelines provide the definition of what is required for a causal link to be established between a exterior forcing agent like noise and health. They state:

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[28] Schomer, P., PE, INCE Bd. Cert., "Cape Vincent Background Noise Study," May 11, 2009

[29] Schneider, C. "Measuring background noise with an attended, mobile survey during nights with stable atmospheric conditions" Noise-Con 2009

[30] WHO Night Noise Guidelines (2007)

*"**Sufficient evidence:** A causal relation has been established between exposure to night noise and a health effect. In studies where coincidence, bias and distortion could reasonably be excluded, the relation could be observed. The biological plausibility of the noise leading to the health effect is also well established.*

*"**Limited evidence:** A relation between the noise and the health effect has not been observed directly, but there is available evidence of good quality supporting the causal association. Indirect evidence is often abundant, linking noise exposure to an intermediate effect of physiological changes which lead to the adverse health effects."*

Table 3. Summary of the relation between night noise and health effects in the population

$L_{night\text{-}outside}$ up to 30 dB	Although individual sensitivities and circumstances differ, it appears that up to this level no substantial biological effects are observed.
$L_{night\text{-}outside}$ of 30 to 40 dB	A number of effects are observed to increase: body movements, awakening, self-reported sleep disturbance, arousals. With the intensity of the effect depending on the nature of the source and on the number of events, even in the worst cases the effects seem modest. It cannot be ruled out that vulnerable groups (for example children, the chronically ill and the elderly) are affected to some degree.
$L_{night\text{-}outside}$ of 40 to 55 dB	There is a sharp increase in adverse health effects, and many of the exposed population are now affected and have to adapt their lives to cope with the noise. Vulnerable groups are now severely affected.
$L_{night\text{-}outside}$ of above 55 dB	The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a high percentage of the population is highly annoyed and there is some limited evidence that the cardiovascular system is coming under stress.

End of WHO 2007 Guideline Excerpts

In Table 3 of the 2007 Guidelines, WHO presents the maximum sound levels that should be permitted outside the walls of a home to prevent adverse health effects. The new criteria are based on recent research into nighttime noise and health that was not available when the 1999 guidelines were published. The outdoor criteria ($L_{night\text{-}outside}$) represent the long term conditions, not a single night's exposure. Table 3 shows that nighttime sound levels of 30 dBA and under pose no health risks. However, nighttime sound levels of 40 to 50 dBA as projected for homes in the footprint of Glacier Hills would result in "a sharp increase in adverse health effects, and many of the exposed population are now affected and have to adapt their lives to cope with the noise.

An article in Noise and Health by Dr. Levanthall addresses these coping mechanisms for people exposed to noise.[31] It deserves careful reading by the WPSC. It describes the coping mechanisms and other adaptations to life style that people adopt when exposed to ILFN over long periods of time. It is interesting to note that many of the coping mechanisms in that article are used by people who are now living in the footprint of wind utilities like Glacier Hills. Indeed, there has been an ongoing debate between Dr. Leventhall and Dr. Pierpont about the risks of exposure to wind turbine sounds that seem to be contradicted by the statements of Dr. Leventhall in this article. If it can be assumed that the causal link between wind turbine noise exposure and the ILFN from wind turbines is established by the new medical research referenced earlier, and the levels of ILFN required to initiate a response from our bodies is lower than previously thought, then the disagreement between them appears to resolve in favor of Dr. Pierpont's research.

[31] Leventhall, H. G. "Low Frequency Noise and Annoyance," Noise and Health, Vol. 6, Issue 23, Page 59-72 (2004)

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3) Computer Model Predictions

Studies on behalf of WEPCO presenting computer simulations that purportedly estimate the "worst-case" sound levels that will be received in the community should be viewed with serious skepticism. Models are representations and simplifications of complex interactions between noise emitters, and their surrounding environment. Models are not precise instruments, and are not any better than the input data used to represent the noise source and accuracy of the algorithms used to represent how sound decays with increasing distance from the location of each source. For specific situations of modeling wind turbines in complex terrain, such as ridges and valleys, acoustical models are seriously challenged. The ability of the model to accurately replicate how the sounds are blocked by terrain or reflected by terrain is especially weak. Errors in models of wind turbine noise propagation located on flat terrain have been shown to have errors of 5 to 10 dB or more when studied by independent acoustical engineers. It would be expected that errors of this magnitude or higher would be found in models of more complex terrain such as is found in the community near WEPCO's footprint.

