

The following outline summarizes the criteria as we have formulated them for use in siting wind turbines to minimize the risk of adverse impacts from noise on the adjacent community²¹.

Proposed Wind Turbine Siting Sound Limits

1. Audible Sound Limit

- a. No Wind Turbine or group of turbines shall be located so as to cause an exceedance of the pre-construction/operation background sound levels by more than 5 dBA. The background sound levels shall be the dBA L_{90A} sound descriptor measured during a pre-construction noise study during the quietest time of evening or night. All data recording shall be a series of contiguous ten (10) minute measurements. L_{90A} results are valid when L_{10A} results are no more than 10 dBA above L_{90A} for the same time period. Noise sensitive sites are to be selected based on wind development's predicted worst-case sound emissions (in dBA and dBC) which are to be provided by the developer.
- b. Test sites are to be located along the property line(s) of the receiving non-participating property(s).
- c. Not to exceed 35 dBA within 30 m. (approx. 100 feet) of any occupied structure.
- d. A 5 dB penalty is applied for tones as defined in IEC 61400-11.

2. Low Frequency Sound Limit

- a. The dBC sound levels from the wind turbine at the receiving property shall not exceed the lower of either:
 - 1) dBC less dBA L_{90A} greater than 20 dB outside any occupied structure, or
 - 2) A maximum not-to-exceed sound level of 50 dBC (outside any occupied structure) from the wind turbines without other ambient sounds for properties located at one mile or more from State Highways or other major roads or 55 dBC for properties with occupied structures closer than one mile.

These limits shall be assessed using the same nighttime and wind/weather conditions required in 1.a. Turbine operating sound immissions (dBA and dBC) shall represent worst case sound immissions for stable nighttime conditions with low winds at ground level and winds sufficient for full operating capacity at the hub.

3. Requirements

- a. All instruments must meet ANSI or IEC Precision integrating sound level meter performance specifications.
- b. Procedures must meet ANSI S12.9 and other applicable ANSI standards.
- c. Measurements must be made when ground level winds are 2m/s (4.5 mph) or less. Wind shear in the evening and night often results in low ground level wind speed and nominal operating wind speeds at wind turbine hub heights.
- d. IEC 61400-11 procedures are not suitable for enforcement of these requirements except for the presence of tones.

²¹ The authors have based these criteria, procedures, and language on their current understanding of wind turbine sound emissions, land-use compatibility, and the effects of sound on health. However, use of the following, in part or total, by any party is strictly voluntary and the user assumes all risks. Please seek professional assistance in applying the recommendations of this document to any specific community or WES development.

V. How to Include the Recommended Criteria in Ordinances and/or Community Noise Limits

The following two sections present the definitions, technical requirements, and complaint resolution processes that support the recommended criteria. Following the formal elements is a section discussing the measurement procedures and requirements for enforcement of these criteria. For the purpose of this article the government authority will be referred to as the Local Government Authority (LGA) as a place marker for State, County, Township or other authorized authority. The abbreviation 'WES' is used for industrial scale wind energy system.

The authors have based these criteria, procedures, and language on their current understanding of wind turbine sound emissions, land-use compatibility, and the effects of sound on health. However, use of the following, in part or total, by any party is strictly voluntary and the user assumes all risks. Please seek professional assistance in applying the recommendations of this document to any specific community or WES development.

VI. ELEMENTS OF A WIND ENERGY SYSTEMS LICENSING ORDINANCE FOR SOUND

I. Purpose and Intent.

Based upon the findings stated above, it is the intended purpose of the LGA to regulate Wind Energy Systems to promote the health, safety, and general welfare of the citizens of the Town and to establish reasonable and uniform regulations for the operation thereof so as to control potentially dangerous effects of these Systems on the community.

II. Definitions.

The following terms have the meanings indicated:

"Aerodynamic Sound" means a noise that is caused by the flow of air over and past the blades of a WES.

"Ambient Sound" Ambient noise encompasses all sound present in a given environment, being usually a composite of sounds from many sources near and far. It includes intermittent noise events, such as, from aircraft flying over, dogs barking, wind gusts, mobile farm or construction machinery, and the occasional vehicle traveling along a nearby road. The ambient also includes insect and other nearby sounds from birds and animals or people. The near-by and transient events are all part of the ambient sound environment but are not to be considered part of the background sound. If present, a different time or location should be selected for determining the L_{90} background sound levels.

"American National Standards Institute (ANSI)" Standardized acoustical instrumentation and sound measurement protocol shall meet all the requirements of the following ANSI Standards:

ANSI S1.43 Integrating Averaging Sound Level Meters: Type-1 (or IEC 61672-1)

ANSI S1.11 Specification for Octave and One-third Octave-Band Filters (or IEC 61260)

ANSI S1.40 Verification Procedures for Sound Calibrators

ANSI S12.9 Part 3 Procedures for Measurement of Environmental Sound

ANSI S12.18 Measurement of Outdoor Sound Pressure Level

IEC 61400-11 Wind turbine generator systems –Part 11: Acoustic noise measurements

"Anemometer" means a device for measuring the speed and direction of the wind.

