BAYSHORE REGIONAL SEWERAGE AUTHORITY

100 Oak Street, Borough of Union Beach, New Jersey

Proposed Wind Turbine
SOUND ASSESSMENT STUDY

August 2009

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100 Oak Street, Borough of Union Beach, New Jersey

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03785-0004-050

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Bayshore Regional Sewerage Authority
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1.0 EXECUTIVE SUMMARY

A Sound Assessment Study has been performed at the Bayshore Regional Sewerage Authority (BRSA) Site in support of a proposed wind turbine generation system to assess potential for sound impacts at the closest residential property boundaries of the Site (adjacent residential areas). This assessment involved comparing projected sound-levels from the proposed wind turbine system at two nearby residential locations to applicable State of New Jersey sound-level standards. Monitoring of existing (background) sound-levels in the vicinity of the BRSA Site and adjacent residential community and identification and characterization of existing sound sources influencing this area were included in the assessment.

Wind turbine sound is a function of wind speed and of other aspects of the design of the wind turbine. Generally, wind turbines radiate more sound as the wind speed increases. Audibility is distinct from the sound-level and it depends on the relationship between the sound-level from the wind turbines and the ambient background sound-level. At high wind speeds, sound generated by wind passing through and around structures and vegetation will generally mask the broadband component of sound generated by typical wind turbines.

The future projected total wind turbine equipment sound-levels are less than the State of New Jersey daytime (65 dBA) and nighttime (50 dBA) sound-level standards at the two closest residential property boundaries for both 3 m/s and 7 m/s wind speeds. The projected wind turbine system sound-levels are much less than the monitored existing background sound-levels for the 3 m/s wind speed condition and are much less than the projected background sound-levels for the 7 m/s wind speed condition. The projected increases to ambient (background) sound-levels, at the two nearest residential property boundaries, due to contributions from the proposed wind turbine system is anticipated to be less than 1 dBA. The impact on the existing dBA sound-levels is anticipated to be minimal and the wind turbine is anticipated to be barely perceptible at the nearest residential locations. Expected sound-level contributions from the wind turbine at distances beyond the nearest residences would be lower than projected sound-levels at the nearest residences and would be in compliance with State of New Jersey sound-level standards.

The human ear can detect changes in sound as small as 1 dBA, however, a 3 dBA change in sound-level is considered to be the smallest detectable change over an extended period of time. The anticipated differences between existing sound-levels and projected wind turbine sound-levels are much less than 3 dBA at the closest property boundary receptors to the planned wind turbine. The sound from the wind turbine generation system is anticipated to be "barely perceptible" at these locations.

The following can be concluded from this Sound Assessment Study:

- Wind turbine sound-levels are projected to be less than the State of New Jersey daytime and nighttime sound-level standards at the nearest residential property boundaries.

- The projected sound-levels indicate a minimal/insignificant increase in existing sound-levels at and beyond the nearest residential property boundaries to the BRSA facility.

- The increase in existing sound-levels is projected to be less than 1 dBA and is expected to be barely perceptible at, and beyond, the nearest residences.

SECTION 2.0

INTRODUCTION

2.0 INTRODUCTION

2.1 Background

Bayshore Regional Sewerage Authority (BRSA) is planning the installation of a 1.5 MW wind turbine at the Union Beach, New Jersey Plant (Site). The wind turbine is to be located in the northern corner of the BRSA plant partially within a cleared and maintained portion of the facility and partially within a disturbed area located just outside of the plant fence. The wind turbine has the potential for generating sound, thus BRSA has requested Paulus, Sokolowski and Sartor, LLC (PS&S) to perform a sound assessment in support of this Wind Turbine Project.

This report summarizes the sound assessment study performed at the BRSA Site in support of the planned Wind Turbine Project to assess the potential for sound-level impacts at the closest property boundary (adjacent to a residential area) located at the southwest and eastern ends of the site. These residential locations are approximately 1000 feet from the location of the proposed wind turbine.

PS&S performed the following as part of this Sound Assessment Study:

1. Conducted a survey of the existing ambient background sound-levels to assist in defining criteria and to provide a benchmark for any sound measurements following start-up of the operation;
2. Projected sound-levels from the turbine near the adjacent residential community to determine the potential contribution to ambient sound-levels from the wind turbine;
3. Compared calculated sound pressure levels from the wind turbines with background sound pressure levels at the locations of concern;
4. Reviewed sound-level standards, guidance and criteria potentially applicable to the site.

2.2 Sound Basic Fundamentals

Appendix B presents a discussion of basic sound/noise fundamentals including: sensitive receptors, sound-level standards/criteria, FHWA Noise Abatement Criteria, Sound Monitoring Survey methodology, equipment/calibration/procedures, statistical descriptors (A-weighting, Equivalent Sound Level (Leq), residual sound level), and sound propagation modeling methodology.

Noise sensitivity criteria used by the FHWA for evaluating the significance of sound/noise impacts are presented in Table 2-1. Generally, a three-dBA or smaller change in sound-level would be barely perceptible to most listeners, whereas a ten dBA change is normally perceived as a doubling (or halving) of sound-levels. These criteria provide an indication of individual perception of changes in sound-levels. A three-dBA increase is commonly used as the threshold for assessing the potential significance of sound-level impacts.

Table 2-1
Noise Sensitivity Criteria
Decibel Changes and Loudness

Change (dBA)	Relative Loudness
0	Reference
3	Barely perceptible change
5	Readily perceptible change
10	Twice as loud
20	Four times as loud
30	Eight times as loud

Source: Based on Highway Traffic Noise Analysis and Abatement – Policy and Guidance. (FHWA, June 1995.)

SECTION 3.0

SITE/AREA CHARACTERIZATION

3.0 SITE/AREA CHARACTERIZATION

3.1 Site Location / Facility Description

The project site is located in the Borough of Union Beach, Monmouth County, New Jersey and identified in the Borough of Union Beach's Tax Maps as Block 251, Lot 3 (Project Site). The site is approximately 24.7-acres and currently the location of an active sewerage treatment plant. The project site is characterized as an industrial property and consists of multiple buildings, aeration/settling tanks, asphalt parking areas and access ways, maintained lawn, chain-link fences and other industrial features. The closest property boundaries to the location of the proposed Wind Turbine are residential areas located approximately 1000 feet to the east and 1000 feet to the south (southwest).

The proposed wind turbine will have a hub height of approximately 262-feet (80 meters) and a rotor radius of +/- 118-feet (a total combined height of +/-380-feet from base to tip). The turbine will be supported on a concrete pile cap foundation. The turbine will generate power for use by the BRSA facility.

3.2 Sound-level Sources

Sound-level influences observed at the Site include existing BRSA operations (plant equipment such as emergency generators, pumping equipment, aeration blowers and stack exhausts), vehicular traffic on local roads, overhead aircraft flyovers, lawn maintenance equipment and air conditioning units. Natural sounds include neighborhood children at play, dogs barking, the wind blowing over and through tree-tops and/or vegetation causing leaves to "rustle", insects and birdsong.

3.3 Sound-level Standards/Criteria

3.3.1 Borough of Union Beach Noise Code

The Borough of Union Beach, New Jersey has adopted a noise ordinance or "Noise Code" identified as "Chapter 3-12 Noise Control" revised August 1995.

The Borough of Union Beach Chapter 3-12 "Noise Control" is presented in Appendix A.

Section 3-12.4a, Noise Disturbances Prohibited, states that "No person shall make, continue, or cause to be made or continued, any noise disturbance." Section 3-12.1 defines a noise disturbance as "any sound which endangers or injures the safety or health of humans or animals, or annoys or disturbs a reasonable person of normal sensitivities…"

Section 3-12.5a, Sound Levels by Receiving Land Use, establishes maximum permissible sound-levels by receiving land use; the noise control code references the limits established by the State of New Jersey in N.J.A.C. 7:29-1.2.

Section 3-12.5b, Correction for Character of Sound, states that for any source of sound which emits a pure tone or impulsive sound, the maximum sound-level limits set forth in subsection 3-12.5a shall be reduced by 5 dBA. A "pure tone" is defined in section 3-12.1 as "any sound which can be distinctly heard as a single pitch or a set of single pitches. For the purposes of this section, a pure tone shall exist if the one-third octave band sound pressure level in the band with the tone exceeds the arithmetic average of the sound pressure levels of the two contiguous one-third octave bands by 5 dB for center frequencies of 500 Hz and above and by 8 dB for center frequencies between 160 and 400 Hz and by 15 dB for center frequencies less than or equal to 125 Hz."

3.3.2 New Jersey State Sound-level Standards

The State of New Jersey sound-level standards require that sound from any industrial or commercial operation measured at any residential property line must not exceed a continuous sound level of 65 dBA during the daytime (7:00 A.M. to 10:00 P.M.), or a level of 50 dBA during the nighttime (10:00 P.M. to 7:00 A.M.). These standards also limit continuous sound from any industrial or commercial

operation measured at any other commercial property line to 65 dBA day or night (New Jersey Administrative Code (N.J.A.C.) 7:29 Noise Control, 2005).

The State of New Jersey sound-level standards require that sound from any industrial or commercial operation measured at any residential property line must not exceed a continuous airborne sound which has an octave band sound pressure level in decibels which exceeds the values listed in N.J.A.C. 7:29-1.2 in one or more octave bands. Table 3-1 lists the State of New Jersey octave band sound pressure levels.

Table 3-1. State of New Jersey Octave Band Sound Pressure Levels

Octave Band Center Frequency ***(Hz)***	**Octave Band Sound Pressure Level (7:00 A.M. to 10:00 P.M.)** ***(dB)***	**Octave Band Sound Pressure Level (10:00 P.M. to 7:00 A.M.)** ***(dB)***
31.5	96	86
63	82	71
125	74	61
250	67	53
500	63	48
1000	60	45
2000	57	42
4000	55	40
8000	53	38

Source: N.J.A.C. 7:29-1.2 Noise Control (Amended November 2005).

SECTION 4.0

SOUND MONITORING SURVEY/RESULTS

4.0 SOUND-LEVEL MONITORING SURVEY/RESULTS

4.1 Sound-level Monitoring

Ambient sound, or background sound, can strongly affect the audibility of a particular sound in a particular environment. The background sound in an area is important as it directly affects audibility through masking. The A-weighted spectrum provides the best indicator of spectral makeup of a sound as perceived by the human ear and is commonly used in environmental sound assessments.

Ambient sound-level measurements were performed on July 6th and July 7th, 2009 at three monitoring locations in the vicinity of the BRSA plant. Sound-level monitoring was performed at one location on the project site and at two nearby residential neighborhood locations. Sound-level measurements were obtained using the A-weighted scale (dBA), for approximately 20 to 30 minutes at the selected locations during the daytime and nighttime; a 24-hour sound-level measurement was performed at the on-site location (BRSA-1). Integrated sound-level measurements (i.e., 1/min, etc.) were recorded in the memory of the sound meter, and later the data was transferred to a computer for compilation and tabulation.

Existing nearby sound sources potentially influencing the area, observed during sound-level monitoring, were noted. PS&S prepared this Sound Assessment Study in accordance with accepted sound-level evaluation procedures, requirements, standards, and guidance. PS&S sound engineers and scientists are certified by the New Department of Environmental Protection (NJDEP) to monitor sound-levels in accordance with New Jersey Administrative Code (NJAC) 7:29 Noise Control.

Information on the general survey approach and sound-level monitoring procedures are presented in Appendix B.

4.2 Sound-level Monitoring Locations

A-weighted and octave band sound-level measurements were performed at locations BRSA-1, BRSA-SW and BRSA-E (see Figure 4-1) in the vicinity of the Site. These monitoring locations were selected to identify existing ambient background sound-levels at the closest residential areas to the planned location of the proposed wind turbine.

Sound-level monitoring was performed at one location in the southwest corner of the BRSA plant (BRSA-1), near a residential area, for a period of 24-hours using a Larson Davis

Model 820 sound-level meter. Additional short-term (i.e., approximately 30-minutes) sound-level measurements were performed at this location using a Bruel and Kjaer Model 2250 sound-level meter for confirmatory background sound-levels and to obtain octave band frequencies. The short-term (i.e., approximately 30-minutes) sound-level measurements were also performed at two locations in nearby residential areas; one sound-level measurement was performed to the southwest of the Site, adjacent to the BRSA plant, located at the end of Henry Street (BRSA-SW) and one sound-level measurement was performed to the east of the Site, located off Dock Street, at the end of 3rd Street (BRSA-E). The short-term sound-level measurements were performed during the daytime hours (between 2:00 P.M. and 3:30 P.M) and nighttime hours (between 10:00 P.M. and 11:30 P.M) at each location. The sound-level monitoring locations are described in Table 4-1 and are shown on Figure 4-1.

4.3 Sound-Level Measurement Results (A-Weighted)

Existing/current ambient background sound-level monitoring data obtained at the BRSA plant has been compiled and tabulated. Sound-level measurement results are summarized in Table 4-1; this table lists the L_{90}, Leq, and L_{10} values for each location (BRSA-1, BRSA-SW and BRSA-E) for both the daytime and nighttime measurements. A summary of A-weighted sound-level monitoring data is presented graphically in Figure 4-2 which shows the ambient (L_{90}) sound-levels for the three monitoring locations in the vicinity of the BRSA plant (BRSA-1, BRSA-SW and BRSA-E). Figure 4-3 presents the 24-hour background sound-level measurement time history at the on-site monitoring location (BRSA-1).

The L_{90} (referred to as the ambient level) is a measurement of the residual or background sound-level and is useful in characterizing a community with respect to sound-levels. The residual sound-level is the minimum sound-level in the absence of identifiable or intermittent local sources and has been used in this analysis to characterize sound-levels associated with the facility. The Leq is a single sound-level value for a desired duration, which includes all of the time-varying sound energy during the measurement period. The L_{10}, the Sound Pressure Level (SPL) exceeded 10 percent of the time, provides an indication of the contribution from extraneous sound-levels (i.e., car pass-bys, aircraft flyovers, etc.).

Sound-levels (L_{90}) in the vicinity of the BRSA plant ranged from 41.3 dBA to 47.2 dBA during the day and from 42 dBA to 44.9 dBA at night. Daytime sound-levels were within

(i.e., in compliance with) the applicable NJ State standard of 65 dBA. Nighttime sound-levels were within (i.e., in compliance with) the applicable NJ State standard of 50 dBA.

The background sound-levels were measured during calm wind conditions (winds < 4 mph or 1.8 m/s). It is important to note that, particularly in quiet rural areas, the ambient sound-levels are influenced by wind; as wind speed increases the ambient sound-levels increase. The wind-generated contribution to background sound-levels tends to increase with wind speed and therefore increases background sound-levels. The most likely sources of wind-generated sound are interactions between wind and vegetation. Sound-levels measured in the vicinity of the BRSA plant are considered representative of the surrounding residential area during calm wind conditions and were observed to be similar during the daytime and nighttime; birdsong influenced the daytime measurements and insect sounds influenced the nighttime measurements.

Table 4-1. Bayshore Regional Sewerage Authority

Ambient (Background) Sound-Level Measurement Summary

Location ID	Monitoring Location Description	LAS90 [dB]	LAeq [dB]	LAS10 [dB]
Daytime	***NJ State Standard = 65 dBA***			
BRSA (24-hr)	Southwest Corner of BRSA Site	47.22	53.47	57.23
BRSA-1	Southwest Corner of BRSA Site	43.70	49.04	52.01
BRSA--SW	Southwest of Site at end of Henry Street	43.54	47.72	50.64
BRSA-E	East of Site at end of 3rd Street	41.32	46.95	49.65
Nighttime	***NJ State Standard = 50 dBA***			
BRSA (24-hr)	Southwest Corner of BRSA Site	42.78	45.26	47.29
BRSA-1 N	Southwest Corner of BRSA Site	42.02	47.27	49.15
BRSA-SW N	Southwest of Site at end of Henry Street	42.66	44.04	45.43
BRSA-E N	East of Site at end of 3rd Street	44.87	45.83	46.70

Notes:
Data Collected on 07-06-09 through 07-07-09
D = Daytime (7 AM to 10 PM); N = Nighttime (10 PM to 7 AM)
Sound Level Meter set to slow measurement speed

Legend

- Site Boundary
- Wind Turbine
- Sound Monitoring Location

Source:
Sound Monitoring Location taken from field observations by PS&S, 2009.
Site Boundary locations taken from plan entitled "Site Plans", prepared by PS&S, dated 2/23/09.
ESRI StreetMap USA, 2007.
Aerial imagery from NJ Office of Information Technology (NJOIT), Office of Geographic Information Systems (OGIS), 3/29/07.