This range of levels is understandable, given the discussion earlier in this report about the assumptions in the modeling process and also in the input data used to replicate the more important interactions as the wind turbine's sound propagates into the community. First, the model estimates a single number at a receiving site. This is an average value, representing for the input data and assumptions a yearly estimate of the sound immissions at the receiving site. It also does not reflect all of the conditions that can lead to higher sound immissions from blade swish and other weather induced effects on the turbine's noise.[32] Sometimes it is easier to understand this variability visually. The chart in Figure 7, was presented to the citizens of Mars Hill, Maine in December of 2008 by the Director of the Maine Bureau of Land and Water Quality which includes the Dept. of Environmental Protection. Maine's MDEP commissioned a four quarter study of the sound levels under various operating conditions and seasonal variations. This chart shows the 'best' of the data that was hand selected to represent only sound levels when wind turbines were operating and clearly audible. The test site is over 2000 feet

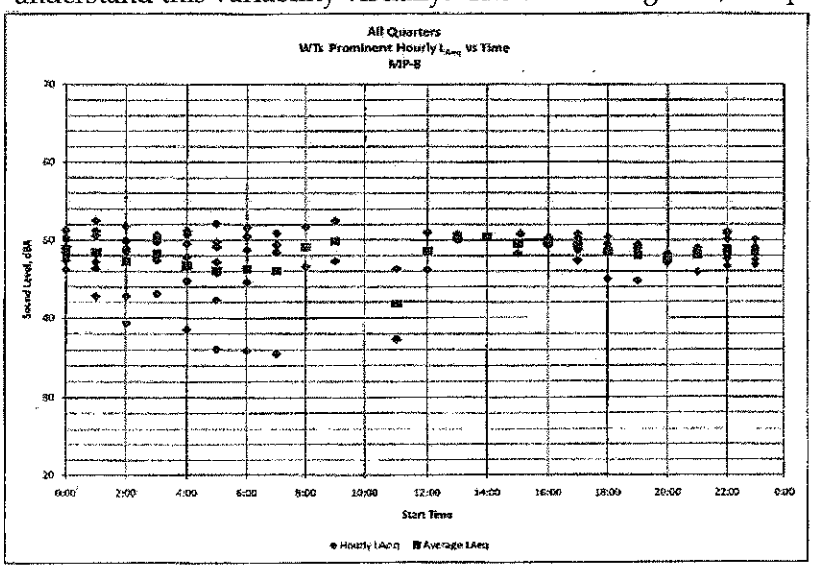

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Figure 7-Chart showing range of sound levels at one Mars Hill test site from four quarterly sound studies

[32] Ebbing, C. E. Some Limitations and Errors in Current Turbine Noise Models, Report for Appeal of Record Hill Wind decision in Maine.

from the nearest wind turbine, a 1.5MW upwind model. Note that the sound levels range from a low of about 35 dBA to a high of just over 52 dBA. All of these represent wind turbine sounds and not wind or other artifacts. The initial model estimated that the sound levels at this site would be 47.5 dBA. Sound levels higher than 52 dBA were observed but winds prevented accurate measurement.

Assuming that wind and other factors can result in a 17 dB range of sound levels for this operating wind utility, and that measurements during the highest noise conditions were precluded by wind speeds at the microphone exceeding the limits of the wind screen, how can any study of a operating wind utility claim that the levels estimated by the model were found during a single series of field tests. If the model reflects 'worst-case' wind speeds for the turbine, how can the follow-up study claim that test results for operating conditions that were not part of the model's assumptions demonstrate the model is accurate? The truth of the matter is that when the person who constructs the model is permitted to assess its accuracy the results should be viewed with suspicion. It is in that light that this reviewer views the results of the model presented in the October 2008 study by Mr. Hessler. It is suggested that the WPSC view the estimates of sound propagation in the same way. It is at best a guide to estimate how the sound will affect the community, but to imply that the results have a high degree of accuracy is to stretch the credulity of the reviewer.

Furthermore, studies that use models normally disclose the strengths and weaknesses of the models and also disclose the input data and other important assumptions. They give appropriate cautions and disclose error tolerances for all possible known conditions that the model does not consider. This is not done in the WEPCO study. The model is poorly documented and missing important data if the study is to be critically reviewed by others competent to do so.

Much could be said again about the flaws in computer modeling of sound in complex situations but that evidence has been previously submitted. The arguments are academic and not something that most non-engineers would not care to review. Therefore, the easiest way to establish that wind turbine models underestimate sounds at properties adjacent wind utilities is to look at existing wind projects. Since most, if not all, follow-up sound studies in Wisconsin were conducted by acoustical consultants with strong ties to the wind utility developers it is reasonable to look at projects outside of Wisconsin. This review has conducted studies of operating wind utilities in many different states, and in Ontario. In all cases the projects were granted permits based on sound studies claiming the community had high background sound levels, came with discussions of how wind noise masks turbine noise, and presented wind turbine sound models estimating levels in the low to mid 40 dBA range at the nearest properties. Note how close the parallel is to what WEPCO has presented for the Glacier Hills wind utility under consideration. But, what has happened at those locations? The promises of compatibility with existing community sound levels, of no potential for nighttime sleep disturbance or low frequency 'vibrations' have been replaced with numerous complaints about noise and health to the local Boards. In some cases this has escalated to threats of litigation.