"**Applicant**" means the individual or business entity that seeks to secure a license under this section of the Town municipal code.

"**A-Weighted Sound Level (dBA)**" A measure of over-all sound pressure level designed to reflect the response of the human ear, which does not respond equally to all frequencies. It is used to describe sound in a manner representative of the human ear's response. It reduces the effects of the low with respect to the frequencies centered around 1000 Hz. The resultant sound level is said to be "A-weighted" and the units are "dBA." Sound level meters have an A-weighting network for measuring A-weighted sound levels (dBA) meeting the characteristics and weighting specified in ANSI Specifications for Integrating Averaging Sound Level Meters, S1.43-1997 for Type 1 instruments and be capable of accurate readings (corrections for internal noise and microphone response permitted) at 20 dBA or lower. In this document dBA means L_{eqA} unless specified otherwise.

"**Background Sound (L_{90})**" refers to the sound level present at least 90% of the time. Background sounds are those heard during lulls in the ambient sound environment. That is, when transient sounds from flora, fauna, and wind are not present. Background sound levels vary during different times of the day and night. Because WES operates 24/7 the background sound levels of interest are those during the quieter periods which are often the evening and night. Sounds from near-by birds and animals or people must be excluded from the background sound test data. Nearby electrical noise from street lights, transformers and cycling AC units and pumps etc must also be excluded from the background sound test data.

Background sound level (dBA and dBC (as L_{90})) is the sound level present for at least 90% of the time during a period of observation that is representative of the quiet time for the soundscape under evaluation and with duration of ten (10) continuous minutes. Several contiguous ten (10) minute tests may be performed in one hour to determine the statistical stability of the sound environment. Measurement periods such as at dusk when bird and insect activity is high or the early morning hours when the 'dawn chorus' is present are not acceptable measurement times. Longer term sound level averaging tests, such as 24 hours or multiple days are not at all appropriate since the purpose is to define the quiet time background sound level. It is defined by the L_{90A} and L_{90C} descriptors. It may be considered to be the quietest one (1) minute during a ten (10) minute test. L_{90A} results are valid only when L_{10A} results are no more than 10 dB above L_{90A} for the same time period. L_{10C} less L_{90C} are not to exceed 15 dBC to be valid.

The background noise environment consists of a multitude of distant sources of sound. When a new nearby source is introduced the new background noise level would be increased. The addition of a new source with a noise level 10 below the existing background would increase the new background 0.4 dB. If the new source has the same noise level as the existing background then the new background is increased 3.0 dB. Lastly, if the new source is 3.3 dB above the existing background then the new background would have increased 5 dB. Therefore, if the existing quiet nighttime background noise level is 26 dBA, for example, then the maximum wind turbine noise immission contribution alone cannot exceed 29.3 dBA at a dwelling to meet the requirement of $L_{90A} + 5 \text{ dB} = 31 \text{ dBA}$ ($26 \text{ dBA} + 29.3 \text{ dBA} = 31 \text{ dBA}$).

Further, background L_{90} sound levels documenting the pre-construction baseline conditions should be determined when the ten minute average wind speed is 2 m/s (4.5 mph) or less at the ground level/microphone location.

"**Blade Passage Frequency**" (BPF) means the frequency at which the blades of a turbine pass a particular point during each revolution (e.g. lowest point or highest point in rotation) in terms of

events per second. A three bladed turbine rotating at 28 rpm would have a BPF of 1.4 Hz. [E.g. ((3 blades times 28rpm)/60 seconds per minute = 1.4 Hz BPF)]

“C-Weighted Sound Level (dBC)” Similar in concept to the A-Weighted sound Level (dBA) but C-weighting does not de-emphasize the frequencies below 1k Hz as A-weighting does. It is used for measurements that must include the contribution of low frequencies in a single number representing the entire frequency spectrum. Sound level meters have a C-weighting network for measuring C-weighted sound levels (dBC) meeting the characteristics and weighting specified in ANSI S1.43-1997 Specifications for Integrating Averaging Sound Level Meters for Type 1 instruments. In this document dBC means L_{eqC} unless specified otherwise.

“Decibel (dB)” A dimensionless unit which denotes the ratio between two quantities that are proportional to power, energy or intensity. One of these quantities is a designated reference by which all other quantities of identical units are divided. The sound pressure level (L_p) in decibels is equal to 10 times the logarithm (to the base 10) of the ratio between the pressure squared divided by the reference pressure squared. The reference pressure used in acoustics is 20 MicroPascals.

“Emission” Sound energy that is emitted by a noise source (wind farm) is transmitted to a receiver (dwelling) where it is immitted (see “immission”).

“Frequency” The number of oscillations or cycles per unit of time. Acoustical frequency is usually expressed in units of Hertz (Hz) where one Hz is equal to one cycle per second.

“Height” means the total distance measured from the grade of the property as existed prior to the construction of the wind energy system, facility, tower, turbine, or related facility at the base to its highest point.

“Hertz (Hz)” Frequency of sound expressed by cycles per second.

“Immission” Noise immitted by a receiver (dwelling) is transmitted from noise source (wind turbine) that emitted sound energy (see “emission”).