0 100 200
Feet

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BAYSHORE REGIONAL
SEWERAGE AUTHORITY
WIND TO ENERGY PROJECT
BLOCK 251 LOT3
UNION BEACH BOROUGH,
MONMOUTH COUNTY, NJ

WIND TURBINE SOUND ASSESSMENT

SOUND MONITORING LOCATIONS

Dm By: JA	Scale: 1" = 200'	Project: 03785.004.050
Ch'kd By: MH	Date: 07/09/09	Figure No. : 4-1

Map Document: (P:\03785\004\YN\Maps\Fig_SoundMonitoringLocations_070909_00.mxd)
7/13/2009 -- 10:14:17 AM

Figure 4-2. Bayshore Regional Sewerage Authority
Ambient Sound-level Measurement Data Summary

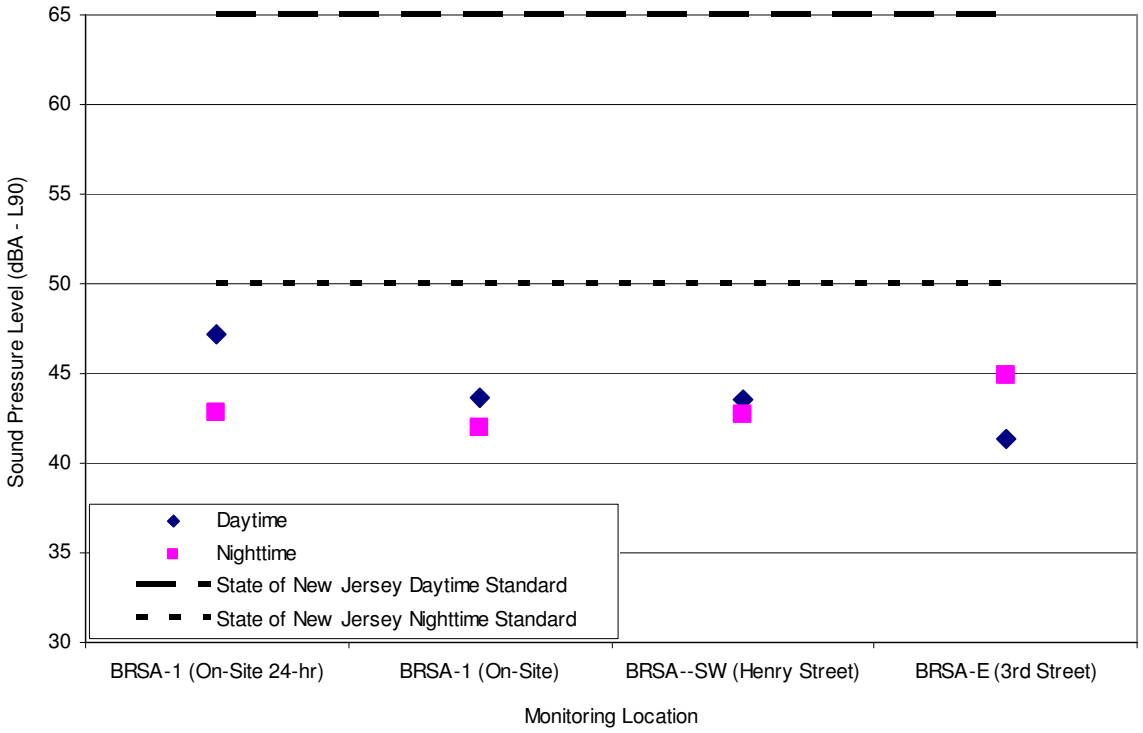
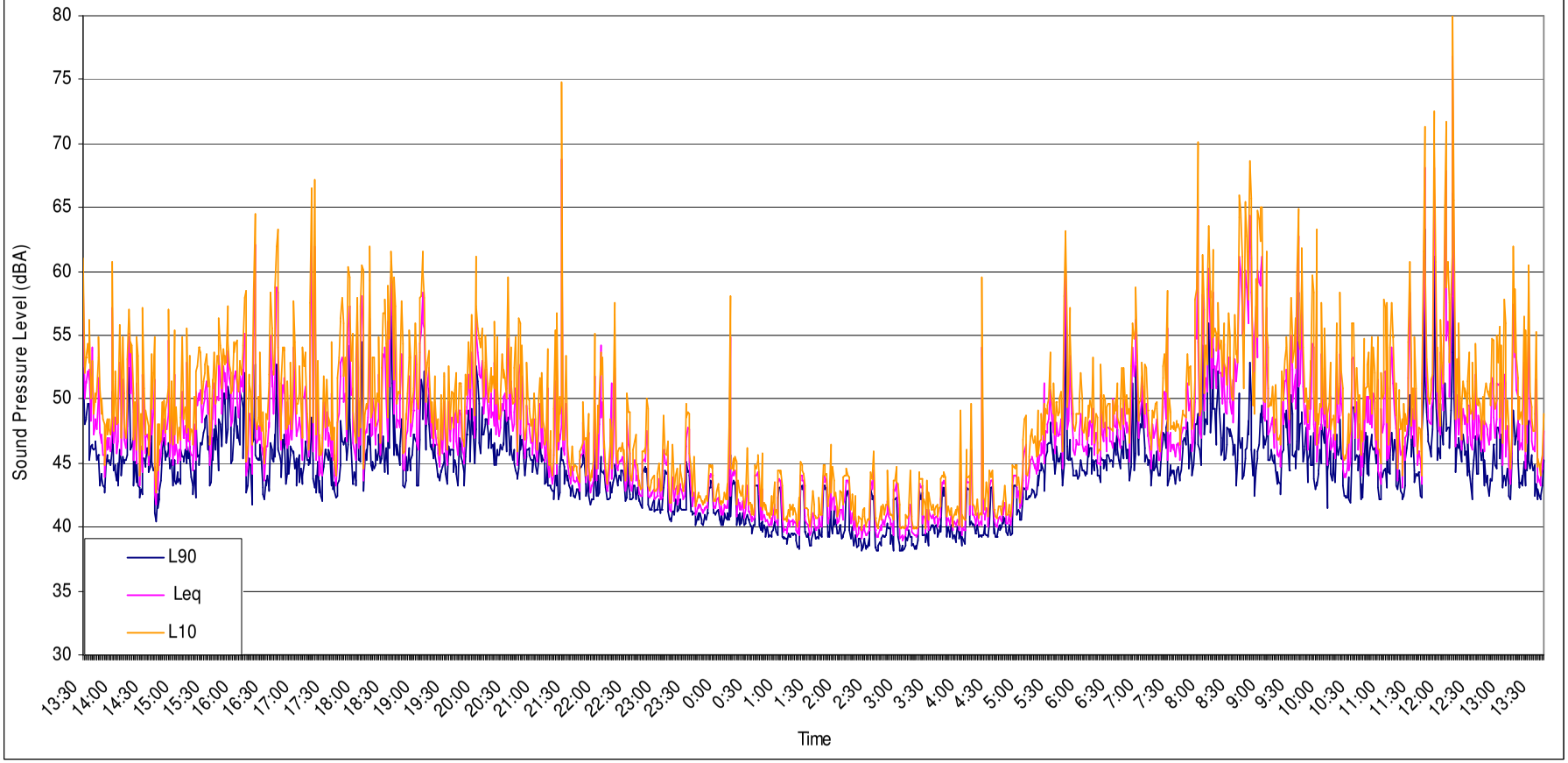


Figure 4-3. Bayshore Regional Sewerage Authority (24-hour) Background Sound-Level Measurement Time History



4.4 Octave Band Sound-Level Measurement Results

The frequency content (or spectrum) is the property we perceive as pitch, which gives a sound its unique character. Frequency is most commonly measured in cycles per second, or Hertz (Hz).

PS&S performed measurements of one-third octave band frequency sound pressure levels on July 6th and July 7th, 2009 at three monitoring locations in the vicinity of the BRSA plant during daytime and nighttime hours at locations BRSA-1, BRSA-SW and BRSA-E. One-third octave band measurements were converted to octave bands for comparison to NJ State Standards. The daytime and nighttime octave band measurements are presented graphically in Figure 4-4 and Figure 4-5, respectively.

Both the daytime sound pressure levels and the nighttime sound pressure levels were within (i.e., in compliance with) the applicable NJ State standards.

Figure 4-4. Bayshore Regional Sewerage Authority Octave Band Sound-level Measurements (Daytime)

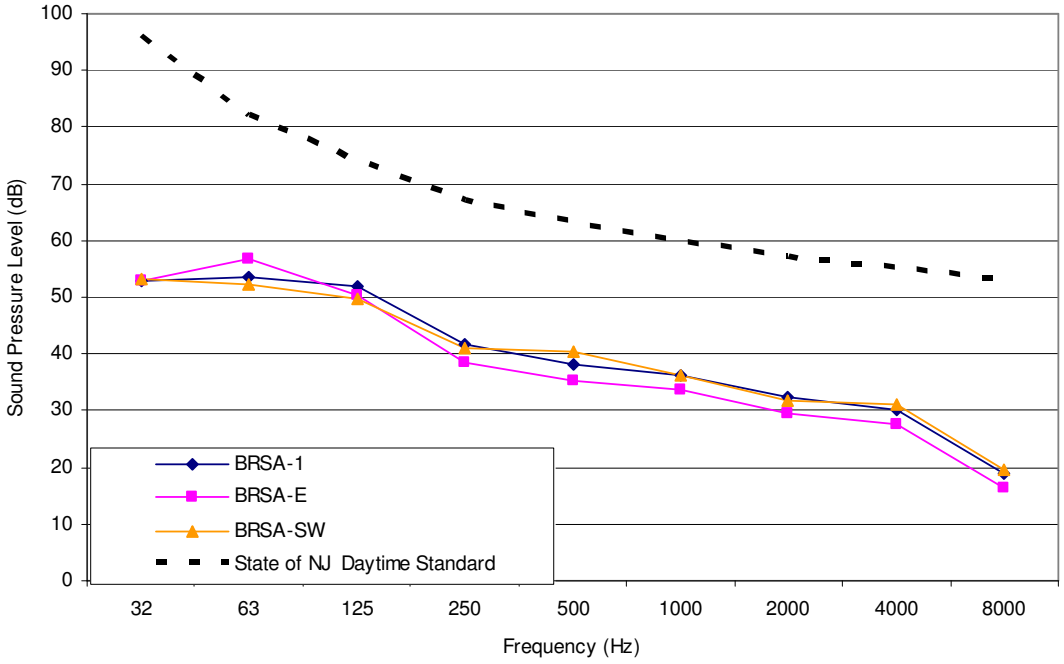
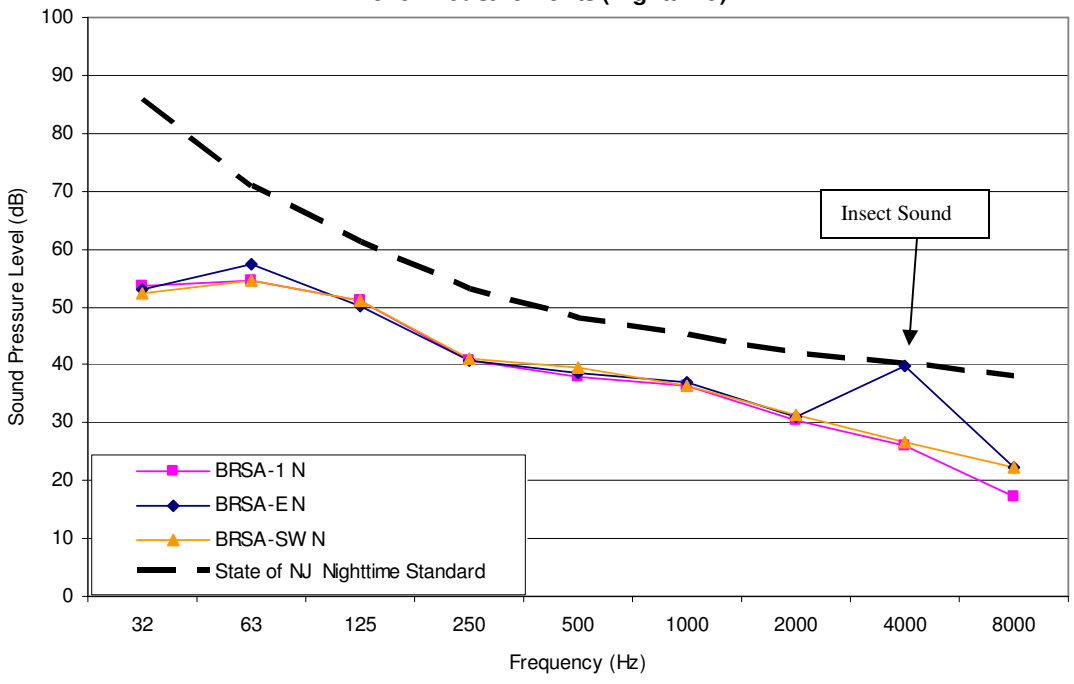


Figure 4-5. Bayshore Regional Sewerage Authority Octave Band Sound-level Measurements (Nighttime)



SECTION 5.0

SOUND-LEVEL MODELING

5.0 SOUND-LEVEL MODELING

The general approach and sound propagation modeling procedures are presented in Appendix B.

5.1 Wind Turbine Equipment Description

BRSA is planning the installation of a 1.5 MW wind turbine at the Union Beach, New Jersey Plant (Site). The wind turbine is to be located in the northern corner of the BRSA plant partially within a cleared and maintained portion of the facility and partially within a disturbed area located just outside of the plant fence. The proposed wind turbine has a base diameter of 13.8 feet, a hub height of 262.4 feet and a tip height of 380.5 feet (with a blade radius of 118 feet).

PS&S reviewed specifications of similar equipment (wind turbines) to the planned equipment. PS&S obtained technical documentation, included as Appendix C, of noise emission characteristics from General Electric (GE) for a representative model (GE 1.5xle) wind turbine for use in sound propagation modeling. For purposes of this assessment, PS&S assumes that the installed equipment will have similar sound emission characteristics as a GE Model XLE Wind Turbine.

5.2 Wind Turbine Sound-level Sources

Sound associated with wind turbines can have broadband and tonal components. The sound generated by a wind turbine is variable and dependent upon wind speed and the design of the turbine. The four types of noise that can be generated by wind turbine operation include tonal, broadband, low frequency and impulsive.

- *Tonal sound (discrete frequencies) is caused by wind turbine components such as meshing gears, unstable flows over holes or slits, or a blunt trailing edge.*

- *Broadband sound is often caused by the interaction of wind turbine blades with atmospheric turbulence; this type of sound is sometimes described as a "swishing" or "whooshing" sound.*

- *Low frequency sound (20 Hz to 100 Hz) caused by localized flow deficiencies due to the flow around a tower is mostly associated with downwind turbines.*

- *Impulsive sound is caused by the interaction of wind turbine blades with disturbed air flow around the tower of a downwind machine.*

Sources of sound emitted from operating wind turbines include sounds generated by mechanical equipment as well as aerodynamic motion. Mechanical equipment includes the gearbox and the generator both of which are housed within the nacelle located at the top of the turbine support tower. The yaw motors are also a source of mechanical sound located in the nacelle at the top of the turbine support tower. The wind turbine transformer is located at the base of the turbine support tower and is an additional source of sound. Mechanical sound is transmitted along the structure of the turbine and is radiated from its surfaces. Since the emitted sound is associated with the rotation of mechanical and electrical equipment, it tends to be tonal (of common frequency). Aerodynamic sound is produced by the flow of air around the blades and generally increases with rotor speed. Aerodynamic broadband sound is typically the largest source of wind turbine sound and is produced through a variety of processes as air passes over and past the blades. These include:

- *Low frequency sound – generated when the rotating blade encounters localized flow deficiencies due to the flow around a tower or wind speed changes.*
- *Inflow turbulence sound – atmospheric turbulence results in local pressure fluctuations around the blade.*
- *Airfoil self sound – generated by air flow right along the surface of the airfoil.*

For a variety of reasons, large modern wind turbines produce less sound than either smaller or older wind turbines. Current nacelle designs typically feature sound dampening elements to mitigate the transmission of mechanical sound from equipment located within the nacelle. Wind turbine design also affects aerodynamic noise in that different blade designs and alterations in the ordination of the blades relative to the turbine support tower affect aerodynamic sound. Turbines designed with upwind facing rotors produce less sound than those designed with rotors that face downwind. Because sound generation is dependent upon wind speed, large variable speed wind turbines limit the generation of sound in low wind speed conditions as the rotors turn less rapidly in these conditions. Other ways that modern wind turbine designers have reduced the amount of sound generated by turbines during operation include: streamlining the towers and nacelles and the introduction of sound dampening materials within gearboxes. The proposed wind turbine incorporates a number of sound control design features and devices to minimize operational sound.