Given that track record, it is a safe assumption to consider the WEPCO models to be estimates of turbine noise under optimum operating conditions and nothing more.

4) Supplemental information provided by WEPCO (Leventhall et. al.)

Recent studies link low frequency noise impacts to impairment of the vestibular system or other organs.[33] This new link between health and noise should be considered along with studies showing that wind utility noise from turbines operating at distances of up to one mile is a cause of sleep disturbance for a vulnerable minority, and chronic sleeplessness results in adverse health effects. The supplemental reports provided by WEPCO written by Dr. Leventhal and others take issue with this position.

Kamperman/James

There are two primary issues that require a response to the comments on the K/J paper.

Dr. Leventhall's review of the Kamperman/James paper asserts that:

1. K/J are too focused on ILFN, and
2. The proposed criteria using the difference in a-weighted sound levels and c-weighted sound levels should not apply.

Information provided earlier in this report demonstrated that wind turbines do produce ILFN and that new research, not well known by acoustical engineers, show that the levels of acoustical energy are in the range of perception for at least a small segment of the exposed population. With respect to whether wind turbines emit ILFN, consider that if one totals the acoustic energy of a wind turbine across the entire frequency spectrum from 16Hz up to the speech frequencies, the difference in the sum of the energy below 200 Hz is often 10-15 dB higher than the sum of the energy at 200 Hz and above. It is clear that wind turbines are primarily producers of noise in the ILFN range.

Any critique of the K/J emphasis on ILFN must consider that the recommendations be seen as precautionary. At the time the manuscript was prepared there was less information about the nature of the sound immission in operating wind utilities. Based on information culled from studies of some of the first wind projects in the US and other countries, it was decided that there was a need for a limit to ILFN as a precaution. We did not know, at that time, if all wind turbines produced the same spectrums as those we saw in the sound tests conducted for many of the participants in Dr. Pierpont's study. But, based on the initial indications, and our experience with other large fans, and related problems in work areas subject to 'rumble' it was decided to include criteria that would severely limit any increases in the existing long term ILFN to which people in rural areas are typically exposed. Dr. Leventhall's critique misses this important point. The focus by K/J on ILFN was initially precautionary. Subsequent to the development of those criteria additional information has been accumulated that supports the need for that precaution.

Even if only 5-10% of the people living in the footprint of an operating wind utility are susceptible, that is still a large number and given the fast rate at which wind utilities are being constructed this number will continue to increase. The K/J manuscript is written to apply the Precautionary Principle to what we do and do not know about the causal links and the short

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[33] See Alves-Pereira and Branco, 2007; (linking the low-frequency component of wind turbine noise to abnormal growth of collagen and elastin in the blood vessels, cardiac structures, trachea, lungs, and kidneys of humans and animals exposed to infrasound (0–20 Hz) and low-frequency noise (20–500 Hz), in the absence of an inflammatory process). See also Pierpont "Wind Turbine Syndrome" study (2009) and Minnesota Department of Public Health (2009), pp. 7-8.

and long term health effects of wind turbine noise emissions. The criteria developed in that manuscript (which the reviewer encourages the WPSC to consider as a replacement for the current 50 dBA criteria) are based on that principle. When solving one problem, the need for clean energy, it is not appropriate to expose people to a second problem, a potential health risk. It is hoped that the discussion about the causal links between ILFN and adverse health effects can help the debate between those that are concerned about health effects and those who continue to deny need for such caution can now progress beyond the 'if you can't hear it, it can't hurt you' stage of argument. When, new information of the type disclosed by Dr. Pierpont and others is made available, wind turbine manufacturers and reasonable experts will try to understand these new concepts before rejecting them in favor of the former beliefs.

Dr. Leventhall's critique of K/J's use of C-A demonstrates that he did not conduct a careful review of the manuscript. If he had done so, he would have noticed that the subscripts for the C-A criteria are: $L_{Ceq\,(immission)}$ minus ($L_{A90\,(background)}$ +5) ≤ 20 dB. This formulation is again an application of the precautionary principle. Given that we do not know how much increase in ILFN is needed to trigger an adverse health effect, the criteria was established to limit the additional ILFN from the operating turbines to no more than a small increase over the pre-operational background sound levels. In addition, the K/J paper suggests that the L_{Ceq} when the turbines are operating $L_{Ceq\,(immision)} = L_{C90}(background)$ +5 dB. In both cases, the justification is precaution. Until the extent of the links between nighttime sleep disturbance from audible sounds; and vestibular and cardio pathologies from audible sound or ILFN are known, it is best to error on the side of safety and health.