“Infra-Sound” sound with energy in the frequency range of 20 Hz and below is considered to be infrasound and is normally considered to not be audible unless in relatively high amplitude. The most significant exterior noise induced dwelling vibration occurs in the frequency range between 5 Hz and 50 Hz. Moreover, levels below the threshold of audibility can still cause measurable resonances inside dwelling interiors. Conditions that support or magnify resonance may also exist in human body cavities and organs under certain conditions, although no specific test for infrasound is provided in this document, its presence will be accounted for in the comparison of dBA and dBC sound levels for the complaint test provided later in this document. See low-frequency sound (LFN) for more information.

“Low Frequency Sound (LFN)” refers to sounds with energy in the lower frequency range of 20 to 200 Hz. LFN is deemed to be excessive when the difference between a C-weighted sound level and an A-weighted sound level is greater than 20 decibels at any measurement point outside a residence or other occupied structure. E.G. C-A>20 dB.

“Measurement Point (MP)” means location where sound and measurements are taken such that no significant obstruction blocks sound from the site. The Measurement Point should be located so as to not be near large objects such as buildings and in the line-of-sight to the nearest turbines. Proximity to large buildings or other structures should be twice the largest dimension of the structure, if possible.

“Measurement Wind Speed” For measurements conducted to establish the background sound pressure levels (dBA, dBC, $L_{90\ 10\ min}$, and etc.) the 2m wind speed less than 5m from the microphone’s Measurement Point shall not exceed 2 m/s (4.5 mph) for valid background measurements. For valid wind farm noises measurements conducted to establish the post-construction sound level the 2m wind speed less than 5m from the microphone’s Measurement Point shall not exceed 4m/s (9 mph) and the wind speed at the WES blade height shall be at or above the nominal rated wind speed. For purposes of enforcement, the wind speed and direction at the WES blade height shall be selected to reproduce the conditions leading to the enforcement action while also restricting wind speeds at the microphone to 4 m/s (9 mph).

For purposes of models used to predict the sound levels and sound pressure levels of the WES to be submitted with the Application, the Wind Speed shall be the speed that will result in the worst-case dBA and dBC sound levels in the community adjacent the nearest WES. For the purpose of constructing the model the wind direction shall consider the dominant wind direction for the seasons from the late spring to early fall. If other wind directions may cause levels to exceed those of the predominant wind direction at nearby sensitive receptors, these levels and conditions shall be included in the Application.

“Mechanical Noise” means sound produced as a byproduct of the operation of the mechanical components of a WES(s) such as the gearbox, generator and transformers.

“Noise” means any unwanted sound. Not all noise needs to be excessively loud to represent an annoyance or interference.

“Project Boundary” means the external property boundaries of parcels owned by or leased by the WES developers.

“Property Line” means the recognized and mapped property parcel boundary line.

“Pure Tone” A sound for which the sound pressure is a simple sinusoidal function of the time, and characterized by its singleness of pitch. Pure tones can be part of a more complex sound wave that has other characteristics.

“Qualified Independent Acoustical Consultant” Qualifications for persons conducting baseline and other measurements and reviews related to the application for a WES or for enforcement actions against an operating WES include, at a minimum, demonstration of competence in the specialty of community noise testing. An example is a person with Full Membership in the Institute of Noise Control Engineers (INCE). Certifications such as Professional Engineer (P.E.) do not test for competence in acoustical principles and measurement and are thus not, without further qualification, appropriate for work under this document. The Independent Qualified Acoustical Consultant can have no financial or other connection to a WES developer or related company.

“Sensitive Receptor” means places or structures intended for human habitation, whether inhabited or not, public parks, state and federal wildlife areas, the manicured areas of recreational establishments designed for public use, including but not limited to golf courses, camp grounds and other nonagricultural state or federal licensed businesses. These areas are more likely to be sensitive to the exposure of the noise, shadow or flicker, etc. generated by a WES or WESF. These areas include, but are not limited to: schools, daycare centers, elder care facilities, hospitals, places of seated assemblage, non-agricultural businesses and residences.

“Sound” A fluctuation of air pressure which is propagated as a wave through air

“Sound Power” The total sound energy radiated by a source per unit time. The unit of measurement is the watt. Abbreviated as L_w . This information is determined for the WES

manufacturer under laboratory conditions specified by IEC 61400-11 and provided to the local developer for use in computer model construction. It cannot be assumed that these values represent the highest sound output for any operating condition. They reflect the operating conditions required to meet the IEC 61400-11 requirements. The lowest frequency is 50 Hz for acoustic power (L_w) requirement in IEC 61400-11. This Ordinance requires wind turbine certified acoustic power (L_w) levels at rated load for the total frequency range from 6.3 Hz to 10k Hz in one-third octave frequency bands tabulated to the nearest 0.1 dB. The frequency range of 6.3 Hz to 10k Hz shall be used throughout this Ordinance for all sound level modeling, measuring and reporting.

“Sound Pressure” The instantaneous difference between the actual pressure produced by a sound wave and the average or barometric pressure at a given point in space.