Wind Speed and Wind Turbine Sound

Wind turbine sound is a function of wind speed and of other aspects of the design of the wind turbine. Generally, wind turbines radiate more sound as the wind speed increases.

Sound Power Level, Tonality and Octave Band Spectra

The technical documentation provided by GE describes the sound characteristics of the turbine for normal operation. It is important to note that the specifications are based on measurement results of a single turbine of a particular make and model; there will be individual variation in sound pressure levels and tonality between different turbines and varying environmental conditions.

Sound Power

Sound power level is a property of the source of the sound and it provides the total acoustic power emitted by a source. Sound pressure is a property of sound at a given observer location and can be measured by a single microphone.

Sound power is essentially independent of the surroundings, while the sound pressure depends on the surroundings (reflecting surfaces) and distance to the receiver. If the sound power is known, the sound pressure at a point can usually be calculated. The sound power is very useful to characterize sound sources and to calculate sound pressure.

The sound power level of the GE 1.5xle wind turbine is provided in Appendix C for various wind speed conditions and is summarized in Table 5-1. The sound power level of a GE 1.5xle wind turbine with an 80 m hub height has been used in this analysis.

The wind turbine sound emission rating, specified for a 3 m/s wind speed condition (wind speed at 10 m height), is a sound power of < 96 dB and is used in this analysis for comparison to the measured background sound-levels. The wind turbine sound emission rating, specified for a > 7 m/s wind speed condition (wind speed at 10 m height), is a sound power ≤ 104 dB. The sound power of 104 dB has been used in this analysis to represent a conservative condition; background sound-levels were measured during calm wind conditions (winds < 4 mph or 1.8 m/s). The measured sound-levels can be considered representative of the surrounding residential area during calm wind conditions and will be influenced by wind; as wind speed increases the ambient sound-levels increase. Table 5-1, the wind turbine sound-level summary table, presents the sound power levels for various wind speeds.

The sound power level is usually declared by dual-number sound emission values reporting both sound power and "K". K represents a certain confidence level and K=+/- 1.65 reflects a probability of 5% that a sound power level measurement result, made according to IEC

61400-11, performed at a turbine of the batch exceeds the declared value. An uncertainty band of K = +/- 2 dB is defined for the GE 1.5xle wind turbine.

Table 5-1. Wind Turbine Sound-level Summary Table

Wind Turbine ID	Sound Power (Lwa [dB]) at selected Wind Speed (10m Height in m/s)				
	3	4	5	6	7 – cut out
GE 1.5xle – 50 Hz & 60 Hz (80m HH)	< 96	97.2	101.5	≤ 104	≤ 104

Tonality

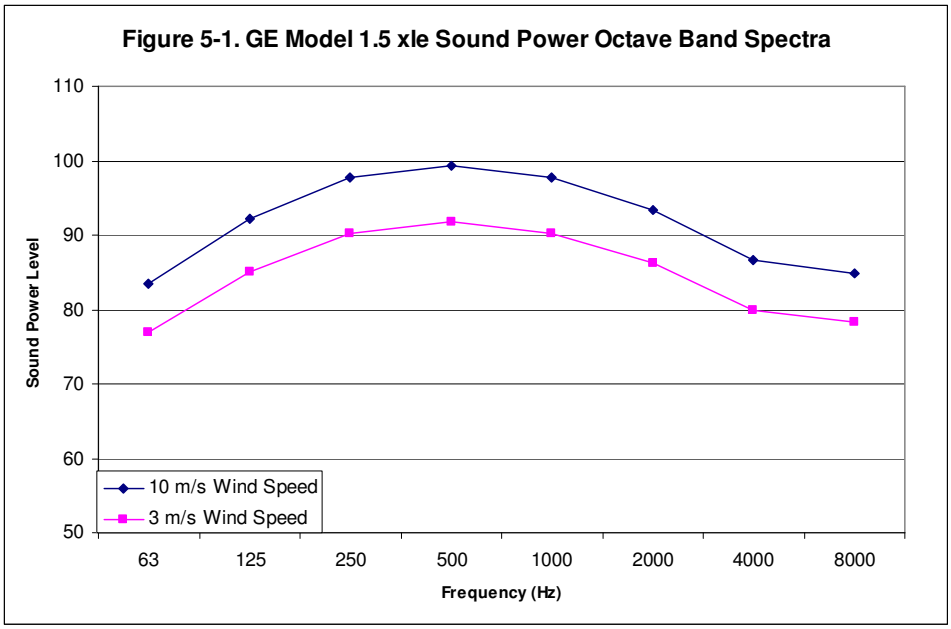
A tonal sound is a sound with a significant portion of its energy confined to a narrow frequency band. A highly tonal sound is sometimes described as a buzz, whine or hum. It is common for community noise standards to incorporate a penalty for pure tones, typically 5 dBA. The Borough of Union Beach noise code states that if a pure tone exceeds the arithmetic average of the sound pressure levels of the two contiguous one-third octave bands by 5 dB for center frequencies of 500 Hz and above, and 8 dB for center frequencies between 160 and 400 Hz and by 15 dB for center frequencies less than or equal to 125 Hz, the maximum sound-level limits shall be reduced by 5 dBA. The presence of tones in the sound at different wind speeds is determined on the basis of a narrowband analysis. The International Standard IEC 61400-11 for Wind Turbine Generator Systems details the procedure for determining tonality. This procedure states that for identifying possible tones, if the local maximum (of an octave band) is more than 6 dB above the average masking sound-level then it is a possible tone. The GE 1.5xle wind turbine specification for tonality is ≤ 4 dB, irrespective of wind speed, hub height and grid frequency. Variables such as specific equipment, atmospheric conditions and the sound pressure level at specific frequencies will affect the tonality and audibility and therefore the subjective response of a "typical" listener.

Octave Band Spectra

The octave band spectra used in this analysis correspond to wind speeds larger than 10 m/s (at 10 m height); the octave band spectra for wind speeds of 3 m/s (at 10 m height) have been derived using the appropriate conversion to represent the calmer wind condition. Figure 5-1 presents the wind turbine source data for the octave band spectra.

Typical sound-levels associated with the proposed wind turbine have been estimated based on technical documentation for wind turbine generator systems, Model GE 1.5xle, noise emission characteristics provided to PS&S.

Figure 5-1. GE Model 1.5 xle Sound Power Octave Band Spectra



Wind Speed and Background Sound-levels

It is important to note that, particularly in quiet rural areas, the ambient sound-levels are influenced by wind; as wind speed increases the ambient sound-levels increase. The wind-generated contribution to background sound tends to increase with wind speed and therefore increases background sound-levels. The most likely sources of wind-generated sound are interactions between wind and vegetation.

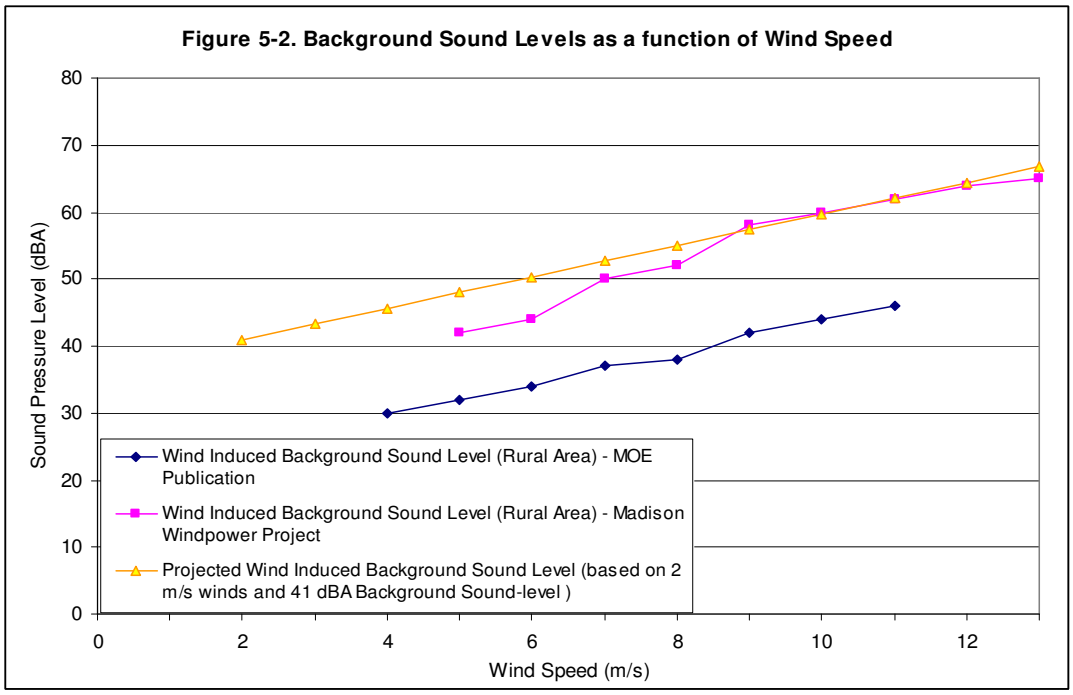
Sound-levels measured in the vicinity of the BRSA plant are considered representative of the surrounding residential area during calm wind conditions (winds < 4 mph or 1.8 m/s) and were observed to be similar during the daytime and nighttime.

To correlate ambient sound-levels to wind speed (i.e., account for an increase in background sound-levels with increasing wind speed), projections of ambient sound-levels have been performed. Two datasets of wind-induced background sound-levels were used to estimate sound-levels during periods of high wind. One dataset was obtained from the Ontario Ministry of the Environment (2004) and one dataset was obtained from re-published data of

the Madison Windpower Project (Rogers et al., 2002). These two datasets (obtained from other studies) of ambient (rural) sound-levels measured over increasing wind speeds were plotted and the slopes of the datasets were calculated. Using a mathematical formula, the measured (Site) background sound-levels were projected for various wind speeds.

Projected sound-levels were used in sound propagation calculations for a wind speed condition of 5 m/s. A 5 m/s ground level (2 m height) wind speed was used to represent background sound-level conditions for an upper air (10 m height) wind speed of 7 m/s. This adjustment was performed using the standard power law wind profile calculation to account for the wind speed at ground-level. These projected sound-levels have been used in the sound propagation modeling of the wind turbine, with a 7 m/s wind speed condition, to represent ambient background conditions during periods of high winds.

Figure 5-2. Background Sound Levels as a function of Wind Speed



5.3 Sound-level Modeling

Projected sound-levels have been estimated based on a relationship that expresses sound attenuation as a logarithmic function of receptor distance from the source (Peterson and Gross, 1972). This is a conservative approach, since attenuation due to other buildings, barriers and vegetation have not been taken into account; nor were factors such as changes in relative humidity and ground cover and wind (except for the equipment sound power specifications and background adjustments). Sound-levels associated with operation of the wind turbine were predicted at selected receptor locations.

Resultant sound-levels were predicted for receptor locations at the nearest residential properties along the Site property boundary nearest the proposed wind turbine location (i.e., approximately 1,000 to 1,100 feet away). Environmental factors (e.g., any buildings or structures between sources and receptors, buildings, vegetation, meteorological conditions, etc.) could serve to reduce these estimated sound-levels. The sound receptor locations may be subject to various types of sounds at different times as generated by the wind turbine equipment operation under varying atmospheric and environmental conditions.

Sound-level modeling has been performed based on preliminary engineering design information and vendor specified (GE 1.5xle wind turbine generator system) sound generation levels (Appendix C) for the wind turbine equipment as provided to PS&S. Projected sound-levels were estimated at the nearest residential property boundaries shown on Figure 4-1, utilizing the sound propagation and combining techniques discussed above.

5.4 Results

Projected sound-levels associated with the proposed wind turbine have been assessed for two wind speed conditions; a 3 m/s wind speed condition and a 7 m/s wind speed condition. A profile of the projected sound-levels versus distance from the proposed wind turbine (80 m tower) with a source sound power level of 96 dBA (3 m/s wind speed) and the sound pressure level predicted at ground level is shown in Figure 5-3. A similar profile is presented in Figure 5-4 for a source sound power level of 104 dBA (7 m/s wind speed).

Figure 5-3. Wind Turbine Tower Height (80 Meters / 262 Feet)
(For Wind Speeds of 3 m/s, Turbine Sound Power = 96 dBA)

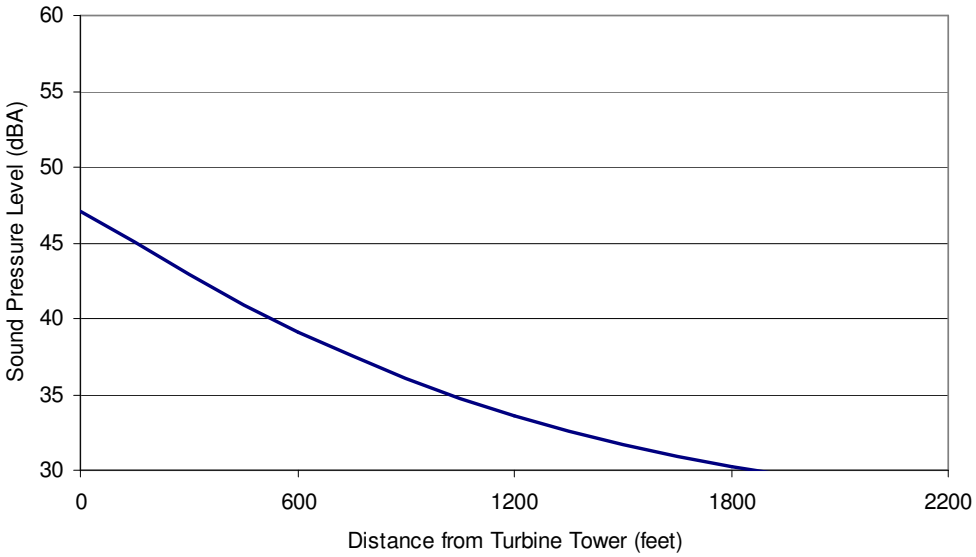
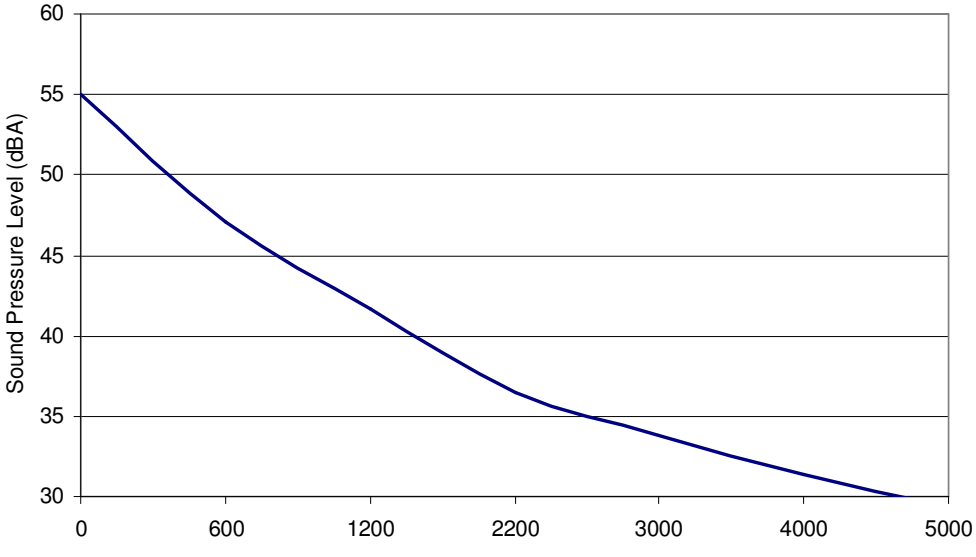


Figure 5-4. Wind Turbine Tower Height (80 Meters / 262 Feet)
(For Wind Speeds of 7 m/s, Turbine Sound Power = 104 dBA)



5.4.1 3 m/s Wind Speed Condition (96 dBA Sound Power Level)

The projected sound-levels, for the 3 m/s wind speed condition, associated with the proposed wind turbine generator system at the nearest residential property

boundary locations are shown in Table 5-2 and presented in Figure 5-5. The estimated wind turbine sound-levels at the nearest residential receptors are predicted to be 6 dBA to 8 dBA below the measured ambient background sound-level environment. The predicted sound-level contributions from the wind turbine system, along with existing monitored sound-levels, at the 3rd Street (BRSA-E) and Henry Street (BRSA-SW) property boundary locations are less than the State of New Jersey daytime (65 dBA) and nighttime (50 dBA) sound-level standards. As shown on Table 5-2, the ambient background sound-levels at property boundary locations are projected to increase by less than 1 dBA due to the wind turbine system equipment (for the 3 m/s wind speed condition).