Pierpont

The symptoms reported by Dr. Pierpont for people exposed to dynamically modulated ILFN from wind turbines are not that different from the symptoms reported by Kirsten Persson Waye in collaboration with Dr. Leventhal in their 1997 paper "*Effects On Performance And Work Quality Due To Low Frequency Ventilation Noise*,"[34] This study compared the performance and other factors for a work group that was exposed to dynamically modulated low frequency sound to that of a work group exposed to more normal HVAC system sound spectrum with lower levels of LFN and no modulation. This study reported that the group exposed to LFN reported:

1. subjective estimations of noise interference with performance were higher for the low frequency noise (exposed group)

2. The exposure to low frequency noise resulted in lower social well-being ('96 words) "more disagreeable, less co-operative, helpful and a tendency to lower pleasantness "more bothered, less contented as compared to the mid frequency noise (exposed group)

3. Data may indicate that the response time during the last part of the test was longer in the low frequency noise exposure e.g. cognitive demands were less well coped with under the low freq. noise condition.

4. The effects seemed to appear over time

5. The hypothesis that cognitive demands are less well coped with under the low frequency noise condition needs to be further studied.

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34 *Journal of Sound and Vibration* (1997), 205(4), 467-474

They also reported that a "few previous studies indicate that low frequency noise may reduce performance at levels that can occur in such occupational environments. Some of the symptoms that are related to exposure to low frequency noise such as

1. Mental tiredness,
2. Lack of concentration and
3. Headache related symptoms,

could be associated with a reduced performance and work satisfaction."

"The reported symptoms and effects on mood were apart from tiredness in accordance with earlier findings on effects after exposure low-frequency noise. The subjects reported a feeling of pressure on the head rather than headache and lower social orientation and pleasantness after low-frequency noise exposure (Persson-Waye 1995)."

Given that this study identified adverse health effects from dynamically modulated LFN that is similar in level to what is experienced inside the homes of people living near turbines, one might think that Dr. Leventhal would embrace the new medical studies and Dr. Pierpont's research as a possible answer to the HVAC study's findings. The symptoms listed in Dr. Pierpont's report are very similar to those reported in the HVAC study.

5) Conclusion

The World Health Organization (WHO) has a long established position that considers sleep disturbance to be an adverse health effect and to lead to secondary adverse health effects[35]. Dr. Leventhal did not seem to think this was important enough to include in his critique of K/J or of Dr. Pierpont. Nothing about these guidelines was mentioned in either of Mr. Hessler's reports. Chronic sleeplessness, in turn, causes a variety of health effects, including "*primary physiological effects . . . induced by noise during sleep, including increased blood pressure; increased heart rate; increased finger pulse amplitude; vasoconstriction; changes in respiration; cardiac arrhythmia; and an increase in body movements.*[36]" "*Exposure to night-time noise also induces secondary effects, or so-called after effects . . . including reduced perceived sleep quality; increased fatigue; depressed mood or well-being; and decreased performance.*[37]" Waking up in response to nighttime noise decreases as people get habituated to the noise; however, "*habituation has been shown for awakenings, but not for heart rate and after effects such as perceived sleep quality, mood and performance.*"[38]

WHO issued the 2007 Night Time Noise Guidelines (NNGL) as a replacement for the 1999 Guidelines. These guidelines are intended to replace all earlier guidelines with respect to sleep and noise. They supersede the prior guidelines that recommended that sleeping rooms be protected from outside sound that raises sound levels inside to above 30 dBA. Because the earlier guidelines provided a limit in terms of interior sound levels and also included special conditions when low frequency sounds were present outside the home WHO explains that it was decided there was too much room for interpretation of their research findings. Thus, in 2007, following several years of research by respected experts in health and noise and three major meetings to present their findings WHO issued the new guidelines. This time, they elected to establish the guidelines for the outside façade of the home and not the sleeping area.

[35] WHO (1999), pp. 44-46
[36] Id., p. 44.
[37] Id., pp. 44-45
[38] Id., p. 45.

This avoided issues such as whether windows are open and if so how much and also issues of various types of building construction that affect how low frequency sounds penetrate into the home. The focus was to establish science based guidelines that would promote healthful sleep.

The table excerpted from WHO's 2007 guideline clearly states that to avoid adverse health effects during sleeping hours that the sound levels at the outside wall of a home should not exceed 30 dBA at night. It also states that when sound levels outside a home are over 40 dBA there is a sharp increase in adverse health effects; that people would be attempting to adapt to cope with the high outdoor noises, and that the more vulnerable members of the exposed population would be severely affected. These are the same sound levels that WEPCO has claimed are compatible with the community and safe for the people living under and adjacent to the turbines. WHO's descriptions of the health effects on the exposed populations closely parallel the experiences of people in other communities where wind utilities are currently operating.