“Sound Pressure Level (SPL)” 20 times the logarithm, to the base 10, of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micronewtons per square meter. In equation form, sound pressure level in units of decibels is expressed as $SPL (dB) = 20 \log p/p_r$.

“Spectrum” The description of a sound wave's resolution into its components of frequency and amplitude. The WES manufacturer is required to supply a one-third octave band frequency spectrum of the wind turbine sound emission at 90% of rated power. The published sound spectrum is often presented as A-weighted values. This information is used to project the wind farm sound levels at all locations of interest. Confirmation of the projected sound spectrum can be determined with a small portable one-third octave band frequency (spectrum) analyzer. The frequency range of interest for wind turbine noise is approximately 10 Hz to 10k Hz.

“Statistical Noise Levels” Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{NA} , where L_{NA} is the A-weighted sound level exceeded for N% of a given measurement period. For example, L_{10} is the noise level exceeded for 10% of the time. Of particular relevance, are: L_{10A} and L_{10C} the noise level exceed for 10% of the ten (10) minute interval. This is commonly referred to as the average maximum noise level. L_{90A} and L_{90C} the noise level exceeded for 90% of the ten (10) minute sample period. The L_{90} noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level. L_{eq} is the frequency-weighted equivalent noise level (basically the time weighted average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

“Tonal sound (sometimes Pure Tone)” A sound for which the sound pressure is a simple sinusoidal function of the time, and characterized by its singleness of pitch. Tonal sound can be simple or complex.

“Wind Energy Systems (WES)” means equipment that converts and then transfers energy from the wind into usable forms of energy on a large, industrial scale for commercial or utility purposes. Small scale wind systems of less than 170 feet in height with a 60-foot rotor diameter and a nameplate capacity of less than 100 kilowatts or less are exempt from this definition and the provisions of this Ordinance.

“Wind Turbine” or “Turbine” (WTi) means a mechanical device which captures the kinetic energy of the wind and converts it into electricity. The primary components of a wind turbine are the blade assembly, electrical generator and tower.

III. APPLICATION PROCEDURE FOR WIND ENERGY SYSTEMS AND TECHNICAL REQUIREMENTS FOR LICENSING

This ordinance is intended to promote the safety and health of the community through criteria limiting sound emissions during operation of Wind Energy Systems. It is recognized that the requirements herein are neither exclusive, nor exhaustive. In instances where a health or safety concern is known to the wind project developer or identified by other means with regard to any application for a Wind Energy System, additional and/or more restrictive conditions may be included in the license to address such concerns. All rights are reserved to impose additional restrictions as circumstances warrant. Such additional or more restrictive conditions may include, without limitation (a) greater setbacks, (b) more restrictive noise limitations, or (c) limits restricting operation during night time periods or for any other conditions deemed reasonable to protect the community.

A. Application

Any Person desiring to secure a Wind Energy Systems license shall file an application form provided by the LGA Clerk, together with two additional copies of the application with the LGA Clerk.

B. Information to be submitted with Application

1. Information regarding the: make and model of the turbines, Sound Power Levels (L_w) for each one-third octave band from 6.3 Hz up through 10,000 Hz, and a projection showing the expected dBA and dBC sound levels computed using the one-third octave band sound power levels (L_w) with appropriate corrections for modeling and measurement accuracy tolerances and directional patterns of the WT_i for all areas within and to one (1) mile from the project boundary for the wind speed, direction and operating mode that would result in the worst case WT_i nighttime sound emissions.

The prediction model shall assume that the winds at hub height are sufficient for the highest sound emission operating mode even though the enforcement tests will be with ground level winds of 4m/s (9.5 mph) or less. The projection may be by means of computer model but shall include a description of all assumptions made in the model's construction and algorithms. If the model does not consider the effects of wind direction, geography of the terrain, and/or the effects of reinforcement from coherent sounds or tones from the turbines these should be identified and other means used to adjust the model's output to account for these factors. These results may be displayed as a contour map of the predicted levels, but should also include a table showing the predicted levels at noise sensitive receptor sites and residences within the model's boundaries. The predicted values must include dBA and dBC values but shall also include un-weighted octave band sound pressure levels from 8 Hz to 10k Hz in data tables.

C. Preconstruction Background Noise Survey

1. The Town reserves the right to require the preparation of (a) a preconstruction noise survey for each proposed Wind Turbine location conducted per procedures provided here-in and in the Appendix showing background dBA and dBC sound levels ($L_{90(10min)}$) over one or more valid ten (10) minute continuous measurement periods prior to approval for the final layout and construction as part of an environmental study evaluating what impact the project may have on sensitive receptors in the vicinity of the proposed WES sites.