The wind turbine is anticipated to be barely perceptible at the nearest residential locations under the 3 m/s wind speed condition. Expected sound-level contributions from the wind turbine at distances beyond the nearest residential locations would be lower than projected sound-levels at the nearest residential locations.

5.4.2 7 m/s Wind Speed Condition (104 dBA Sound Power Level)

In order to combine projected turbine sound-levels for the 7 m/s wind speed condition with representative background sound levels, it was necessary to adjust the background sound-level for wind speed. This adjustment is discussed in section 5.2. The projected background sound-levels at the 3rd Street (BRSA-E) and Henry Street (BRSA-SW) property boundary locations, for the 7 m/s wind speed condition, are below the State of New Jersey daytime (65 dBA) sound-level standard and above the State of New Jersey nighttime (50 dBA) sound-level standard due to wind-induced noise. The increase in background sound-levels due to wind-induced noise is a normal occurrence and is independent from variables such as wind turbines.

The projected sound-levels, for the 7 m/s wind speed condition, associated with the proposed wind turbine generator system at the nearest residential property boundary locations are shown in Table 5-3 and presented in Figure 5-6. The estimated wind turbine sound-levels at the nearest residential receptors are predicted to be 10 dBA to 13 dBA below the projected background sound-level environment. The predicted sound-level contributions from the wind turbine system at the 3rd Street (BRSA-E) and Henry Street (BRSA-SW) property boundary locations are less than the State of New Jersey daytime (65 dBA) and nighttime (50 dBA) sound-level standards. The

predicted sound-level contributions from the wind turbine system, combined with projected background sound-levels, at the 3rd Street (BRSA-E) and Henry Street (BRSA-SW) property boundary locations are less than the State of New Jersey daytime (65 dBA) sound-level standard, but above the State of New Jersey nighttime (50 dBA) sound-level standard due to the fact that the background sound-levels are projected to be above the nighttime standard.

The projected additional contribution to the nighttime background sound-levels during high wind-speed conditions is anticipated to be less than 0.5 dBA at the 3rd Street (BRSA-E) and Henry Street (BRSA-SW) property boundary locations and is not anticipated to have a perceptible increase in sound-levels.

As shown on Table 5-3, the ambient background sound-levels at property boundary locations are projected to increase by less than 0.5 dBA due to the wind turbine system equipment (for the 7 m/s wind speed condition).

The wind turbine is anticipated to be barely perceptible at the nearest residential locations under these wind speed conditions due to the wind-generated contribution to background sound-levels. Expected sound-level contributions from the wind turbine at distances beyond the nearest residential locations would be lower than projected levels at the nearest residential locations.

Table 5-2. Wind Turbine Sound-level Assessment Summary of Combined Sound-levels (Wind Speed of 3 m/s)							
Sound Power: 96	Projected Wind Turbine Equipment Contribution	Measured Daytime Background	Combined (Background + Turbine) Day	Daytime Difference	Measured Nighttime Background	Combined (Background + Turbine) Night	Nighttime Difference
	Lp	*L90*	*Leq*		*L90*	*Leq*	
Receptor Name	*dBA*	*dBA*	*dBA*	*dBA*	*dBA*	*dBA*	*dBA*
BRSA-SW (Henry St)	35.0	43.5	44.1	0.6	42.7	43.4	0.7
BRSA-E (3rd St)	34.8	41.3	42.2	0.9	44.9	45.3	0.4

Table 5-3. Wind Turbine Sound-level Assessment Summary of Combined Sound-levels (Wind Speed of >7 m/s)							
Sound Power: 104	Projected Wind Turbine Equipment Contribution	Projected Daytime Background	Combined (Background + Turbine) Day	Daytime Difference	Projected Nighttime Background	Combined (Background + Turbine) Night	Nighttime Difference
	Lp	*L90*	*Leq*		*L90*	*Leq*	
Receptor Name	*dBA*	*dBA*	*dBA*	*dBA*	*dBA*	*dBA*	*dBA*
BRSA-SW (Henry St)	43.0	55.2	55.5	0.3	54.4	54.7	0.3
BRSA-E (3rd St)	42.8	53.0	53.4	0.4	56.6	56.8	0.2

Figure 5-5. BRSA Facility Projected Wind Turbine Sound-Levels
(Based on a Sound Power of 96 dB - 3 m/s winds)

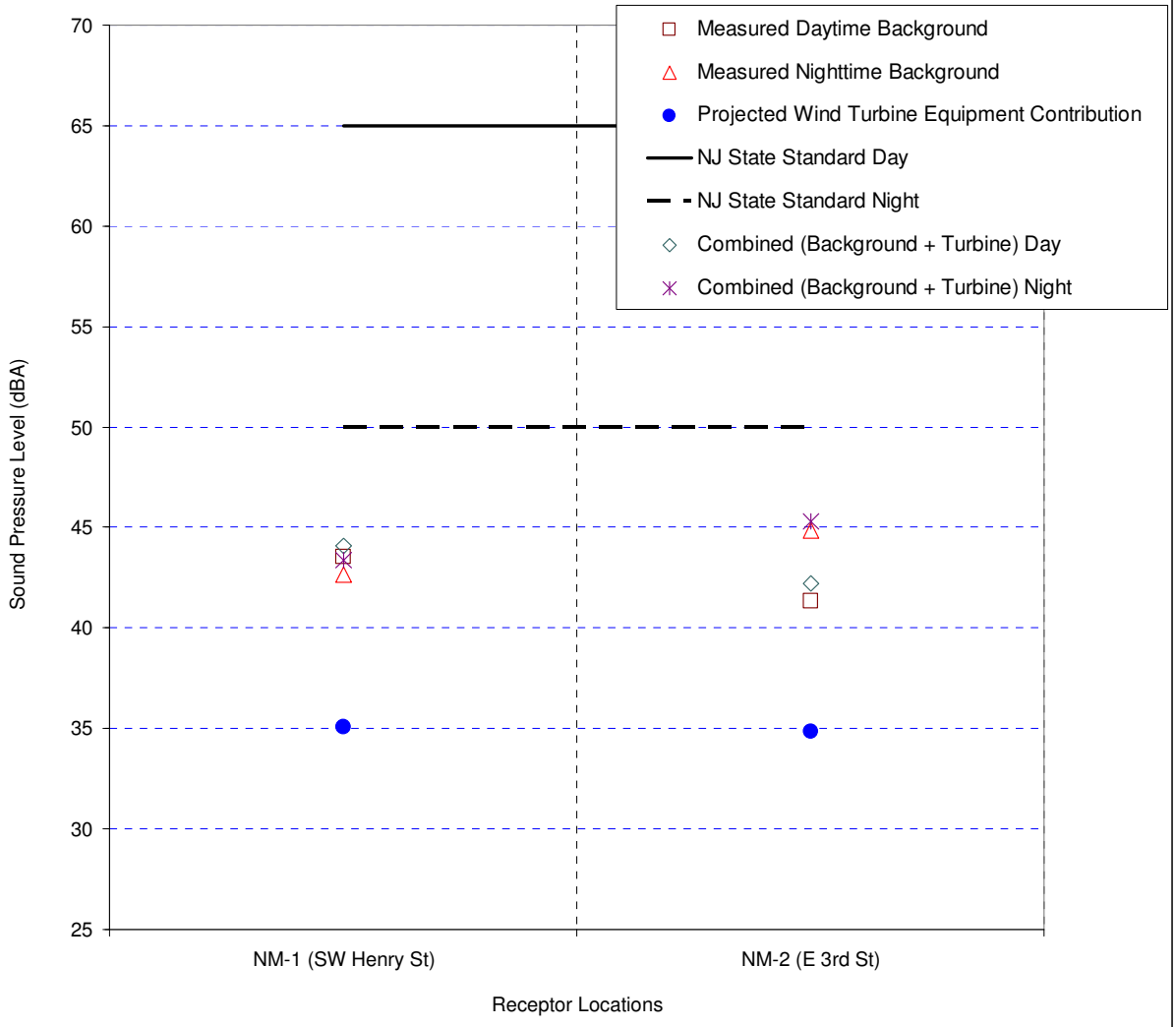
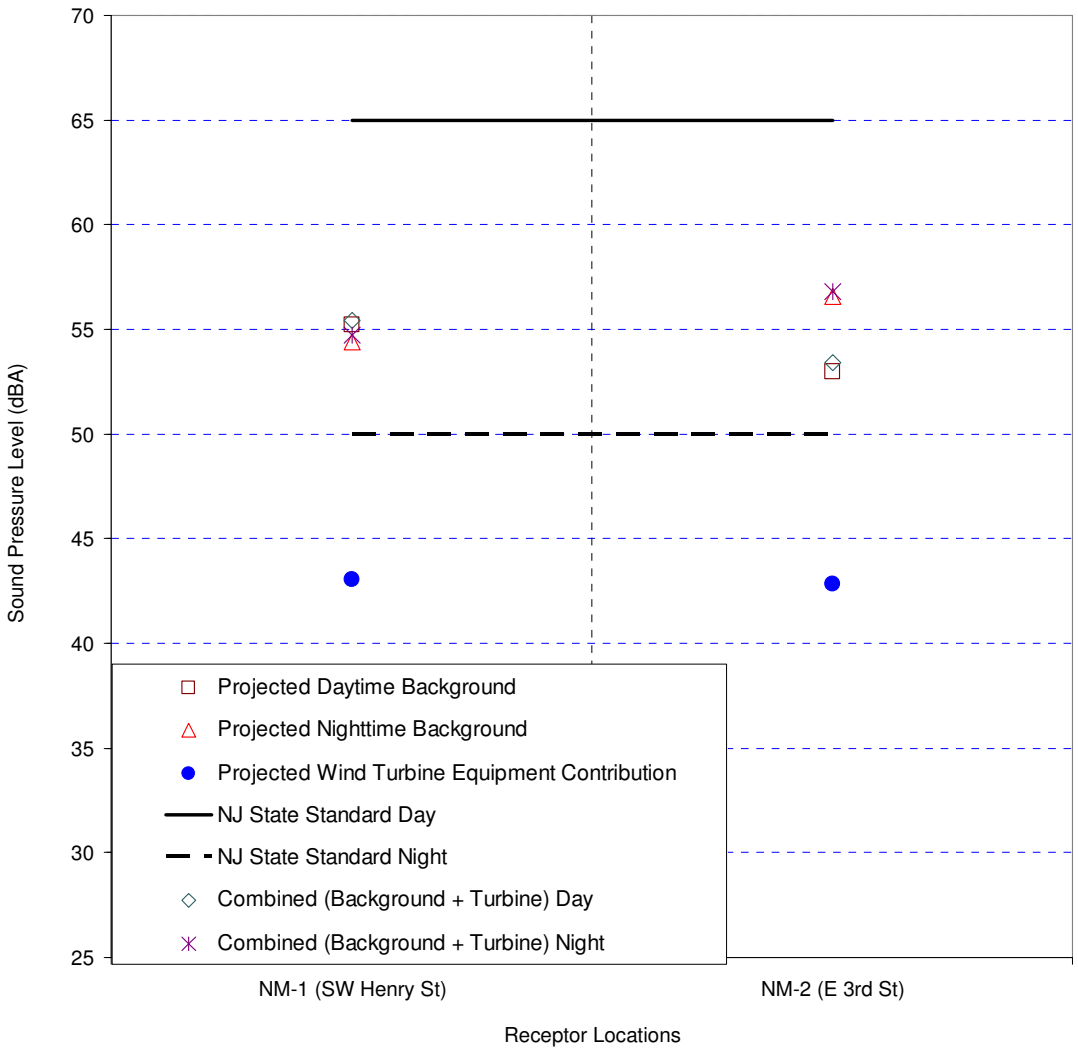


Figure 5-6. BRSA Facility Projected Wind Turbine Sound-Levels
(Based on a Sound Power of 104 dB - 7 m/s winds)



5.4.3 Octave Band Spectra Sound-levels

Octave band frequency values are provided in the GE 1.5xle wind turbine sound emission characteristics and are meant to be for informative purposes only; atmospheric conditions and contribution from blade rotation and aerodynamic sound may change the octave band frequency profile. However, these values have been projected through sound propagation calculations as a preliminary assessment of the octave band sound-levels and are based on available information.

The octave band sound pressure levels associated with the proposed wind turbine generator system have been projected for the 3 m/s wind speed condition at the nearest residential property boundary locations and are presented in Figure 5-7 and Figure 5-8 for 3rd Street and Henry Street, respectively. The predicted octave band sound pressure level contributions from the wind turbine system, combined with existing monitored sound-levels, at the 3rd Street (BRSA-E) and Henry Street (BRSA-SW) property boundary locations are less than the State of New Jersey daytime and nighttime octave band sound pressure level standards.