The new guidelines from WHO and other recent medical research have led several health organizations to call for serious research before more wind turbines are located near people's homes. Recently, Health Canada, which functions much as the US Center for Disease Control does in the US, issued a position statement calling for reconsideration of a wind utility project in Nova Scotia that would result in sound levels at homes similar to those projected for the WEPCO project. The basis for their statement includes the new medical research, Guidelines such as WHO's, and the existence of other projects in Nova Scotia where the studies submitted for permitting showed no potential for health risks or complaints but operation of the utilities resulted in them anyway. The Maine Medical Association, which has been evaluating new health research on residents of Maine's first wind utility at Mars Hill, issued a Resolution stating:

"WHEREAS, there is a need for modification of the State's regulatory process for siting wind energy developments to reduce the potential for controversy regarding siting of grid-scale wind energy development and ***to address health controversy with regulatory changes...****"* (emphasis added)

Wisconsin's medical community has yet to address the health controversy with a call for regulatory changes, but the situation in Wisconsin is similar to that in Maine. Public officials with a duty to protect the public health and welfare should seriously consider whether it is a wise decision to grant permits to a utility operator that, by its own admission, will expose the public to unsafe conditions 24 hours a day and 365 days a year.

It should be of great significance to those who wish to be fair and impartial in making decisions that affect the public and its health that many of the complaints this author has been asked to evaluate for residents and local governments including wind utilities operating or proposed in New York and other states, Canada, the U.K., and, places as remote as New Zealand are all directly related to noise resulting from operation of turbines during conditions excluded from the IEC test results and the sound propagation models.

Has WEPCO in its reports, presentations, studies and recommendations to the WPSC discussed these negatives and uncertainties in an open manner or have they focused on defending themselves when these issues have arisen through public questions? Have they disclosed that there are operating wind utilities, possibly even some of their own, where complaints or lawsuits have been lodged?.

Finally, this caution is offered. If the data submitted by WEPCO has created the impression with the WPSC that there will be no future problems from noise they should consider that these same assertions were made to other government officials tasked with deciding on whether or not to issue permits. The local government officials of areas affected by WEPCO's plans for a wind utility will be in the same place as the officials of other communities where anger, complaints, and litigation are common. Those other officials, or their successors, are now facing complaints and threats of litigation from the people living in their wind utility's footprint.

The background sound levels obtained by an independent acoustical consultant (Kamperman) shows that existing conditions at Glacier Hills are often below 30 dBA. Operation of wind turbines will increase sound levels on a routine basis to 40-45 dBA for many local residents and above that for conditions not accounted for in the models. For WEPCO to meet WHO's guidelines the limits for sound at affected properties would need to be set at 35 dBA or lower. The studies and representations by WEPCO show that estimated sound levels at properties adjacent to and inside the footprint of the proposed utility will exceed the nighttime sound levels WHO has identified as a health risk. Experience with other wind utilities with operating turbines having similar sound emission characteristics shows that wind turbine noise levels at distances of 1500 feet can exceed 50 dBA and that sound levels inside homes can easily exceed 30 dBA.

Based on the above, the WEPCO project, as proposed, will, with a high degree of certainty, have noise and health impacts that are "significant."

End of Report Narrative

Richard R. James, INCE,
For E-Coustic Solutions

Richard R. James

Date: Oct. 5, 2009

Details on References not provided in Narrative:

1) Alves-Pereira, Marianna and Nuno A. A. Branco (2007a). *Vibroacoustic disease: Biological effects of infrasound and low-frequency noise explained by mechanotransduction cellular signaling*, 93 PROGRESS IN BIOPHYSICS AND MOLECULAR BIOLOGY 256–279, available at http://www.ncbi.nlm.nih.gov/ pubmed/17014895><

2) Alves-Pereira, Marianna and Nuno A. A. Branco (2007b). *Public health and noise exposure: the importance of low frequency noise*, Institute of Acoustics, Proceedings of INTER-NOISE 2007, http://www.bevarandmyran.com/publikasjoner/ILFN.pdf>Istanbul (Turkey),

3) Bajdek, Christopher J. (2007). *Communicating the Noise Effects of Wind Farms to Stakeholders*, Proceedings of NOISE-CON (Reno, Nevada), available at http://www.hmmh.com/cmsdocuments/ Bajdek_NC07.pdf

4) Bolton, R. H. (2006). EVALUATION OF ENVIRONMENTAL NOISE ANALYSIS FOR "JORDANVILLE WIND POWER PROJECT" (public comments).