- a. If any proposed wind farm project locates a WES within one mile of a sensitive receptor these studies are mandatory. The preconstruction baseline studies shall be conducted by an Independent Qualified Acoustical Consultant selected by the LGA.
 - b. The LGA shall hire an Independent Qualified Acoustical Consultant to conduct the sound study for the LGA as specified in this document. However, the applicant shall be responsible for paying the consultant's fees and costs associated with conducting the study. These fees and cost shall be negotiated with the consultant and determined prior to any work being done on the study. The applicant shall be required to set aside 100% of these fees in an escrow account managed by the LGA, before the study is commenced by the consultant. Payment for this study does not require the WES developer's acceptance of the study's results.
 - c. If the review shows that the predicted dBA or dBC sound levels exceed the criteria specified in this document then the application cannot be approved.
2. The LGA will refer the application to the LGA engineer (if qualified in acoustics) or an independent qualified acoustical consultant for further review and comparison against the predicted dBA and dBC sound levels supplied with the application. The reasonably necessary costs associated with the review of the sound study shall be the responsibility of the applicant, in accord with the terms of this ordinance.

D. Post Construction Noise Measurement Requirements

1. **Sound Regulations Compliance:** A WES shall be considered in violation of the conditional use permit unless the applicant demonstrates that the project complies with all sound level limits. Sound levels in excess of the limits established in this ordinance shall be grounds for the LGA to order immediate shut down of all non-compliant WTi.
2. **Post-Construction Sound Measurements:** Within twelve months of the date when the project is fully operational, and within four weeks of the anniversary date of the pre-construction background noise measurements, repeat the existing sound environment measurements taken before the project approval. Post-construction sound level measurements shall be taken both with all WES's running and with all WES's off. At the discretion of the Town, the Pre-construction background sound levels (L_{90A}) can be substituted for the "all WES off" tests if a random sampling of 10% of the pre-construction study sites shows that background L_{90A} and C conditions have not changed more than +/- 5 dB (dBA and dBC) measured under the pre-construction nighttime meteorological conditions. The post-construction measurements will be reported to the LGA (available for public review) using the same format as used for the preconstruction sound studies. Post-construction noise studies shall be conducted by a firm chosen by the LGA. Costs of these studies are to be reimbursed by the Licensee in a similar manner to that described above. The wind farm developer's own consultant is free to observe the publicly retained consultant at the convenience of the latter. The WES developer/applicant shall provide all technical information and wind farm data required by the independent qualified acoustical consultant before, during, and/or after any acoustical studies required by this document and for local area acoustical measurements.

3. Sound Limits

1. Audible Sound Limit

- a. No WTi or WES shall be located so as to cause an exceedance of the pre-construction/operation background sound levels by more than 5 dBA. The background sound levels shall be the L_{90A} sound descriptor measured with a stable

atmosphere during a pre-construction noise study during the quietest time of night (10pm until 4am). All data sampling shall be one or more contiguous ten (10) minute measurements. L_{90A} results are valid when L_{10A} results are no more than 10 dBA above L_{90A} for the same time period and L_{10C} less L_{90C} is no more than 15 dBC. Noise sensitive sites are to be selected based on wind development's predicted worst-case sound emissions (in L_{eqA} and L_{eqC}) which are to be provided by developer.

- b. Test sites are to be located along the property line(s) of the receiving non-participating property(s).
- c. Not to exceed 35 dBA within 30 m. (approx. 100 feet) of any occupied structure.
- d. A 5 dB penalty is applied for tones as defined in IEC 61400-11. (the reference preconstruction measured L_{90A} and L_{90C} are lowered 5 dB).

2. Low Frequency Sound Limit

- a. The L_{eqC} and L_{90C} sound levels from the wind turbine at the receiving property shall not exceed either:
 - 1) dBC minus L_{90A} greater than 20 dB outside any occupied structure, or
 - 2) A maximum not-to-exceed sound level of 50 dBC from the wind turbines without contribution from other ambient sounds for properties located one mile or more away from state highways or other major roads or 55 dBC for properties closer than one mile.

These limits shall be assessed using the same nighttime and wind/weather conditions required in 1.a. Turbine operating sound immissions shall represent worst case sound immissions for stable atmospheric nighttime conditions with low winds at ground level and winds sufficient for full operating capacity at the hub.

3. Operations Exceeding any of the limits in this section will be considered as proof that the WES/WTi is non-compliant and must be shut down immediately.

4. Requirements

- a. All instruments must meet ANSI or IEC Type 1 Precision integrating sound level meter performance specifications.
- b. Procedures must meet ANSI S12.9 Part 3 including the addendum in the Appendix to this document. Where there are differences between the procedures and definitions of this document and ANSI standards the procedures and definitions of this document will be applied. Where a standard's requirements may conflict with other standards the most stringent requirement shall be followed.
- c. Measurements for background sound levels must be made when ground level winds are 2m/s (4.5 mph) or less with wind speeds at the turbine hub at or above nominal operating requirements and for other tests when ground level winds are less than 4m/s (9 mph). Weather in the night often results in low ground level wind speed and nominal operating wind speeds at wind turbine hub heights when the atmosphere is stable.
- d. IEC 61400-11 procedures are not suitable for enforcement of these requirements except for the presence of tones.