Figure 5-7.
GE Model 1.5 xle Projected Combined (Background and Wind Turbine) Octave Band Frequencies at 3rd Street (BRSA-E) Residential Receptor Location (3 m/s Wind Speed)

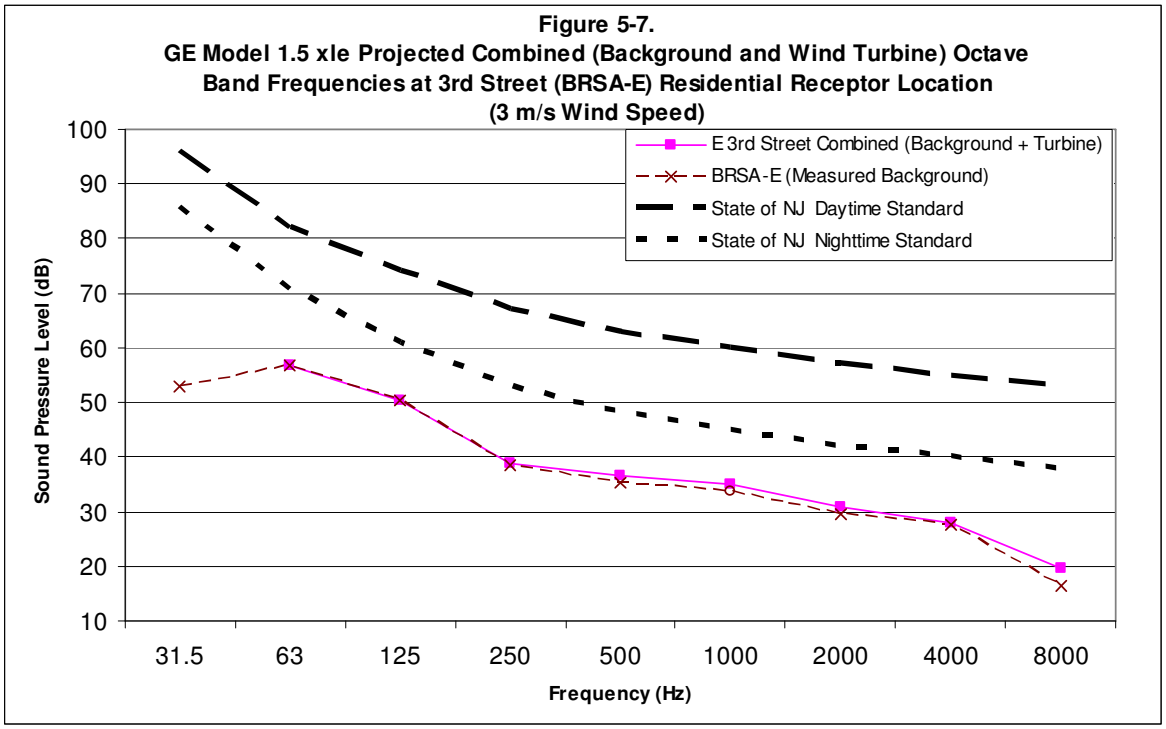
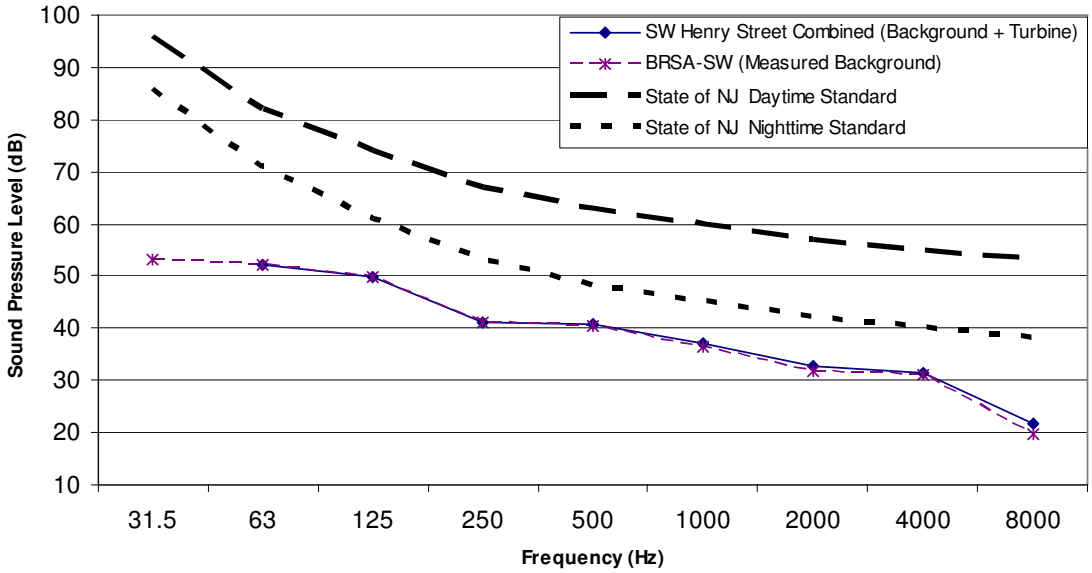


Figure 5-8.
GE Model 1.5 xle Projected Combined (Background and Wind Turbine) Octave Band Frequencies at Henry Street (BRSA-SW) Residential Receptor Location (3 m/s Wind Speed)



SECTION 6.0

SUMMARY AND CONCLUSIONS

6.0 SUMMARY AND CONCLUSIONS

A Sound Assessment Study has been performed at the BRSA Site in support of the proposed wind turbine generation system to assess potential for sound-level impacts at the closest residential property boundaries of the Site (adjacent residential areas). This assessment involved comparing projected sound-levels from the proposed wind turbine system at two nearby residential boundary locations to applicable State of New Jersey sound-level standards. Monitoring of existing (background) sound-levels in the vicinity of the BRSA Site and adjacent residential community and identification and characterization of existing sound sources influencing this area were included in the assessment.

Wind turbine sound is a function of wind speed and of other aspects of the design of the wind turbine. Generally, wind turbines radiate higher sound-levels as the wind speed increases. Audibility is distinct from the sound-level and it depends on the relationship between the sound-level from the wind turbines and the ambient background sound-level. At high wind speeds, sound generated by wind passing through and around structures and vegetation will generally mask the broadband component of sound generated by typical wind turbines if only because these sounds are being produced much closer to the observer than are the sounds generated by the turbine.

The results of this study indicate that wind turbine sound-levels are anticipated to have an insignificant impact on background sound-levels at the nearest residential property boundaries. This does not imply that sound associated with the wind turbine will be inaudible under all circumstances; however sound-levels associated with the proposed operation of the wind turbine are anticipated to be within reasonable sound-levels in relation to the ambient sound environment.

The use of sound pressure level measurement specifications may not always indicate when a sound is detectable by a listener. Sounds with particular frequencies or in an identifiable pattern may be heard through background sound that is otherwise loud enough to mask those sound-levels. Sound from wind turbines may also vary with changes in wind turbulence through the rotor and blades.

The specifications provided by GE for the wind turbine indicate that tonal components of sound associated with this model wind turbine appear to be insignificant; however localized atmospheric conditions around the turbine blades and the specific equipment installed may have related tonal

components that are not identified in general specifications. It is possible that tonal components may exist; however, based upon this analysis they are anticipated to be insignificant.

The future projected total wind turbine equipment sound-levels are less than the State of New Jersey daytime (65 dBA) and nighttime (50 dBA) standards at the two closest residential property boundaries for both 3 m/s and 7 m/s wind speeds. The projected wind turbine system sound-levels are much less than the monitored existing background sound-levels for the 3 m/s wind speed condition and are much less than the projected background sound-levels for the 7 m/s wind speed condition. The projected increases to ambient (background) sound-levels, at the two nearest residential property boundaries, due to contributions from the proposed wind turbine system is anticipated to be less than 1 dBA. The impact on the existing dBA sound-levels is anticipated to be minimal and the wind turbine is anticipated to be barely perceptible at the nearest residential locations. Expected sound-level contributions from the wind turbine at distances beyond the nearest residences would be lower than projected sound-levels at the nearest residences and would be in compliance with State of New Jersey sound-level standards.

The human ear can detect changes in sound as small as 1 dBA, however, a 3 dBA change in sound-level is considered to be the smallest detectable change over an extended period of time. The anticipated differences between existing sound-levels and projected wind turbine sound-levels are much less than 3 dBA at the closest property boundary receptors to the planned wind turbine. The sound from the wind turbine generation system is anticipated to be "barely perceptible" at these locations.

The following can be concluded from this Sound Assessment Study:

- Wind turbine sound-levels are projected to be less than the State of New Jersey daytime and nighttime sound-level standards at the nearest residential property boundaries.

- The projected sound-levels indicate a minimal/insignificant increase in existing sound-levels at and beyond the nearest residential property boundaries to the BRSA facility.

- The increase in existing sound-levels is projected to be less than 1 dBA and is expected to be barely perceptible at, and beyond, the nearest residences.

SECTION 7.0

REFERENCES

7.0 REFERENCES

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APPENDIX A

Borough of Union Beach Noise Code & New Jersey Administrative Code 7:29 Noise Control

Borough of Union Beach

Office of Borough Clerk

650 Poole Avenue

Union Beach NJ 07735

1 of 21 Pages

To: Mark Noffman

Phone: _____ Fax: 732-271-4890

From: Mary Sabik

Phone: 732-264-2277 Fax: 732-264-1267

Date: June 30, 2009

Comments:

3-12 NOISE CONTROL.

3-12.1 Definitions and Standards. All terminology used in this section, not defined below, shall be in conformance with applicable publications of the American National Standards Institute (ANSI) or its successor body.

"A-weighted sound level" shall mean the sound pressure level in decibels as measured on a sound level meter using the A-weighting network. The level so read is designated dB(A) or dBA.

"Commercial area" shall mean any area designated for commercial or business uses under the zoning ordinance of the borough.

"Commercial facility" shall mean any premises, property, or facility involving traffic in goods or furnishing of services for sale or profit including but not limited to:

a. Banking and other financial institutions;

b. Dining establishments;

c. Establishments for providing retail services;

d. Establishments for providing wholesale services;

e. Establishments for recreation and entertainment;

f. Office buildings;

g. Transportation;

h. Warehouses;

"Community services facility" shall mean any nonresidential facility used to provide services to the public, including but not limited to:

a. Club meeting halls, offices, and facilities;

b. Organization offices and facilities;

c. Facilities for the support and practice of religion;

d. Private and parochial schools.

"Construction" shall mean any site preparation, assembly, erection, substantial repair, alteration, or similar action, but excluding demolition.

"Decibel (dB)" shall mean a unit for measuring the volume of a sound, equal to twenty times the logarithm to the base ten of the ratio of the pressure of the sound measured to the reference pressure, which is twenty micropascals (twenty micronewtons per square meter).

"Demolition" shall mean any dismantling, intentional destruction or removal of structures, utilities, public or private right-of-way surfaces, or similar property.

"Emergency" shall mean any occurrence or set of circumstances involving actual or imminent physical trauma or property damage which demands immediate action.

"Emergency work" shall mean any work performed for the purpose of preventing or alleviating the physical trauma or property damage threatened or caused by an emergency.

"Enforcement agency" shall mean the police department of the borough, and any of its authorized officers.

"Gross vehicle weight rating (GVWR)" shall mean the value specified by the manufacturer as the recommended maximum loaded weight of a single motor vehicle. In cases where trailers and tractors are separable, the gross combination weight rating (GCWR), which is the value specified by the manufacturer as the recommended maximum loaded weight of the combination vehicle, shall be used.

"Impulsive sound" shall mean sound of short duration, usually less than one second, with an abrupt onset and rapid decay. Examples of sources of impulsive sound include explosions, drop forge impacts, and the discharge of firearms.

"Industrial area" shall mean an area designated for any industrial use under the zoning ordinance of the borough.

"Industrial facility" shall mean any activity and its related premises, property, facilities, or equipment involving the fabrication,

or equipment involving the fabrication, manufacture, or production of durable or nondurable goods.

"Motor carrier vehicle engaged in interstate commerce" shall mean any vehicle for which regulations apply pursuant to Section 18 of the Federal Noise Control Act of 1972 (Pub Law 92-574), as amended, pertaining to motor carriers engaged in interstate commerce.

"Motor vehicle" shall mean any vehicle which is propelled or drawn on land by a motor, such as, but not limited to, passenger cars, trucks, truck-trailers, semitrailers, campers, go-carts, snowmobiles, amphibious craft on land, dune buggies, or racing vehicles, but not including motorcycles.

"Motorboat" shall mean any vessel which operates on water and which is propelled by a motor, including, but not limited to, boats, barges, amphibious craft, water ski towing devices and hover craft.

"Motorcycle" shall mean an unenclosed motor vehicle having a saddle for the use of the operator and two or three wheels in contact with the ground, including, but not limited to, motor scooters and minibikes.

"Muffler or sound dissipative device" shall mean a device for abating the sound of escaping gases of an internal combustion engine.

"Noise" shall mean any sound which annoys or disturbs humans or which causes or tends to cause an adverse psychological or physiological effect on humans as specified and prohibited in N.J.A.C. 7:29-1.2.

"Noise disturbance" shall mean any sound which endangers or injures the safety or health of humans or animals, or annoys or disturbs a reasonable person of normal sensitivities, or endangers or injures personal or real property as specified and prohibited by subsection 3-12.8 of this section.

"Noise sensitive zone" shall mean any area designated pursuant to this section for the purpose of ensuring exceptional quiet.

"Person" shall mean any individual, association, partnership, or corporation, and includes any officer, employee, department, agency or instrumentality of a state or any political subdivision of a state.

"Powered model vehicle" shall mean any self-propelled airborne, waterborne, or landborne plane, vessel, or vehicle, which is not designated to carry persons, including, but not limited to, any model airplane, boat, car or rocket.

"Public right-of-way" shall mean any street, avenue, boulevard, highway, sidewalk or alley or similar place which is owned or controlled by a governmental entity.

"Public space" shall mean any real property or structures thereon which are owned or controlled by a governmental entity.

"Pure tone" shall mean any sound which can be distinctly heard as a single pitch or a set of single pitches. For the purposes of this section, a pure tone shall exist if the one-third octave band sound pressure level in the band with the tone exceeds the arithmetic average of the sound pressure levels of the two contiguous one-third octave bands by 5 dB for center frequencies of 500 Hz and above and by 8 dB for center frequencies between 160 and 400 Hz and by 15 dB for center frequencies less than or equal to 125 Hz.

"Real property boundary" shall mean a line along the ground surface, and its vertical extension, which separates the real property owned by one person from that owned by another person, but not including intrabuilding real property divisions.

"Residential area" shall mean an area designated for any residential use under the zoning ordinance of the borough.

"RMS sound pressure" shall mean the square root of the time averaged square of the sound pressure, denoted Prms.

"Sound" shall mean an oscillation in pressure, particle displacement, particle velocity or other physical parameter, in a medium with internal forces that causes compression and rarefaction of that medium. The description of sound may include any characteristic of such sound, including duration, intensity and frequency.

"Sound level" shall mean the sound pressure level measured in decibels with a sound level meter set for A-weighting; sound level is expressed in dBA.

"Sound level meter" shall mean an instrument used in accordance with the provisions of N.J.A.C. 7:29B-1 to measure sound pressure level, sound level, octave band sound pressure level, or peak sound pressure level, separately or in any combination thereof.

"Sound pressure" shall mean the instantaneous difference between the actual pressure and the average or barometric pressure at a given point in space, as produced by sound energy.

"Sound pressure level" shall mean the level of a sound measured in dB units with a sound level meter which has a uniform ("flat") response over the band of frequencies measured.

"Stationary emergency signalling device" shall mean any device, excluding those attached to motor vehicles, used to alert persons engaged in emergency operations. These include, but are not limited to, firefighters, first aid squad members, and law enforcement officers, whether paid or volunteer.

"Vibration" shall mean an oscillatory motion of solid bodies of deterministic or random nature described by displacement, velocity, or acceleration with respect to a given reference point.

"Weekday" shall mean any day Monday through Friday which is not a legal holiday.

3-12.2 Powers and Duties of the Enforcement Agency.

a. Agency. The noise control program established by this section shall be administered by the enforcement agency.

b. Powers of the Enforcement Agency. In order to implement and enforce this section and for the general purpose of sound and vibration abatement and control, the enforcement agency shall have, in addition to any other authority vested in it, the power to:

1. Studies. Conduct, or cause to be conducted, research, monitoring, and other studies related to sound and vibration.

2. Education.

(a) Conduct programs of public education regarding:

(1) The causes, effects and general methods of abatement and control of noise and vibration; and

(2) The actions prohibited by this section and the procedures for reporting violations; and

(b) Encourage the participation of public interest groups in related public information efforts.

3. Coordination and cooperation.

(a) Coordinate the noise and vibration control activities of all municipal departments;

(b) Cooperate to the extent practicable with all appropriate state and federal agencies;

(c) Cooperate or combine to the extent practicable with appropriate county and municipal agencies; and,

(d) Enter into contracts, with the approval of the borough council, for the provision of technical and enforcement services.

4. Review of Actions of Other Departments. Request any other department or agency responsible for any proposed or final standard, regulation or similar action to consult on the advisability of revising the action, if there is reason to believe that the action is not consistent with the section.

5. Review of Public and Private Projects. Review public and private projects subject to mandatory review or approval by other departments, for compliance with this section, if such projects are likely to cause sound or vibration in violation of this section.

6. Inspections.

(a) Upon presentation of proper credentials, enter and inspect any private property or place, and inspect any report or records at any reasonable time when granted permission by the owner, or by some other person with apparent authority to act for the owner. When permission is refused or cannot be obtained, a

search warrant or other court order may be sought by the enforcement agency from a court of competent jurisdiction upon showing of a probable cause to believe that a violation of this section may exist. Such inspection may include administration of any necessary tests.