5) Bowdler, Dick (2008). *Amplitude modulation of Wind Turbine Noise. A Review of the Evidence.* 33:4 INSTITUTE OF ACOUSTICS BULLETIN.

6) Cavanagh Tocci Assocs. (2008). CAPE VINCENT POWER PROJECT (report to Town of Cape Vincent, NY).

7) Cummings, Jim (2009). *AEI Special Report: Wind Turbine Noise Impacts* (Acoustic Ecology Institute, Santa Fe, NM), available at <AcousticEcology.org/srwind.html>.

8) Davis, Julian and S. Jane Davis (2007). *Noise Pollution from Wind Turbines: Living with amplitude modulation, lower frequency emissions and sleep deprivation*, presented at Second International Meeting on Wind Turbine Noise, Lyon (France).

9) James, Richard R. (2009a). Letter to Gary A. Abraham, Esq. [re: Everpower Renewable wind project in Allegany, New York].

10) James, Richard R. (2009b). A REPORT ON LONG TERM BACKGROUND (AMBIENT) SOUND LEVELS AT SELECTED RESIDENTIAL PROPERTIES, MACHIAS, NY, June 2009.

11) Kamperman, George and Richard R. James (2008). Simple guidelines for siting wind turbines to prevent health risks, The Institute of Noise Control Engineering of the USA, 117 Proceedings of NOISE-CON 2008 1122-1128, Dearborn, Michigan, available at <http://www.inceusa.org/

12) Oerlemans, S., Schepers, G. "Prediction of wind turbine noise directivity and swish" Third International Meeting on Wind Turbine Noise Aalborg Denmark 17 – 19 June 2009

13) Palmer, P.Eng., K., "A New Explanation for Wind Turbine Whoosh – Wind Shear" Third International Meeting on Wind Turbine Noise Aalborg Denmark 17 – 19 June 2009

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From: Mills, Dora A.
Sent: Monday, November 30, 2009 6:13 AM
To: Margerum, Mark T
Subject: RE: Helath Effects of Wind Turbine Noise
I am so very sorry not to respond to this. I've been extremely consumed by managing H1N1 activities for the past few weeks and have not been able to do anything else. In scanning these documents, they do not alter my views on things. But, let me know if there is anything else I can do. Thanks! Dora

---

From: Margerum, Mark T
Sent: Monday, October 19, 2009 4:31 PM
To: Mills, Dora A.
Subject: Helath Effects of Wind Turbine Noise

Dr. Mills,

I am a project manager in the Bureau of Land and Water Quality at the DEP. An attorney has submitted the attached documents for the DEP's consideration in our review of the proposed Oakfield Wind Project. The documents, listed below, are in support of his argument that the Oakfield Wind Project will have adverse health impacts on local residents. I would like to request that you review these documents to see if they would alter your previously expressed opinions on the health impacts of wind turbine noise and the adequacy of the DEP's noise regulations to protect the public from potential health impacts.

If it is possible for you to respond by November 6, that would be much appreciated. If you have any questions, feel free to contact me at 287-7842.

Thank you,
Mark Margerum
Maine DEP

Exhibits relating to health effects of wind turbines:

#14 Affidavit of Michael A. Nissenbaum, M.D., dated September 17, 2009, "in support of citizens of the Roxbury, Maine area who are requesting the Board of Environmental Protection ("BEP") to grant a hearing on the health effects of the proposed Record Hill Wind Project." With attached exhibit D, Maine Medical Association, Resolution re: wind energy and public health (undated).

#15 Wind Turbine Syndrome, A Report on a Natural Experiment, March 7, 2009, pre-publication draft, by Nina Pierpont, MD, PhD.

#16 Night Noise Guidelines (NNGL) for Europe, Final implementation report, World Health Organization, European Centre for Environment and Health, 2007.

#17 Guidelines for Community Noise, World Health Organization, 1995, pages 52 and 53.

#18 Report by Dr Christopher Hanning, BSc, MB, BS, MRCS, LRCP, FRCA, MD, on Sleep disturbance and wind turbine noise, on behalf of Stop Swinford Wind Farm Action Group, June 2009.

Comments on Oakfield Wind Project, Evergreen Wind Power II, LLC, Regarding Wind Turbine Noise and Its Impact on the Community, Richard R. James, INCE, E-Coustic Solutions, October 15, 2009. (See particularly section 6, Comments on Health Risks and Wind Turbines, beginning on page 18.)