4. Complaint Resolution

1. The owner/operator of the WES shall respond within five (5) business days after notified of a noise complaint by any property owner within the project boundary and a one-mile radius beyond the project boundary.
2. The tests shall be performed by a qualified acoustical consultant acceptable to the complainant and the local agency charged with enforcement of this ordinance.
3. Testing shall commence within ten (10) working days of the request. If testing cannot be initiated within ten (10) days, the WES(s) in question shall be shut down until the testing can be started.
4. A copy of the test results shall be sent to the property owner, and the LGA's Planning or Zoning department within thirty (30) days of test completion.
5. If a Complaint is made, the presumption shall be that it is reasonable. The LGA shall undertake an investigation of the alleged operational violation by a qualified individual mutually acceptable to the LGA.
 - a) The reasonable cost and fees incurred by the LGA in retaining said qualified individual shall be reimbursed by the owner of the WESF.
 - b) Funds for this assessment shall be paid or put into an escrow account prior to the study and payment shall be independent of the study findings.
6. After the investigation, if the LGA reasonably concludes that operational violations are shown to be caused by the WESF, the licensee/operator/owner shall use reasonable efforts to mitigate such problems on a case-by-case basis including such measures as not operating during the night time or other noise sensitive period if such operation was the cause of the complaints.

5. Reimbursement of Fees and Costs.

Licensee/operator/owner agrees to reimburse the LGA 's actual reasonable fees and costs incurred in the preparation, negotiation, administration and enforcement of this Ordinance, including, without limitation, the LGA 's attorneys' fees, engineering and/or consultant fees, LGA meeting and hearing fees and the costs of public notices. If requested by the LGA the funds shall be placed in an escrow account under the management of the LGA. The preceding fees are payable within thirty (30) days of invoice. Unpaid invoices shall bear interest at the rate of 1% per month until paid. The LGA may recover all reasonable costs of collection, including attorneys' fees.

VII. MEASUREMENT PROCEDURES

APPENDIX TO WIND ENERGY SYSTEMS LICENSING ORDINANCE FOR SOUND

I. Introduction

The potential impact of sound and sound induced building vibration associated with the operation of wind powered electric generators is often a primary concern for citizens living near proposed wind energy systems (WES(s)). This is especially true of projects located near homes, residential neighborhoods, businesses, schools, and hospitals in quiet residential and rural communities. Determining the likely sound and vibration impacts is a highly technical

undertaking and requires a serious effort in order to collect reliable and meaningful data for both the public and decision makers.

This protocol is based in part on criteria published in American National Standards S12.9 –Part 3 Quantities and Procedures for Description and Measurement of Environmental Sound, and S12.18 and for the measurement of sound pressure level outdoors.

The purpose is to first, establish a consistent and scientifically sound procedure for evaluating existing background levels of audible and low frequency sound in a WES project area, and second to use the information provided by the Applicant in its Application showing the predicted over-all sound levels in terms of dBA and dBC as part of the required information submitted with the application.

These values shall be presented as overlays to the applicant's iso-level plot plan graphics (dBA and dBC) and in tabular form with location information sufficient to permit comparison of the baseline results to the predicted levels. This comparison will use the level limits of the ordinance to determine the likely impact operation of a new wind energy system project will have on the existing community soundscape. If the comparison demonstrates that the WES project will not exceed any of the level limits the project will be considered to be within allowable limits for safety and health. If the Applicant submits only partial information required for this comparison the application cannot be approved. In all cases the burden to establish the operation as meeting safety and health limits will be on the Applicant.

Next it addresses requirements for the sound propagation model to be supplied with the application.

Finally, if the project is approved, this Appendix covers the study needed to compare the post-build sound levels to the predictions and the baseline study. The level limits in the ordinance apply to the post-build study. In addition, if there have been any complaints about WES sound or low frequency noise emissions or wind turbine noise induced dwelling vibration by any resident of an occupied dwelling that property will be included in the post-build study for evaluation against the rules for sound level limits and compliance.

The characteristics of the proposed WES project and the features of the surrounding environment will influence the design of the sound and vibration study. Site layout, types of WES(s) selected and the existence of other significant local audible and low frequency sound sources and sensitive receptors should be taken into consideration when designing a sound study. The work will be performed by an independent qualified acoustical consultant for both the pre-construction background and post-construction sound studies as described in the body of the ordinance.

II. Instrumentation

All instruments and other tools used to measure audible, inaudible and low frequency sound shall meet the requirements for ANSI or IEC Type 1 Integrating Averaging Sound Level Meter Standards. The principle standard reference for this document is ANSI 12.9/Part 3 with important additional specific requirements for the measuring instrumentation and measurement protocol.