(b) Stop any motor vehicle, motorcycle, or motorboat operated on a public right-of-way, public space, or public waterway reasonably suspected of violating any provision of this section, and issue a notice of violation or abatement order which may require the motor vehicle, motorcycle or motorboat to be inspected or tested.

7. Records. Require the owner or operator of any commercial or industrial activity to establish and maintain records and make reports.

8. Measurements by the Owner or Operator. Require the owner or operator of any commercial or industrial activity to measure the sound level of or the vibration from any source in accordance with the methods and procedures and at such locations and times as the enforcement agency may reasonably prescribe and to furnish reports of the results of such measurements to the enforcement agency. The enforcement agency may require the measurements to be conducted in its presence.

9. Product Performance Standard Recommendations.

(a) Develop and recommend to the borough council provisions regulating the use and operation of any product, including the specification of maximum allowable sound emission levels of such product.

(b) Develop and recommend to the borough council provisions prohibiting the sale of products which do not meet specified sound emission levels, where such provisions are not in conflict with the applicable federal legislation found in 42 USC §4917(c)(1) and (2), and applicable regulations.

10. Noise Sensitive Zone Recommendations. Prepare recommendations, to be approved by ordinance for the designation of noise sensitive zones which contain noise sensitive activities. Existing quiet zones shall be considered noise sensitive zones until otherwise designated. Noise sensitive activities include, but are not limited to, schools, libraries open to the public, churches, hospitals, and nursing homes.

c. Duties of Enforcement Agency. In order to implement and enforce this section effectively, the enforcement agency shall within a reasonable time after the effective date of the section:

1. Standards, Testing Methods, and Procedures. Develop and recommend to the borough council standards, testing methods and procedures.

2. Investigate and Pursue Violations. Investigate and pursue possible violations of this section.

3. Truck Routes and Transportation Planning.

(a) Study the existing transportation systems, such as truck routes within the community; determine areas with sensitivity to sound and vibration caused by transportation; recommend changes or modifications to transportation systems to minimize the sound and vibration impact on residential areas and noise sensitive zones.

(b) Assist in or review the total transportation planning of the community, including planning for new roads and highways, bus routes, airports, and other systems for public transportation, to ensure that the impact of sound and vibration receives adequate consideration.

4. Capital Improvements Guidelines. Establish noise assessment guidelines for the evaluation of proposed improvements for capital improvements. These guidelines shall assist in the determination of the relative priority of each improvement in terms of noise impact.

5. State and Federal Laws and Regulations.

(a) Prepare and publish a list of those products manufactured to meet specified noise emission limits under federal, state, or community law for which "tampering" enforcement will be conducted; and

(b) Make recommendations for amendments to this section to ensure consistency with all state and federal laws and regulations.

6. Planning to Achieve Long Term Noise Goals. Develop a generalized sound level map of the borough, a long term plan for achieving quiet in the borough, and recommend integration of this plan into the planning process of the borough.

7. Administer Grants, Funds and Gifts. Administer noise program grants and other funds and gifts from public and private sources, including the state and federal governments.

8. Periodic Report. Evaluate and report, every year following the effective date of this section, on the effectiveness of the borough noise control program and make recommendations for any legislative or budgetary changes necessary to improve the program. This report shall be made to the borough council.

3-12.3 Duties and Responsibilities of Other Departments.

a. Departmental Actions. All departments and agencies shall, to the fullest extent consistent with law, carry out their programs in such a manner as to further the policy of this section.

b. Department Cooperation. All departments and agencies shall cooperate with the enforcement agency to the fullest extent in enforcing this section.

c. Departmental Compliance with Other Laws. All departments and agencies shall comply with federal and state laws and regulations and the provisions and intent of this section respecting the control and abatement of noise to the same extent that any person is subject to such laws and regulations.

d. Project Approval. All departments whose duty it is to review and approve new projects or changes to existing projects, that result, or may result, in the production of sound or vibration shall consult with the enforcement agency prior to any such approval.

e. Contracts. Any written contract, agreement, purchase order, or other instrument whereby the borough is committed to the expenditure of an amount of dollars requiring competitive bidding under state law or other contracts which by their nature generate noise shall contain provisions requiring compliance with this section.

f. Low Noise Emission Products. Any product which has been certified by the administrator of the United States Environmental Protection Agency pursuant to Section 15 of the Noise Control Act as a low noise emission product and which he determines is suitable for use as a substitute, shall be procured by the borough and used in preference to any other product provided that such certified product is reasonably available and had a procurement cost which is not more than 125 percent of the cost of the least expensive type of product for which it is certified as a substitute.

g. Capital Improvement Program. All departments responsible for a capital improvements budget and program shall prepare an analysis of the noise impact of any proposed improvements in accordance with the noise assessment guidelines established by the enforcement agency. Proposed capital improvements include land acquisition, building construction, highway improvements, and utilities and fixed equipment installation.

3-12.4 Prohibited Acts.

a. Noise Disturbances Prohibited. No person shall make, continue, or cause to be made or continued, any noise disturbance. Noncommercial public speaking and public assembly activities conducted on any public space or public right-of-way shall be exempt from the operation of this subsection.

b. Specific Prohibitions. The following acts, and the causing thereof, are declared to be in violation of this section:

1. Radios, Television Sets, Musical Instruments and Similar Devices. Operating, playing or permitting the operation or playing of any radio, television, phonograph, drum, musical instrument, sound amplifier, or similar device which produces, reproduces, or amplifies sound:

(a) Between the hours of 11:00 p.m. and 7:00 a.m. the following day in such a manner as to create a noise

disturbance across a real property boundary or within a noise sensitive zone.

(b) In such a manner as to create a noise disturbance at 50 feet or 15 meters from such device, when operated in or on a motor vehicle on a public right-of-way or public space, or in a boat on public waters; or,

(c) In such a manner as to create a noise disturbance to any person other than the operator of the device, when operated by any passenger on a common carrier:

(d) This section shall not apply to noncommercial spoken language covered under paragraph b, 2.

2. Loudspeakers and Public Address Systems. Using or operating for any purpose any loudspeaker, public address system, or similar device (1) such that the sound therefrom creates a noise disturbance across a real property boundary or within a noise sensitive zone; or (2) between the hours of 10:00 p.m. and 7:00 a.m. the following day on a public right-of-way or public space.

3. Street Sales. Offering for sale or selling anything by shouting or outcry within any residential or commercial area of the borough, except in a stadium or sports arena.

4. Animals and Birds. Owning, possessing or harboring any animal or bird which frequently or for continued duration, howls, barks, meows, squawks, or makes other sounds which create noise disturbance across a residential real property boundary or within a noise sensitive zone. This provision shall not apply to public zoos.

5. Loading and Unloading. Loading, unloading, opening, closing or other handling of boxes, crates, containers, building materials, garbage cans, or similar objects between the hours of 10:00 p.m. and 7:00 a.m. the following day in such a manner as to cause a noise disturbance across a residential real property boundary or within a noise sensitive zone. The municipal garbage contractor shall adhere to these requirements between 6:00 p.m. and 5:00 a.m. pursuant to its contract with the borough.

6. Construction. Operating or permitting the operation of any tools or equipment used in construction, drilling or demolition work:

(a) Between the hours of 10:00 p.m. and 7:00 a.m. the following day on weekdays or at any time on weekends or holidays, such that the sound therefrom creates a noise or a noise disturbance across a residential real property boundary or within a noise sensitive zone, except for emergency work of public service utilities.

(b) At any other time such that the sound level at or across a real property boundary exceeds 65 dBA for the daily period of operation or as provided by N.J.A.C. 7:29-1.2.

(c) This section shall not apply to the use of domestic power tools subject to paragraph b. 17.

7. Vehicle or Motorboat Repairs and Testing. Repairing, rebuilding, modifying, or testing any motor vehicle, motorcycle, or motorboat in such a manner as to cause a noise or noise disturbance across a residential real property boundary or within a noise sensitive zone.

8. Airport and Aircraft Operations.

(a) The enforcement agency shall consult with all airport authorities and airport operators to recommend changes in airport operations to minimize noise disturbance.

(b) Nothing in this section shall be construed to prohibit, restrict, penalize, enjoin, or in any manner regulate the movement of aircraft which are in all respects conducted in accordance with, or pursuant to, applicable federal laws or regulations.

9. Places of Public Entertainment. Operating, playing or permitting the operation or playing of any radio, television, phonograph, drum, musical instrument, sound amplifier, or similar device which produces, reproduces, or amplifies sound in any place of public entertainment, including the interior and exterior portions of the premises, at a sound level greater than

the dBA provided in N.J.A.C. 7:29-1.2, as read by the slow response on a sound level meter at any point that is normally occupied by a customer, unless a conspicuous and legible sign is located outside such place, near each public entrance, stating, "Warning: Sound levels within may cause permanent hearing impairment." At no time can the levels provided in subsection 3-12.8 of this section be exceeded. Such places of public entertainment shall not exceed the levels prescribed in N.J.A.C. 7:29-1.2 beyond the property of the source if on a private property or at 50 feet or 15 meters from the source if on a public space or public right-of-way.

10. Explosives, Firearms, and Similar Devices. The use or firing of explosives, firearms, or similar devices which create impulsive sound so as to cause a noise disturbance across a real property boundary or on a public space or right-of-way.

11. Powered Model Vehicles. Operating or permitting the operation of powered model vehicles so as to create a noise or noise disturbance across a residential real property boundary, in a public space or within a noise sensitive zone between the hours of 10:00 p.m. and 7:00 a.m. the following day. Maximum sound levels in a public space during the permitted period of operation shall conform to those set forth for residential land use in Table I of subsection 3-12.8 and shall be measured at a distance of 50 feet or 15 meters from the vehicle.

12. Vibration. Operating or permitting the operation of any device that creates vibration which is above the vibration perception threshold of an individual at or beyond the property of the source if on private property or at 50 feet or 15 meters from the source if on a public space or public right-of-way. For the purposes of this section, "vibration perception threshold" means the minimum ground- or structure-borne vibrational motion necessary to cause a normal person to be aware of the vibration by such direct means as, but not limited to, sensation by touch or visual observation of moving objects.

13. Stationary Nonemergency Signaling Devices.

(a) Sounding or permitting the sounding of any signal from any stationary bell, chime, siren, whistle, or similar device, intended primarily for nonemergency

purposes, from any place, for more than one minute in any hourly period.

(b) Devices used in conjunction with places of religious worship shall be exempt from the operation of this provision.

14. Emergency Signaling Devices.

(a) The intentional sounding or permitting the sounding outdoors of any fire, burglar, or civil defense alarm, siren, whistle or similar stationary emergency signaling device, except for emergency purposes or for testing, as provided in paragraph b, 14(b).

(b) (i) Testing of a stationary emergency signaling device shall occur at the same time of day each time such a test is performed, but not before 8:00 a.m. or after 9:00 p.m. Any such testing shall use only the minimum cycle test time. In no case shall such test time exceed 60 seconds. (ii) Testing of the complete emergency signaling system, including the functioning of the signaling device and the personnel response to the signaling device, shall not occur before 8:00 a.m. or after 6:00 p.m. The time limit specified in (i) shall not apply to such complete system testing.

(c) Sounding or permitting the sounding of any exterior burglar alarm or any motor vehicle burglar alarm unless such alarm is automatically terminated within six minutes of activation.

15. Motorboats. Operating or permitting the operation of any motorboat in any lake, river, stream, or other waterway in such manner as to exceed a sound level of 65 dBA at 50 feet or 15 meters of the nearest shoreline, whichever distance is less.

16. Noise Sensitive Zones.

(a) Creating or causing the creation of any sound within any noise sensitive zone designated pursuant to subsection 3-12.2, so as to disrupt the activities normally conducted within the zone, provided that conspicuous signs are displayed indicating the presence of the zone; or

(b) Creating or causing the creation of any sound within any noise sensitive zone, designated pursuant to subsection 3-12.2, containing a hospital, nursing home, or similar activity, so as to interfere with the functions of such activity or disturb or annoy the patients in the activity, provided that conspicuous signs are displayed indicating the presence of the zone.

17. Domestic Power Tools. Operating or permitting the operation of any mechanically powered saw, sander, drill, grinder, lawn or garden tool, snowblower, or similar device used outdoors in residential areas between the hours of 10:00 p.m. and 7:00 a.m. the following day so as to cause a noise or a noise disturbance across a residential real property boundary.

18. Tampering. The following acts or the causing thereof are prohibited:

(a) The removal or rendering inoperative by any person other than for purposes of maintenance, repair, or replacement, of any noise control device or element of design or noise label of any product identified under subsection 3-12.2, paragraph c. 5.

(b) The moving or rendering inaccurate or inoperative of any sound monitoring instrument or device positioned by or for the enforcement agency, provided such device or the immediate area is clearly labeled to warn of the potential illegality.

(c) The use of a product, identified under subsection 3-12.2, paragraph c, 5, which has had a noise control device or element of design or noise label removed or rendered inoperative, with knowledge that such action has occurred.

3-12.5 Sound Levels by Receiving Land Use.

a. Maximum Permissible Sound Levels by Receiving Land Use. No person shall operate or cause to be operated on private property any sourse of sound in such a manner as to create a sound level which exceeds the limits set forth for the receiving land use as regulated for industrial, commercial, public service, or community service facilities in N.J.A.C. 7:29-1.2.

b. Correction for Character of Sound. For any source of sound which emits a pure tone or impulsive sound, the maximum sound level limits set forth in subsection 3-12.5a. shall be reduced by 5dBA.

3-12.6 Motor Vehicle Maximum Sound Levels.

a. No person shall operate or cause to be operated a public or private motor vehicle or motorcycle on a public right-of-way at any time in such a manner that the sound level emitted by the motor vehicle or motorcycle exceeds the level set forth in N.J.A.C. 7:29-1.2.

b. Adequate Mufflers or Sound Dissipative Devices.

1. No person shall operate or cause to be operated any motor vehicle or motorcycle not equipped with a muffler or other sound dissipative device in good working order and in constant operation;

2. No person shall remove or render inoperative, or cause to be removed or rendered inoperative, other than for purposes of maintenance, repair, or replacement, any muffler or sound dissipative device on a motor vehicle or motorcycle;

3. The enforcement agency may, by guidelines, list those acts which constitute typical violations of this section.

c. Motor Vehicle Horns and Signaling Devices. The following acts and the causing thereof are declared to be in violation of this section.

1. The sounding of any horn or other auditory signaling device on or in any motor vehicle on any public right-of-way or public space, except as a warning of danger or to alert a person of the presence of the person sounding the horn.

d. Refuse Collection Vehicles. No person shall:

1. On or after two years following the effective date of this section, operate or permit the operation of the compacting mechanism of any motor vehicle which compacts refuse and which creates, during the compacting cycle, a sound level in excess of 88 dBA when measured at 50 feet or 15 meters from any point on the vehicle; or

2. Operate or permit the operation of the compacting mechanism of any motor vehicle which compacts refuse, between the hours of 6:00 p.m. and 5:00 a.m. the following day in a residential area or noise sensitive zone.

e. Standing Motor Vehicles. No person shall operate or permit the operation of any motor vehicle with a gross vehicle weight rating (GVWR) in excess of 10,000 pounds, or any auxiliary equipment attached to such a vehicle, for a period longer than ten minutes in any hour while the vehicle is stationary, for reasons other than traffic congestion, on a public right-of-way or public space within 150 feet or 46 meters of a residential area or designated noise sensitive zone, between the hours of 10:00 p.m. and 7:00 a.m. the following day.

f. Recreation Motorized Vehicles Operating Off Public Rights-of-Way. No person shall operate or cause to be operated any recreational motorized vehicle off a public right-of-way in such a manner that the sound level emitted therefrom exceeds the limits set forth in N.J.A.C. 7:29-1.2 at a distance of 50 feet or 15 meters or more from the path of the vehicle when operated on a public space or at or across the boundary of private property when operated on private property. This section shall apply to all recreational motorized vehicles whether or not duly licensed and registered, including, but not limited to, commercial or noncommercial racing vehicles, motorcycles, go-carts, snowmobiles, amphibious craft, campers and dune buggies, but not including motorboats.

g. Motor Vehicle Music Amplification or Reproduction Systems. The following acts and the causing thereof are declared to be a violation of this section:

1. Personal or commercial vehicular music amplification or reproduction equipment shall not be operated in such a manner that it is plainly audible at a residential property line between the hours of 10:00 p.m. and 9:00 a.m.