Philip A. Powers
714 First Place
Hermosa Beach, CA 90254
Tel: 310-990-7463
e-mail: ppowers714@gmail.com

December 1, 2009

Mr. Mark Margerum
Maine Department of Environmental Protection
17 State House Station
Augusta, ME 04333-0017

Oakfield Wind Project, Aroostook County, Maine
Re: **MDEP# L-24572-24-A-N; IL-24572-TF-B-N**

Dear Mark:

This letter is in response to the First Wind response to the Powers' family's objections to the referenced project. As I indicated earlier, I do not want to waste your time re-hashing old evidence. Rather, there are a few relevant points we have not yet made and a few pieces of new information for your consideration. Also several of First Wind's representations and statements demand a response.

Visual Impact

Ultimately, the question of visual impact and scenic significance is subjective in nature. Obviously, First Wind's position has to be that the project's visual impact is insignificant and that the affected property, particularly Pleasant Lake and environs, has little or no scenic significance and therefore will not be adversely impacted. The factual evidence is that, by their own admission, up to 13 towers each equivalent in height to a 25 story building will be visible from various points around the Lake. These towers are structurally and visually inconsistent with anything else that exists near Pleasant Lake today. Apparently Land Works' attempt to reach out to people who might be affected consisted of a conversation with a single group of visitors from Southern New England. In contrast, affected landowners and locals have been very outspoken in their objection to the project on visual and other grounds, as evidenced by the Island Falls Lakes Association letter opposing the project, individual letters opposing the project, and a petition of Lakefront camp owners opposing the project. Who but actual affected landowners and users are best suited to determine whether a project will have a significant negative visual effect?

Decommissioning Plan

There are three significant problems with First Wind's decommissioning plan. First, there is no satisfactory substantiation of the estimated decommissioning cost of $18,363,561. Second, there is no satisfactory evidence that the $17,428,000 salvage value can ever be realized. This is a very basic issue as the estimated salvage value represents 95% of the estimated decommissioning cost. Finally, First Wind proposes to set aside - or guaranty - $50,000 per year for seven years, which represents a fraction of their estimated decommissioning cost. First Wind has not come close to meeting DEP's requirements for decommissioning.

Effect on Property Values

If the evidence of the effect of wind towers on property values is inconclusive it is because wind towers have not been in existence in likely affected areas long enough for statistically significant data to be available. However, in an area which is regarded for its natural beauty, it is intuitively obvious that the presence of numerous 25 story tall towers will not have a positive effect on a potential buyer.

Sound

There have been volumes of data and analysis concerning the sound emitted by wind towers. At the end of the debate, however, people who have experienced life near the towers will tell you whether or not the noise levels are objectionable or not. That is why Dr. Nissenbaum's study is relevant: it shows that a significant majority of people who live near existing turbines are negatively affected by the noise. Scientific studies addressing decibel levels or high or low frequency sound waves cannot overwhelm the basic fact that people hear the turbines and feel negatively affected by the noise.

Finally, I have attached a recent letter from Congressman Eric Massa of New York to President Obama outlining some very serious charges relating to First Wind and the company's business practices in general. It serves to illustrate a fundamental problem with the proposed Oakfield project: Here is a well connected and well financed out of state private company swooping in to alter the landscape effectively forever, all the while claiming that the damage is for the public good and that affected local landowners who have spent decades over generations trying to preserve the land should accept the plan because it won't have a significant impact.

Did the First Wind response to my letter address my concern that much if not most of the power generated will in effect be sold in Canada? Will the project result in lower energy costs to residents of the State of Maine? It does not appear so. It does not appear that the Oakfield project will satisfy the basic requirement of the 2008 legislation that the project provide a substantial economic benefit. Certainly there is no proposed benefit to Pleasant Lake property owners.

The only possible conclusion is that we are all being sold a bill of goods in order to enrich First Wind and its investors.

Thank you again for taking the time to consider these points.

Very truly yours,

Philip A Powers

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ERIC J.J. MASSA
29TH DISTRICT, NEW YORK

COMMITTEE ON AGRICULTURE
COMMITTEE ON ARMED SERVICES
COMMITTEE ON
HOMELAND SECURITY

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317 NORTH UNION STREET
OLEAN, NY 14760
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FAX: 716-372-2869

September 11, 2009

President Barack Obama
President of the United States of America
1600 Pennsylvania Avenue NW
Washington, DC 20500-0005

Dear President Obama,

I was recently informed of two very alarming grant awards announced in my district from the Department of Energy and the Department of Treasury. These grants, totaling $74.6 million of taxpayer dollars, are to be distributed to Canandaigua Power Partners, LLC and Canandaigua Power Partners II, LLC for projects in Cohocton, New York. This is an extremely contentious issue in my District and this recent announcement has the potential to cause a serious political explosion in Western New York.