III. Measurement of Pre-Construction Sound Environment (Base-lines)

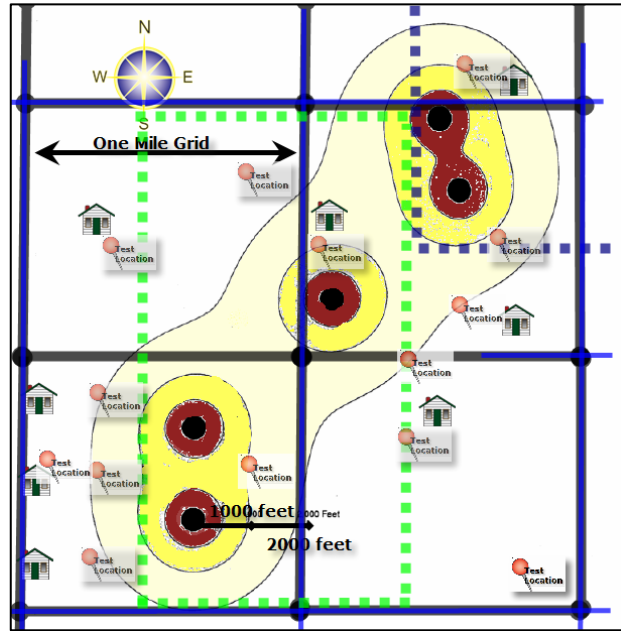
An assessment of the proposed WES project areas existing sound environment is necessary in order to predict the likely impact resulting from a proposed project. The following guidelines must be used in developing a reasonable estimate of an area's existing background sound

environment. All testing is to be performed by an independent qualified acoustical consultant approved by the LGA as provided in the body of the ordinance. The WES applicant may file objections detailing any concerns it may have with the LGA's selection. These concerns will be addressed in the study. Objections must be filed prior to the start of the noise study. All measurements are to be conducted with ANSI or IEC Type 1 certified and calibrated test equipment per reference specification at the end of this Appendix. Test results will be reported to the LGA or its appointed representative.

Sites with No Existing Wind Energy Systems (Base-line Sound Study)

Sound level measurements shall be taken as follows:

The results of the model showing the predicted worst case dBA and dBC sound emissions of the proposed WES project will be overlaid on a map (or separate dBA and dBC maps) of the project area. An example (right) shows an approximately two (2) mile square section with iso-level contour lines prepared by the applicant, sensitive receptors (homes) and locations selected for the baseline dBA and dBC sound tests whichever are the controlling metric. The test points shall



be located at the property line bounding the property of the turbine's host closest to the wind turbine. Additional sites may be added if appropriate. A grid comprised of one (1) mile boundaries (each grid cell is one (1) square mile) should be used to assist in identifying between two (2) to ten (10) measurement points per cell. The grid shall extend to a minimum of one (1) mile beyond the perimeter of the project boundary. This may be extended to more than one mile at the discretion of the LGA. The measurement points shall be selected to represent the noise sensitive receptor sites based on the anticipated sound propagation from the combined WTi in the project. Usually, this will be the closest WTi. If there is more than one WTi near-by then more than one test site may be required.

The intent is to anticipate the locations along the bounding property line that will receive the highest sound immissions. The site that will be most likely negatively affected by the WES project's sound emissions should be given first priority in testing. These sites may include sites adjacent to occupied dwellings or other noise sensitive receptor sites. Sites shall be selected to represent the locations where the background soundscapes reflect the quietest locations of the sensitive receptor sites. Background sound levels (and one-third octave band sound pressure levels for the sound measuring consultants file) shall be obtained according to the definitions and procedures provided in the ordinance and recognized acoustical testing practice and standards.

All properties within the proposed WES project boundaries will be considered for this study.

One test shall be conducted during the period defined by the months of April through November with the preferred time being the months of June through August. These months are normally associated with more contact with the outdoors and when homes may have open

windows during the evening and night. Unless directed otherwise by the LGA the season chosen for testing will represent the background soundscape for other seasons. At the discretion of the LGA, tests may be scheduled for other seasons.

All measurement points (MPs) shall be located with assistance from the LGA staff and property owner(s) and positioned such that no significant obstruction (building, trees, etc.) blocks sound and vibration from the nearest proposed WES site.

Duration of measurements shall be a minimum of ten continuous minutes for each criterion at each location. The duration must include at least six (6) minutes that are not affected by transient sounds from near-by and non-nature sources. Multiple ten (10) minute samples over longer periods such as 30 minutes or one (1) hour may be used to improve the reliability of the L_{90} values. The ten minute sample with the lowest valid L_{90} values will be used to define the background sound.

The tests at each site selected for this study shall be taken during the expected 'quietest period of the day or night' as appropriate for the site. For the purpose of determining background sound characteristics the preferred testing time is from 10pm until 4 am. If circumstances indicated that a different time of the day should be sampled the test may be conducted at the alternate time if approved by the Town.

Sound level measurements must be made on a weekday of a non-holiday week. Weekend measurements may be taken at selected sites where there are weekend activities that may be affected by WTi sound.

Measurements must be taken at 1.2 to 1.5 meters above the ground and at least 15 feet from any reflective surface following ANSI 12.9 Part 3 protocol including selected options and other requirements outlined later in this Section.

Reporting

1. For each Measurement Point and for each measurement period, provide each of the following measurements:

- a. L_{Aeq} , L_{10} , and L_{90} , in dBA
- b. L_{Ceq} , L_{10} , and L_{90} , in dBC

2. A narrative description of any intermittent sounds registered during each measurement. This may be augmented with video and audio recordings.

3. A narrative description of the steady sounds that form the background soundscape. This may be augmented with video and audio recordings.

