

**ACOUSTIC ANALYSIS
DOUGLAS WOODS WIND FARM
WEBSTER STREET
DOUGLAS, MA**

Prepared for:

**American Pro Wind, LLC
195 Libbey Parkway, Unit #2
Weymouth, MA 02189**

Prepared by:

**Atlantic Design Engineers, LLC
P.O. Box 1051
Sandwich, MA 02563**

**February 16, 2009
Atlantic Project #2596.00**

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1. SCOPE OF WORK / INTRODUCTION

American Pro Wind, LLC is proposing to construct thirteen (13) 100 meter wind turbines on \pm 275 acres of land west of the Douglas State Forest and south of Webster Street. The proposed site is located on Webster Street (Assessors Map 205, Lots 2 & 3, Map 206, Lot 1, Map 207, Lots 1 & 2, and Map 230 Lots 2 & 4) in Douglas, Massachusetts. The proposed locations of the turbines are shown on Figure 1. The turbines are anticipated to be similar to Nordex N100 machines with power outputs of 2,500 KW, a hub height of 100 meters and up to 100 meter rotor diameters (i.e. 50 meter blades).

At the request of American Pro Wind, LLC, an acoustic analysis has been completed by Atlantic Design Engineers in order to assess the affect of noise from the proposed turbines at nearby residential properties at Blueberry Hill and on Old Douglas Road.

Between the dates of February 9 to February 13, 2009 Atlantic conducted on-site ambient noise measurements to establish the current sound pressure levels (decibels) at two locations. These sound monitoring locations are designated Location A and Location B and can be seen on Figure 2.

The information gathered from these measurements was used in concert with data from the Nordex N100 Wind Turbine Specifications, wind speed data obtained from the Cross Street Weather Station, and the software program WindPRO, version 2.6.1.252, to determine projected sound levels that will be produced at designated locations once the turbines are in operation. Using the WindPRO software, acoustic modeling was performed for both cut in wind speed and design wind speed operating conditions of the wind turbines. These accurately projected sound values were reviewed for compliance with both state and town noise related by-laws and regulations.

2. SOUND FUNDAMENTALS

All sounds are generated from a source and proceed to travel to a person's ear as sound waves or minute variations in air pressure. Sounds have many varying characteristics including loudness, character, temporal pattern, and are audible to different extents by different people in a range of environments. "Noise" can be defined simply as unwanted sound. Factors such as the amplitude and duration of the sound determine whether or not it is perceived as "noise". In terms of the scope of this analysis and report, it is helpful to understand some basic sound and noise characteristics and terminology.

2.1 Sound Pressure Level

The sound pressure level (SPL) determines the loudness of a sound and can be defined as the ratio of the measured sound pressure from the source to a reference pressure (the quietest sound we can hear). The sound pressure level is measured in units of decibels (dB) or A-weighted decibels (dBA) and is plotted on a logarithmic scale. On this scale, 0 dB is the

quietest sound we can hear, with 120 dB being the loudest. A-weighted decibels more closely correlate with the subjective loudness of a sound, as discerned by the human ear.

As an example, some typical sound levels associated with common activities and environments are provided in the following:

Sound Levels and Relative Loudness of Steady Noises¹

dBA	Subjective Impression	Relative Loudness
130		
120	<i>Uncomfortably Loud</i>	Loud Rock Concert
110		
100	<i>Very Loud</i>	
90		Heavy Traffic
80		
70	<i>Moderately Loud</i>	Normal Conversation
60		
50	<i>Quiet</i>	
40		
30		Quiet Library
20		
10	<i>Just audible</i>	
0	<i>Threshold of Hearing</i>	Weakest Sound Heard

Some properties of sounds measured on the decibel scale include:

- A 1 dB change in the SPL is below the level of human perception.
- For a sound to double in loudness, an increase of 10 dB is required.
- A 3 dB change in the SPL level is minimum level of human perception. (it is just barely noticeable).
- A 6 dB increase in the SPL is the equivalent of moving half the distance to the source.
- A SPL of 140 dB is the threshold of pain.

2.2 Sound Power Level

The sound power level (PWL) is a basic quantity directly describing the amount of acoustic power radiated by a source. It is the fundamental quantity that produces a sound pressure level (SPL) at a distance. In addition to defining the source of the sound for assessment purposes, the (PWL) is also used to calculate the (SPL) at a receptor location. Similar to the sound pressure level, the sound power level is also usually described in decibels (dB) or A-weighted decibels (dBA).

¹ Derived from Table 1.1 in *Community Noise Rating* by Theodore J. Shultz

2.3 Frequency

Frequency is the property of sound that we perceive as pitch, which gives a sound its unique character. The human ear can detect a wide range of frequencies, but it is more sensitive to some than others. Sounds that we experience in daily life are typically formed from a mixture of numerous frequencies, from numerous sources. A spectral analysis breaks a measured sound into a number of frequency bands of defined width, comparable to notes on a musical scale. Frequency is most commonly measured in cycles per second, or Hertz (Hz).