Constituents in our region see these projects as criminal actions, and I have strongly opposed the actions of these companies and their affiliates. Canandaigua Power Partners, LLC and Canandaigua Power Partners II, LLC act as shell companies that deceptively operate on behalf of First Wind, which is currently under investigation by New York State Attorney General Cuomo for corruption charges in Cohocton and across the Northeast. After allegations of bribery, intimidation, and other misconduct surfaced, many residents and local officials in my District have paid very close attention to these projects in Cohocton and in their own back yards with great anger and concern for what could happen in other communities in our area.

This is one of the most volatile issues in Western New York and the award of $74.6 million dollars to corrupt companies that have changed names time and again forming new LLCs and new Inc.s but maintaining their business model of lie, cheat, and corrupt at the expense of taxpayers has stirred great unrest in New York's 29th Congressional District. To date, no electricity has been produced for sale out of the projects in Cohocton and the company has projected that there is none to come until the end of next year. Despite this lack of clean, renewable energy for Cohocton and the citizens of New York, this company has already collected production rewards for non-existent energy that at this point is simply a prediction.

We should not be rewarding anything, let alone cash grants, to companies like this that have abused the public trust and caused such a toxic atmosphere in our region on the topic of wind power.

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There is no use of this money that would, to my satisfaction, warrant the issuance of these grants and I urge you to launch an investigation by the GAO into the use of these federal funds for this purpose. I call on your administration to revoke this award before more damage comes to this rural area where people have already experienced the abuses of foreign-owned wind developers who tear apart communities for corporate gain.

Sincerely,

Eric J. J. Massa
Member of Congress

Cc: Secretary Steven Chu, DOE

Margerum, Mark T

From: Warren Brown [Warren_Brown@umit.maine.edu]
Sent: Thursday, December 17, 2009 8:17 PM
To: Margerum, Mark T
Cc: Cassida, James
Subject: Oakfield Wind Project Amendment Sound Level Assessment -- Peer Review

Attachments: Oakfield Wind Project Application Review.pdf

Oakfield Wind Project Applicat...

Mark,

Please find the attached Oakfield Wind Project Review (Review). I will submit my response to "Objections of the Trustees of Martha A. Powers Trust to Oakfield Wind Project" (Powers) under separate cover at a later date. I find nothing in the Powers submission including the report by E-Coustic Solutions by Richard R. James (October 15, 2009) that changes the opinion I have expressed in the Review.

If you have any questions please don't hesitate to contact me.

Regards,

Warren

****

Warren L. Brown
Radiation Safety Officer
University of Maine
5784 York Village Building 7
Orono, Maine 04469

Phone: (207) 581-4057
Fax: (207) 581-4085
E-mail: warren.brown@maine.edu

Margerum, Mark T

From: Warren Brown [Warren_Brown@umit.maine.edu]
Sent: Friday, December 18, 2009 3:08 PM
To: Margerum, Mark T
Subject: Re: Oakfield Wind Project Amendment Sound Level Assessment -- Peer Review

Mark,

After reviewing the testimony which Richard James proposes to give to the Board of Environmental Protection in the Record Hill appeal, I find nothing that changes my opinion expressed in the peer review conclusion to the Oakfield wind project, submitted December 18, 2009.

Regards,

Warren

"Margerum, Mark T" <Mark.T.Margerum@Maine.gov> writes:
>Thank you, Warren. I am forwarding a summary of testimony which
>Richard James proposes to give to the Board of Environmental Protection
>in the Record Hill appeal. I think most of the points in his testimony
>have already been raised in the comments he submitted on the Oakfield
>project. But section 5 of this proposed testimony describes flaws he
>sees in the Stetson compliance data. Since you have just reviewed the
>Stetson data and refer to it your Oakfield comments, would you take a
>particular look at what Mr. James says about Stetson in section 5 and
>let me know if this would change your opinion in any way.
>
>Thank you,
>Mark Margerum
>Maine DEP
>
>-----Original Message-----
>From: Warren Brown [mailto:Warren_Brown@umit.maine.edu]
>Sent: Thursday, December 17, 2009 8:17 PM
>To: Margerum, Mark T
>Cc: Cassida, James
>Subject: Oakfield Wind Project Amendment Sound Level Assessment -- Peer
>Review
>
>Mark,
>
>Please find the attached Oakfield Wind Project Review (Review). I will
>submit my response to "Objections of the Trustees of Martha A. Powers
>Trust to Oakfield Wind Project" (Powers) under separate cover at a
>later date. I find nothing in the Powers submission including the
>report by E-Coustic Solutions by Richard R. James (October 15, 2009)
>that changes the opinion I have expressed in the Review.
>
>If you have any questions please don't hesitate to contact me.
>
>Regards,
>
>Warren
>
>***
>*
>******************************
>Warren L. Brown
>Radiation Safety Officer
>University of Maine
>5784 York Village Building 7
>Orono, Maine 04469

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