4. Wind speed and direction at the Measurement Point, humidity and temperature at time of measurement will be included in the documentation. Corresponding information from the nearest 10 meter weather reporting station shall also be obtained.

Measurements taken when wind speeds exceed 2m/s (4.5 mph) at the microphone location will not be considered valid for this study. A windscreen of the type recommended by the monitoring instrument's manufacturer must be used for all data collection.

5. Provide a map and/or diagram clearly showing (Using plot plan provided by LGA or Applicant):

- The layout of the project area, including topography, the project boundary lines, and property lines.

- The locations of the Measurement Points.
- The minimum and maximum distance between any Measurement Points.
- The location of significant local non-WES sound and vibration sources.
- The distance between all MPs and significant local sound sources. And,
- The location of all sensitive receptors including but not limited to: schools, day-care centers, hospitals, residences, residential neighborhoods, places of worship, and elderly care facilities.

Sites with Existing Wind Energy Systems

Two complete sets of sound level measurements must be taken as defined below:

1. One set of measurements with the wind generator(s) off unless the LGA elects to substitute the sound data collected for the background sound study.. Wind speeds must be suitable for background testing.
2. One set of measurements with the wind generator(s) running with wind speed at hub height sufficient to meet nominal power output or higher and at 2 m/s or below at the microphone location. Conditions should reflect the worst case sound emissions from the WES project. This will normally involve tests taken during the evening or night when winds are calm (2m/sec or less) at the ground surface yet, at hub height, sufficient to operate the turbines.

Sound level measurements and meteorological conditions at the microphone shall be taken and documented as discussed above.

Sound level Estimate for Proposed Wind Energy Systems (when adding more WTi to existing project)

In order to estimate the sound impact of the proposed WES project on the existing environment an estimate of the sound produced by the proposed WES(s) under worst-case conditions for producing sound emissions must be provided. This study may be conducted by a firm chosen by the WES operator with oversight provided by the LGA.

The qualifications of the firm should be presented along with details of the procedure that will be used, software applications, and any limitations to the software or prediction methods.

Provide the manufacturer's sound power level (L_w) characteristics for the proposed WES(s) operating at full load utilizing the methodology in IEC 61400-11 Wind Turbine Noise Standard. Provide one-third octave band L_w sound power level information from 6.3 Hz to 10k Hz. Furnish the data with and without A-weighting. Provide sound pressure levels predicted for the WES(s) in combination and at full operation and at maximum sound power output for all areas where the predictions indicate dBA levels of 30 dBA and above. The same area shall be used for reporting the predicted dBC levels. Contour lines shall be in increments of 5 dB.

Present tables with the predicted sound levels for the proposed WES(s) in dBA, dBC and at all octave band centers (8 Hz to 10k Hz) for distances of 500, 1000, 1500, 2000, 2500 and 5000 feet from the center of the area with the highest density of WES(s). For projects with multiple WES(s), the combined sound level impact for all WES(s) operating at full load must be estimated.

The above tables must include the impact (increased dBA and dBC above baseline L_{90} Background sound levels) of the WES operations on all residential and other noise sensitive receiving locations within the project boundary. To the extent possible, the tables should include the sites tested in the background study.

Provide a contour map of the expected sound level from the new WES(s), using 5 dBA and 5 dBC increments created by the proposed WES(s) extending out to a distance of one mile from the project boundary, or other distance necessary, to show the 35 dBA and 50 dBC boundary.

Provide a description of the impact of the proposed sound from the WES project on the existing environment. The results should anticipate the receptor sites that will be most negatively impacted by the WES project and to the extent possible provide data for each MP that are likely to be selected in the background sound study (note the sensitive receptor MPs):

1. Report expected changes to existing sound levels for L_{Aeq} , L_{10} and L_{90} , in dBA
2. Report expected changes to existing sound levels for L_{Ceq} , L_{10} and L_{90} , in dBC
3. Report the predicted sound pressure levels for each of the 1/1 octave bands as un-weighted dB in tabular form from 8 Hz to 10k Hz.
4. Report all assumptions made in arriving at the estimate of impact, any limitations that might cause the sound levels to exceed the values of the estimate, and any conclusions reached regarding the potential effects on people living near the project area. If the effects of coherence, worst case weather, or operating conditions are not reflected in the model a discussion of how these factors could increase the predicted values is required.
5. Include an estimate of the number of hours of operation expected from the proposed WES(s) and under what conditions the WES(s) would be expected to run. Any differences from the information filed with the Application should be addressed.

IV. Post-Construction Measurements

Post Construction Measurements should be conducted by a qualified noise consultant selected by and under the direction of the LGA. The requirements of this Appendix for Sites with Existing Wind Energy Systems shall apply

1. Within twelve months of the date when the project is fully operational, and within two weeks of the anniversary date of the Pre-construction ambient noise measurements, repeat the existing sound environment measurements taken before the project approval. Post-construction sound level measurements shall be taken both with all WES(s) running and with all WES(s) off except as provided the ordinance.
2. Report post-construction measurements to the LGA using the same format as used for the background sound study.
- 3 Project Boundary: A continuous line encompassing all WES(s) and related equipment associated with the WES project.