2. Personal vehicular music amplification equipment shall not be operated in such a manner as to be plainly audible at a distance of 50 feet in any direction from the operator between the hours of 9:00 a.m. and 10:00 p.m.

3. These provisions apply to non-music playing as well as music.

3-12.7 Exceptions.

a. Emergency Exception. The provisions of this section shall not apply to (a) the emission of sound for the purpose of alerting persons to the existence of an emergency, or (b) the emission of sound in the performance of emergency work, or (c) any others provided in N.J.A.C. 7:29-1.4.

b. The provisions relating to playing of music by live bands or recorded reproductions shall not apply to community functions and block parties approved by the mayor and council by resolution which shall set forth the dates and hours when this exception shall be applicable.

3-12.8 Enforcement.

a. Immediate Threats to Health and Welfare.

1. The enforcement agency shall order an immediate halt to any sound which exposes any person, except those excluded pursuant to paragraph a, 2, to continuous sound levels in excess of those shown on Table I or to impulsive sound levels in excess of those shown in Table II. Within five days following issuance of such an order, the enforcement agency shall apply to the appropriate court for an injunction to replace the order.

2. No order pursuant to paragraph a, 1 shall be issued if the only person exposed to sound levels in excess of those listed in Tables I and II are exposed as a result of (1) trespass; (2) invitation upon private property by the person causing or permitting the sound; (3) employment by the person of the person causing or permitting the sound.

3. Any person subject to an order issued pursuant to paragraph a, 1 shall comply with such order until (1) the sound is brought into compliance with the order, as determined by the enforcement agency; or (2) a judicial order has superseded the enforcement agency order.

TABLE I

NOISE DISTURBANCE (CONTINUOUS SOUND LEVELS)
(measured at 50 feet or 15 meters)

Continuous Sound Level Limit (dBA)	Duration
90	24 hours
93	12 hours
96	6 hours
99	3 hours
102	1.5 hours
105	45 minutes
108	22 minutes

Use equal energy time-intensity trade-off if level varies; find energy equivalent over 24 hours.

TABLE II

NOISE DISTURBANCES (IMPULSIVE SOUND LEVELS)
(measured at 50 feet or 15 meters)

Impulsive Sound Level Limit (dB)	Number of Repetitions per 24 hour period
145	1
135	10
125	100

b. Other Remedies. No provision of this section shall be construed to impair any common law or statutory cause of action, or legal remedy therefrom, of any person for injury or damage arising from any violation of this section or from other law.

c. Severability. If any provision of this section is held to be unconstitutional or otherwise invalid by any court of competent jurisdiction, the remaining provisions of this section shall not be invalidated. It is the intent of this section to regulate noise within the Borough of Union Beach and to comply with all statutes and codes duly adopted and promulgated, including but not limited to, N.J.A.C. Chapter 29 NOISE CONTROL and Chapter 29B NOISE DETERMINATION. Should any provisions of this section be inconsistent with specific

provisions of said statutes or codes, the codes shall take precedence over this section. For any provisions of this section, not contained in or covered by the codes, this section shall be applicable.

d. Penalty. Any person, firm or corporation violating any provision of this section shall be fined not less than fifty ($50.00) dollars nor more than one thousand ($1,000.00) dollars for each offense, and/or subject to a maximum of 90 days in jail or both, and a separate offense shall be deemed committed on each day during or on which an offense occurs or continues.

3-13 FEES TO BE PAID TO OBTAIN PRETRIAL DISCOVERY.

3-13.1 Pretrial Discovery Fees. The following fees shall be paid by any person or that person's authorized attorney or representative in order to obtain pretrial discovery on the items listed below or other records requested for a lawful purpose from the Borough of Union Beach Police Department:

1-10 pages	$0.75 per page
Next 11-20 pages	$0.50 per page
After 20 pages	$0.25 per page
Photographs	$5.00 per photograph
Cost for any discovery sent by mail	$0.25 per envelope plus actual postage
Copy of video tape	$20.00
Copy of motor vehicle accident reports (N.J.S.A. 39:4-131)	$5.00 for first 3 pages
(If MVA reports are requested other than in person)	$1.00 per page thereafter

3-14 DESIGNATED SCHOOL CROSSINGS.

3-14.1 Purpose. Laws of New Jerscy 1999 Chapter 185 mandates that vehicular homicide is a crime of the first degree under certain circumstances including commission of the offense by an intoxicated individual in violation of N.J.S.A. 39:4-50a, while driving through a school crossing as defined by N.J.S.A. 39:1-1 if the municipality, by ordinance or resolution, has designated the school crossings as such.

APPENDIX B

Environmental Sound Fundamentals

Appendix: Environmental Noise Fundamentals

1.0 Sound / Noise Basics

Sound

Sound is generated when a vibrating object (sound source) creates a physical disturbance that sets the parcels of air or other surrounding medium nearest to it in motion, causing pressure variations that form a series of alternating compression and expansion pressure waves that move or propagate outward away from the source in a spherical pattern.

Sound propagates at different speeds depending on the medium.

- In air sound propagates at a speed of approximately 340m/s;
- In liquids the propagation velocity is greater and in water is approximately 1500 m/s; and
- In solids can be even greater and is 5000 m/s in steel.

Factors that affect how sound is perceived by the human ear include the amplitude or loudness, the frequency, and the duration of the sound, as well as the location of the receiver relative to the source of sound. The sound levels we encounter in daily life vary over a wide range. The lowest sound pressure level the ear can detect is more than a million times less than that of a jet take-off. The audible sound frequency range for young persons is from approximately 20hz to 20,000Hz.The decibel is used as a unit of sound amplitude or loudness and is derived from a comparison sound pressure, in air, with a reference pressure. Broadband sound covers the whole of the audible frequency range and is made up of many tones.

Noise

The terms “sound” and “noise” are often used synonymously Noise is unwanted sound usually composed of a spectrum of many single frequency components, each having its own amplitude. The disturbing effects of noise depend both on the intensity and the frequency of the tones. For example, higher frequencies are often more disturbing than low frequencies. Pure tones can be more disturbing than broadband sound.

Frequency

Noise with distinct tones, for example, noise from fans, compressors, or saws, can be more disturbing than other types of noise. This annoyance factor is not taken into account in a broadband measurement.

A spectral analysis may be needed to identify/assess disturbance. Pure tones can be assessed subjectively, as the human ear is good at detecting tones. Regulations often require an objective measurement of tonal content as well. In practice, this is can be done by octave, 1/3-octave analysis or narrow-band analysis (FFT - Fast Fourier Transform).

A-Weighting (dBA) **-** Noise measurements are most often taken using the "A-weighted" frequency response function. The A-weighted frequency or dBA scale simulates the response of the human ear to sound levels (particularly low-level sound) and has been given prominence as a means for estimating annoyance caused by noise, for estimating the magnitude of noise-induced hearing damage, in hearing conservation criteria, for speech interference measurements, and in procedures for estimating community reaction to (general broad band) noise (Clayton, et al. 1978; Cheremisinoff, et al. 1977). Sound measurements are often made using the “A” frequency weighting when assessing

environmental noise. The Leq or, better, the LAeq (the A-weighted equivalent continuous sound level) is an important parameter.

1.1 Noise Descriptors

There are a number of noise descriptors used to characterize various aspects of noise that take into account the variability of noise levels over time which most environments experience. Various criteria and guidelines used to characterize noise are discussed below. The different descriptors are applicable to different situations. Commonly used descriptors are discussed below.

Equivalent Sound Level (Leq)

The equivalent sound level (Leq) is the value of a steady-state sound which has the same A-weighted sound energy as that contained in the time-varying sound. The Leq is a single sound level value for a desired duration, which includes all of the time-varying sound energy during the measurement period. The U.S. EPA has selected Leq as the best environmental noise descriptor for several reasons, but primarily because it correlates reasonably well with the effects of noise on people, even for wide variations of environmental sound levels and different time exposure patterns. Also, it is easily measurable with available equipment.

Statistical Descriptors

Statistical sound level descriptors such as L_1, L_{10}, L_{50}, and L_{90} are used to represent noise levels that are exceeded 1, 10, 50, and 90 percent of the time, respectively. L_{50}, the Sound Pressure Level (SPL) exceeded 50 percent of the time, provides an indication of the median sound level. L_{90} represents the residual level, or the background noise level without intrusive noises.

Residual Noise Level

Measurement of the residual or background sound level is useful in characterizing a community with respect to noise. The residual sound level is the minimum sound level in the absence of identifiable or intermittent local sources. It is not the absolute minimum sound level during a long observation period, but rather the lowest reading that is reached repeatedly during a given period. The L90 (referred to as the ambient level) is a statistical descriptor, which represents the level that is exceeded 90 percent of the time. Comparisons of data have shown that the L90, measured with a continuous statistical sound meter, and the residual sound level, measured by trained personnel with a sound-level meter, are closely correlated with one another. (Bolt, Beranek, and Neman, Inc. 1978)

Ambient noise is the noise from all sources combined - factory noise, traffic noise, birdsong, running water, etc. Specific noise is the noise from the source under investigation. The specific noise is a component of the ambient noise and can be identified and associated with the specific source.

Day/Night Equivalent Sound Level (Ldn)

The day/night equivalent sound level (Ldn) is the A-weighted equivalent level for a 24-hour period. (U.S. EPA 1974). The Ldn is estimated from the equivalent daytime Ld and nighttime Ln levels with an additional 10 dBA weighting imposed on the equivalent sound levels occurring during nighttime.

The U.S. EPA suggests this descriptor be used to relate noise in residential areas to annoyance caused by interference with speech, sleep and other activity. Based on interpretation of available scientific information, U.S. EPA identified an outdoor Ldn of 55 dBA as a level protective of public health and welfare with an adequate margin of safety, without concern for economic and technical feasibility. (U.S. EPA 1978)

1.2 Noise Standards/Criteria

FHWA Noise Abatement Criteria

The Federal Highway Administration (FHWA) has established noise abatement criteria for motor vehicle noise on roadways (23 CFR 772). These criteria are intended to apply to highway projects, which this is not. However, these criteria can be used as guidance for assessing traffic noise. These criteria represent maximum desirable noise levels for various land-uses and associated human activities, for use in assessing noise levels from roadway traffic. An exterior Leq of 67 dBA is the Noise Abatement Criterion typically used to evaluate noise levels along highways, Activity Category (B), applicable to residential areas. The FHWA Noise Abatement Criterion for areas not considered sensitive receptors, such as manufacturing zones, is an Leq of 72 dBA, Activity Category (C).

Noise sensitivity criteria used by the FHWA for evaluating the significance of noise impacts are presented in Table 1. Generally, a three dBA or smaller change in sound pressure (noise) level would be barely perceptible to most listeners, whereas a ten dBA change is normally perceived as a doubling (or halving) of noise levels. Increases in average or cumulative noise levels of five dBA or more are clearly noticeable. These criteria provide an indication of individual perception of changes in noise levels. A three-dBA increase is commonly used as the threshold for assessing the potential significance of noise impacts.

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New York State

The New York State Department of Environmental Conservation (NYSDEC) has published a policy and guidance document titled *Assessing and Mitigating Noise Impacts* (October 6, 2000). This document provides guidance on when noise due to projects has the potential for adverse impacts and requires review and possible mitigation in the absence of local regulations. The NYSDEC guidance indicates that local noise ordinances or regulations are not superceded by NYSDEC guidance. The New York State Guidance Document contains a Table identifying expected human reaction to various increases in sound pressure levels. This Table is included as Table 2 below. The guidance indicates that a noise increase of 10 dBA deserves consideration of avoidance and mitigation measures in most cases. It is further indicated that the addition of a noise source, in a non-industrial setting, should not raise the ambient noise level above a

maximum of 65 dBA.

The City Environmental Quality Review (CEQR) Noise Code was adopted to prevent unreasonably loud and disturbing noise.

New Jersey State Noise Standards

The State of New Jersey noise standards (Noise Control Regulations) require that sound from any industrial or commercial operation measured at any residential property line must not exceed a continuous sound level of 65 dBA during the daytime (7:00 a.m. to 10:00 p.m.), or a level of 50 dBA during the nighttime (10:00 p.m. to 7:00 a.m.). These standards also limit continuous sound from any industrial or commercial operation measured at any other commercial property line to 65 dBA (New Jersey Administrative Code 7:29, 2000).

Octave band sound levels have been specified by the State of New Jersey, which limit the sound intensity at residential and commercial property boundary lines (New Jersey Administrative Code 7:29, 1997). An octave band sound level limit requires a noise analysis of sound levels at various frequencies. The sound signal energy can be electronically separated into frequency bands, known as octave bands, each of which covers a 2 to 1 range of frequencies. For example, the effective band for the 1,000 Hz octave band center frequency extends from 710 to 1,420 Hz.

New Jersey Model Noise Ordinance

The Model Noise Ordinance was developed to be adopted, enforced, and adjudicated locally. It is a performance code designed to empower municipalities to respond to noise complaints within their community in a timely manner. The model noise ordinance regulates more sound-source categories than the State's Noise Control Regulations, including residential and multi-use properties. The noise standards in this model noise ordinance are the same as that for the New Jersey State Noise Control Regulations.

Local Municipalities

Local municipalities may have their own noise control code or noise ordinance that may regulate noise more stringently than state standards/criteria. Local noise codes will be considered on a project specific basis.

Table 1
Noise Sensitivity Criteria
Decibel Changes and Loudness

Change (dBA)	Relative Loudness
0	Reference
3	Barely perceptible change
5	Readily perceptible change
10	Half or twice as loud
20	1/4 or four times as loud
30	1/8 or eight times as loud

Source: Based on Highway Traffic Noise Analysis and Abatement – Policy and Guidance. (FHWA, June 1995.)

Table 2
HUMAN REACTION TO INCREASES IN SOUND PRESSURE LEVEL

Increase in Sound Pressure (dB)	Human Reaction
Under 5	Unnoticed to tolerable
5 – 10	Intrusive
10 – 15	Very noticeable
15 – 20	Objectionable
Over 20	Very objectionable to intolerable

Source: New York State Department of Environmental Conservation. Assessing and Mitigating Noise Impacts. (NYSDEC October 6, 2000.)

2.0 NOISE MONITORING SURVEY

2.1 Methodology

The following describes the equipment and procedures utilized during this noise survey.

2.2 Equipment

The sound-level meter (SLM) is the conventional instrument used to measure the instantaneous sound-pressure level (SPL), in decibels (dB), of sound energy. The SLM contains a microphone, amplifier, weighting and filter networks, detector networks, and indicators.

An integrating sound-level meter (ISLM) has the capability to compute the long-term root-mean-square (rms) level of time-varying sound energy. The time-averaged, mean square SPL is referred to as the Leq (equivalent constant SPL). The ISLM used for this assessment can compute Leq measurements automatically, providing greater ease and accuracy of Leq determination.

Noise levels were measured and analyzed with a Bruel and Kjaer (B&K) Modular Precision Sound Level Meter Type 2231 and/or a Bruel and Kjaer (B&K) Modular Precision Sound Level Meter Type 2250. A B&K Microphone Type 4189 was used in conjunction with the B&K 2231 and B&K 2250. Both the B&K 2231 and B&K 2250 are Type 1 instruments in accordance with the American National Standards Institute (ANSI), S1.4-1983 Type 1. This instrument can be used to perform a wide range of measurements, take several measurements simultaneously, and automatically store data at the end of a preset time period. The B&K 2231 and 2250 can measure sound levels ranging from 24 to 113 decibels A-weighted (dBA). Measured data can be stored in the instrument memory, which has battery backup, to maintain data integrity. The B&K 2231 and 2250 can be used with modules to enhance the basic functions of the meter.

The B&K 2231 can be used in conjunction with a B&K 1625 Octave Band Filter, to perform octave band measurements. The B&K 1625 Band Pass Filter Set contains 10 active filters with center frequencies from 31.5 Hz to 16 kHz. Each octave filter satisfies requirements of IEC Recommendation R 225-1996, DIN 45651 and ANSI S1, 11-1966 Class II. The total frequency range is from 14 Hz to 28 kHz. The B&K 1625 filter set covers the audio-frequency range with center frequencies arranged according to the preferred frequencies of ISO R266, DIN 45401 and ANSI 1.6-1960. The B&K 2250 has a software module that allows real-time frequency measurements in 1/1 and 1/3 Octave Bands.

2.3 Calibration

Calibration of the B&K 2231 and/or the B&K 2250 was performed using the B&K Calibrator 4230 and/or B&K 4231. Calibrations of the B&K 2231 and/or B&K 2250 were performed prior to and immediately following noise monitoring.

2.4 Procedures

There are many noise monitoring methodologies available for performing baseline noise monitoring studies. Most consist of various data acquisition and analysis procedures, and also include a high degree of subjectivity (Greenberg, et al. 1979). The approach utilized follows appropriate general guidelines and recommended practices.

Observations are made, during measurement, such as with regard to temperature, wind, relative humidity, cloud cover, and wind induced noises (i.e., leaves rustling, etc.). Atmospheric conditions such as rainfall (precipitation), high humidity (greater than 90 percent), and high wind (greater than around 12 to 15 miles per hour) are avoided during

field measurement because of their potential influence to have an adverse effect on noise measurements. A microphone windscreen is utilized (as appropriate) during measurements to minimize potential wind effects.

Nearby buildings and other structures can modify outdoor noise radiation patterns. In addition, specific site conditions and equipment layout can influence sound propagation. To characterize sound levels from a facility requires considering site conditions, facility design, and receptor locations.

2.5 Noise Monitoring Locations

A-Weighted noise measurements are taken at various locations in the vicinity of the equipment/location of concern. Noise monitoring may be performed at a number of different locations; near the noise source along the site perimeter; along adjoining residential property boundaries.

2.6 Sensitive Receptors

Areas or receptors that are considered potentially sensitive to noise include residences, schools, hospitals, and recreational facilities (U.S. Environmental Protection Agency, 1974). Potentially sensitive receptors located near the noise source usually include residential areas near the site. The location of closest residence to the noise source is identified and is commonly a candidate for noise monitoring.

2.7 Other Equipment

A Quest Technologies Q-500 Multi-Function Noise Analyzer (a data-logging dosimeter) is sometimes used for noise monitoring. The Q-500 is a Type 1 instrument in accordance with the American National Standards Institute (ANSI), S1.4-1983 Type 1, and has many of the features of an ISLM. The Q-500 dosimeter can be used to record Leq noise levels in one-minute time history intervals over the course of a 24-hour period. The Q-500 can measure sound levels ranging from 40 to 140 decibels A or C-weighted. The A-weighted (dBA) scale can be utilized with the sound level range set at 40 to 115 decibels. An exchange rate of three (3) was used in conjunction with a slow response. Measured data is stored in the instrument memory, which has battery backup, to maintain data integrity.

Calibration of the Q-500 Multi-Function Noise Analyzer is performed using the QC-20 Calibrator set at 94 dB. Calibrations of the dosimeter are usually performed prior to and following noise monitoring.

3.0 NOISE MODELING

3.1 Noise Modeling Methodology

Noise level contributions due to operation of a particular noise source can be estimated using quantitative techniques (noise modeling). Projected noise levels can be estimated using a noise modeling technique, based on a relationship that expresses noise attenuation as a logarithmic function of receptor distance from the noise source. Noise contribution levels from a noise source can be estimated at selected receptor locations (i.e., noise monitoring locations).

Noise propagation calculations are based on the assumption that, at distances greater than around 50 feet (15 meters) from a source, noise levels are reduced by 6 dB for each doubling of distance away from the noise source (Peterson and Gross 1972). This tends to be a conservative approach, since attenuation due to buildings, barriers, and vegetation are often not taken into account; nor are factors such as relative humidity and wind.

3.2 Modeling Results

Receptor locations can be influenced by many noise sources at the same time but to different degrees, depending on the distances the receptors are from the various noise sources, as well as the magnitude, time and duration of noise from these different noise sources. In a situation with many noise sources, it is sometimes difficult to distinguish which noise sources are influencing a given receptor and what their noise level contributions are.

Noise level estimates of potential contributions from a specific noise source can be made at receptor points (monitoring locations from a noise study or sensitive receptor locations), utilizing the noise propagation techniques discussed above. Approximate distances from each facility component (noise source) to various receptor (property boundary, residential etc.) locations are used in an analysis.

Environmental factors (e.g., any buildings or structures between sources and receptors, buildings, vegetation, etc.) usually are not included in the modeling. These factors could serve to make actual noise levels lower than the modeled estimates.

A noise assessment is usually performed using the noise level estimates for a noise source or measured existing noise levels at the source or similar source. Projected noise, associated with a noise source, can be compared to measured existing noise levels.

4.0 MITIGATION MEASURES

If a review of the noise assessment results suggests that reducing noise levels from existing or proposed new equipment (noise sources) a site may be warranted then mitigation methods should be considered. Mitigation measures to reduce measured or projected noise levels include the following, which may be appropriate for different situations:

- Design considerations – specify "quiet equipment designs" depending on installation and site
- Sound absorption panels barrier panels
- Check/improve installation
- Consider enclosures, buildings, or other structures, isolating equipment, etc.
- Interior wall/window treatments

Retrofit to improve a noise problem after placement can be difficult, and more costly. The above methods can vary widely in their effectiveness, installation and cost.

Installation of indoor mitigation materials/wall treatments:
Take the obvious steps to seal off all cracks, crevices, and paths where sound could escape. Sound can pass through cracks and every crack will offer sound an escape route. Unless you are thorough in sealing off the entire room, you will not achieve the maximum benefit of sound-proofing materials. Sometimes this can be difficult to accomplish, depending on the number of vents, electrical plugs, windows, doors, and other breaks in the wall. Doors and windows are often overlooked. Make sure that doors and windows fit their frames snuggly and that they form a tight seal.

There must be no loose studs, and the sill plates must really hug the floor. The wallboard must be well fitted and all potential cracks must be caulked. (caulk should be flexible, not rigid, and should not crack when the building settles). Do not put holes in sound walls for outlets or pipes; use surface mount electrical fittings and caulk around any wires that pierce gypsum.

Sound can travel through any medium and it passes through solids better than through air. Sound intensity is reduced in the transition from one material to another, as from the air to a wall and back. The amount of reduction (called the transmission loss) is related to the density of the wall, as long as it doesn't move in response to the sound.

Any motion caused by sound striking one side of the wall will result in sound radiated by the other side, an effect called coupling. If the sound hits a resonant frequency, the wall will boom like a drum. Most isolation techniques are really ways to reduce coupling and prevent resonances.

Mass loaded vinyl (MLV) sound barrier is an effective, relatively inexpensive treatment for airborne noise. For multi-level buildings, mass loaded vinyl can be used as an underlayment beneath the floor. This material can be laid directly on the floor under carpets, between sheets of plywood, or over cement.

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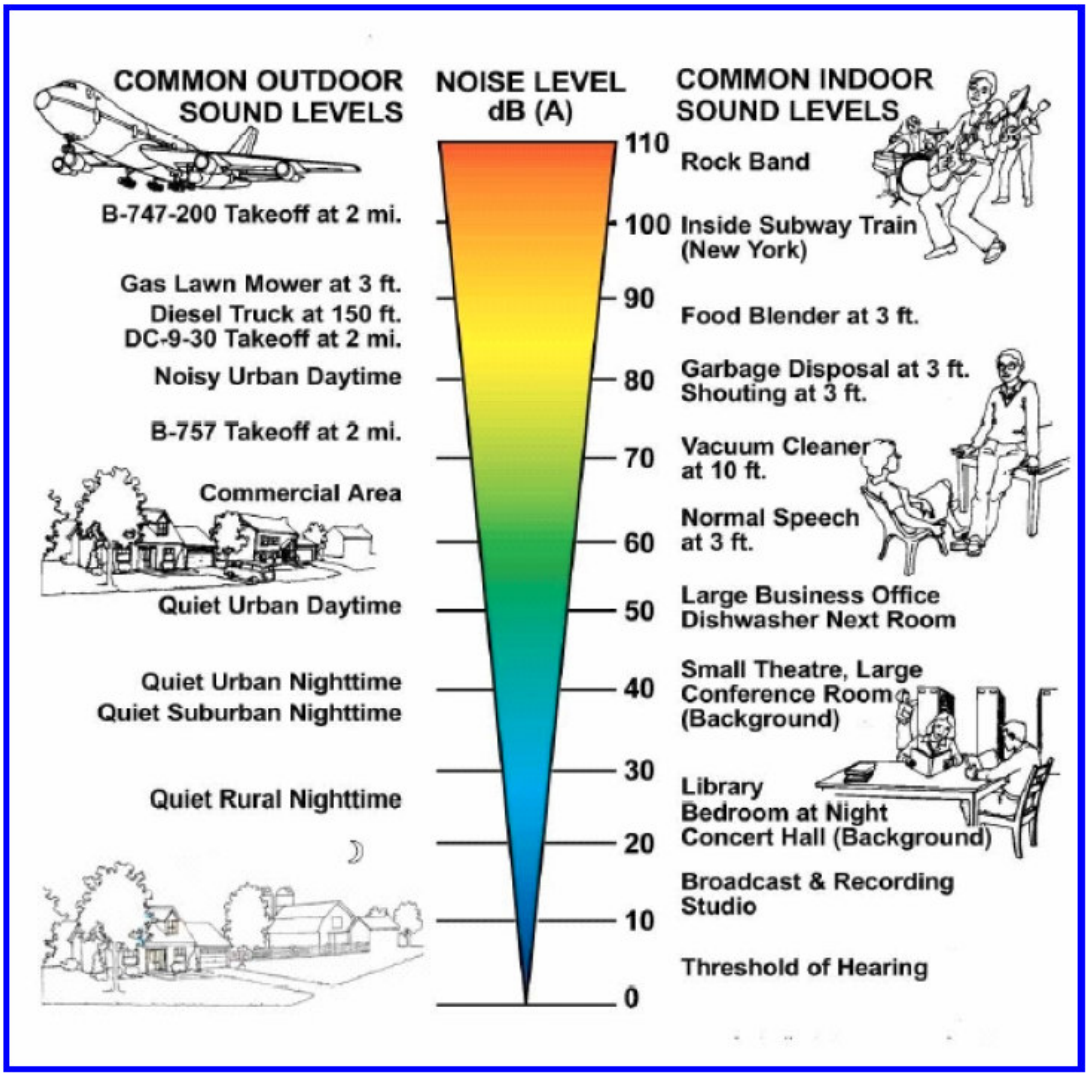
Common Activities and Typical Sound Levels



This chart shows approximate noise levels that are typically generated by various common outdoor and indoor activities. Note, that, typical noise levels in a residential–commercial urban area ranges from 60 to 70 dBA. Also, indoor sound levels with conversation (normal speech at 3 feet) can range at 60 to 70 dBA.

APPENDIX C

Technical Documentation for Wind Turbine Generator Systems (GE 1.5xle – 50 Hz & 60 Hz) Noise Emission Characteristics

GE Energy

Technical Documentation
Wind Turbine Generator Systems
GE 1.5xle - 50 Hz & 60 Hz

Noise emission characteristics

Normal operation
according to IEC

GE imagination at work

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Table of Contents

1 Introduction

The noise emission characteristics of the wind turbine series GE 1.5xle with a rotor diameter of 82.5-meter, 50Hz and 60 Hz versions, including Cold Weather Extreme versions, comprise sound power level data, tonality values, and octave band spectra.

This document describes the noise characteristics of the turbine for normal operation. Noise-reduced operating modes are not taken into consideration in this case.

GE continuously verifies specifications with measurements, including those performed by independent institutes.

The sound power level (L_{WA}) is calculated at hub height over the entire wind speed range from cut-in to cut out wind speed. Tabled specifications for L_{WA} are given as a function of hub height wind speed (reference values) together with an uncertainty band.

Also reference L_{WA}-values as a function of wind speed at 10-meter height are provided, assuming different standard hub heights and a logarithmic wind profile according to a surface roughness $z_{0, ref}$ = 0.03m, see section 2.2. Similar characteristics for different combinations of hub height and wind shear profile can be provided upon request.

If a wind turbine noise performance test is carried out, it needs to be done in accordance with the regulations of the international standard IEC 61400-11, ed. 2: 2002 (abstract available upon request).

2 Sound Power Levels

2.1 L_{WA} as a function of hub height wind speed

The following table provides the calculated reference sound power level values as a function of wind speed.

Wind speed at hub height [m/s]	GE 1.5 xle all hub heights L_{WA} [dB]
3	< 96
4	< 96
5	< 96
6	98.8
7	102.3
8	≤ 104
9	≤ 104
10 – cut out	≤ 104

Table 1: Calculated reference sound power level values

2.2 L_{WA} as a function of wind speed at 10m height

Following are tabled values for the L_{WA} as a function of the wind speed at 10-meter height for different hub heights. The wind speed is converted using a logarithmic wind profile, in this case using a surface roughness of z_{0ref} = 0.03m, which is representative for average terrain conditions.

$$V_{10m\ height} = V_{hub} \frac{\ln\left(10m / z_{0ref}\right)}{\ln\left(hub\ height / z_{0ref}\right)} \quad [1]$$

Characteristics for other combinations of surface roughness and hub height are available upon request.

Wind speed at 10m height [m/s]	GE 1.5 xle 58.7m HH L_{WA} [dB]	GE 1.5 xle 80m HH L_{WA} [dB]	GE 1.5 xle 100m HH L_{WA} [dB]
3	< 96	< 96	< 96
4	96.6	97.2	97.6
5	100.6	101.5	102.2
6	103.7	≤ 104	≤ 104
7 – cut out	≤ 104	≤ 104	≤ 104

Table 2: Reference sound power levels as a function of 10 m wind speed

3 Uncertainty Levels

Mean uncertainty levels for the sound power, or K-factors, are derived from independent measurements. Their value depends on the applied probability level and standard deviation for reproducibility (σ_R), as described in the IEC 61400-14 TS ed. 1[2]. Because the K-factor depends on the quality of the measurements, the number of the measurements, and on local regulations, a fixed value is used to define the uncertainty band with respect to the reference sound power level.

For all 1.5xle turbines an uncertainty band of **K = ± 2.0 dB** is defined.

4 Tonality

At the reference measuring point R_o, a ground distance from the turbine base equal to hub height plus half the rotor diameter, the GE 1.5xle turbine has a value for tonality of **$\Delta L_a \leq 4$ dB**, irrespective of wind speed, hub height, and grid frequency.[3]

[1] Simplified from IEC 61400-11, ed. 2: 2002 equation 7

[2] Here referring to the unofficial release of the IEC 61400-14, ed. 1 TS: 2004, labeled as 'CDV' (committee draft for voting)

[3] R_o and ΔL_a are defined here according to IEC 61400-11: 2002

5 Octave Band Spectra

Following is a table with the octave band values at nominal turbine operation, typically corresponding to wind speeds larger than 10 m/s at 10-meter height.
Octave band spectra as a function of smaller wind speed at 10-meter height depend on hub height and surface roughness. Indicative octave band values can be derived using the table below thereby multiplying the tabled values below with the L_{WA} level for a given wind speed at 10-meter height (section 2) and dividing this by 104 dB(A):

$$\text{Octave Band value } (V_{i,\,10\text{-m}}) = \text{Octave Band value (nominal operation)} \cdot L_{WA}\,(V_{i,\,10\text{-m}}) \,/\, 104\ \text{dB(A)}.$$

Note: The octave band spectra are informative only.

Octave [Hz]	Sound power level [dB]
63	83.4
125	92.2
250	97.8
500	99.4
1000	97.7
2000	93.4
4000	86.6
8000	84.8
Sum	**104.0**

Table 3: Octave band spectra