2.4 Sound Measurement

Sound Level Meters are devices that are used to measure sound pressure levels. These meters are equipped with a single microphone that converts pressure variations into a voltage signal. This signal is then recorded onto the meter in units of decibels. The measurements taken combine all frequencies to obtain a broadband sound level, or a single weighted reading. For the purpose of this study, the A-weighted sound pressure was recorded, which is the most common scale for assessing environmental and occupational noise. This weighting approximates the response of the human ear to sounds of medium intensity.

Once the A-weighted sound pressure level is recorded over a period of time, a number of statistical sound reference levels can be determined. L_{10} statistics measure the noise levels, which are exceeded during only 10 percent of the time period. L_{10} levels indicate noise which is generated by intermittent sources such as traffic, passing jets, etc. L_{90} statistics measure the sound level which is exceeded during 90 percent of the time period. These L_{90} levels reveal the ambient background sound and can strongly affect the audibility of a particular sound in a particular environment. For example, on a very windy day, the sounds that are created by wind flowing over vegetation may be loud enough to mask other nearby sounds such as those produced by wind turbines. However, we must also consider that the sound level emitted from the turbine is a function of wind speed, and in general, the higher the wind speed, the higher the PWL or sound generated by the turbine. Finally, the L_{eq} is determined, which is the continuous equivalent noise level over the period of measurement.

3. SOURCES OF WIND TURBINE SOUND

The sources of sounds emitted from operating wind turbines can be divided into two categories: 1.) Mechanical sounds, from the interaction of turbine components, and 2.) Aerodynamic sounds, produced by the flow of air over the blades. As wind turbine technology has advanced, the sounds that they produce have significantly diminished, however it is still an important siting criterion.

3.1 Mechanical Sounds

Mechanical sounds originate from the relative motion of mechanical components and the dynamic response among them. Sources of such sounds include:

- a. Gearbox
- b. Generator
- c. Yaw Drives
- d. Cooling Fans
- e. Auxiliary Equipment (e.g. hydraulics)

Since the emitted sound is associated with the rotation of mechanical and electrical equipment, it tends to be tonal (of a common frequency), although it may have a broadband component. For example, pure tones can be emitted at the rotational frequencies of shafts and generators, and the meshing frequencies of the gears. In addition, the hub, rotor, and tower may act as loudspeakers, transmitting the mechanical sound and radiating it. The transmission path of the sound can be air-borne or structure-borne. Air-borne means that the sound is directly propagated into the air from the component surface or interior. Structure-borne sound is transmitted along other structural components before it is radiated into the air.

3.2 Aerodynamic Sounds

Aerodynamic broadband sound is typically the largest component of wind turbine acoustic emissions. It originates from the flow of air around the blades. Aerodynamic sound generally increases with rotor speed. The various aerodynamic sound generation mechanisms that have to be considered are divided into three groups:

1. *Low Frequency Sound*: Sound in the low frequency part of the sound spectrum is generated when the rotating blade encounters localized flow deficiencies due to the flow around a tower, wind speed changes, or wakes shed from other blades.
2. *Inflow Turbulence Sound*: This sound depends on the amount of atmospheric turbulence which results in local force or local pressure fluctuations around the blade.
3. *Airfoil Self Noise*: This group includes the sound generated by the air flow right along the surface of the airfoil. This type of sound is typically of a broadband nature, but tonal components may occur due to blunt trailing edges, or flow over slits and holes.²

4. BYLAWS AND LEGISLATION

Current known standards, bylaws or legislation that addresses or regulates noise from wind turbines are provided in Appendix B and are summarized as follows:

4.1 Town of Douglas, Massachusetts Zoning Bylaw

The Zoning Bylaws for Douglas, Massachusetts, dated October 25, 2004, do not contain any requirements or regulations concerning wind turbine siting and any related criteria such as noise and shadow flicker impacts.

4.2 Massachusetts DEP Noise Policy (Regulations and Criteria)

Noise is defined by the Massachusetts Department of Environmental Protection as a type of air pollution that results from sounds that cause a nuisance, are or could injure public

² “Wind Turbine Acoustic Noise” UMASS Renewable Energy Research Laboratory

health, or unreasonably interfere with the comfortable enjoyment of life, property, or the conduct of business.

A noise source will be considered to be violation the Department's noise regulation (310 CMR 7.10) if the source results in

- A. An increase in the broadband sound pressure level of more than 10 decibels (dBA) above ambient, or
- B. Produce a "pure tone" condition – when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 dB or more.

For this report, these criteria have been measured at nearby residential properties on Old Douglas Road and Blueberry Hill. "Ambient" is defined as the background A-weighted sound level that is exceeded 90% of the time, measured during equipment operating hours. This is also referred to as the L90 baseline.

5. EXISTING AMBIENT SOUND LEVELS

In order to establish ambient background sound levels, Atlantic Design Engineers utilized an environmental sound level meter over 24-hour periods to quantify the background sound levels for relevant parameters at locations on the site located near the adjacent residential properties (See Figure 2). The parameters selected for determination of ambient sound levels were average hourly (L_{eq}) and both the L_{10} and L_{90} baseline levels. The combination of this data will provide an understanding of existing daytime and diurnal noise patterns, as well as statistical reference levels, which are used to screen out traffic impacts and other sound amplifiers. Hourly L_{90} sound levels were extracted from the data set in order to compare them to the equivalent hourly wind speed measurements. These hourly wind speed measurements were obtained from the Cross Street Weather Station, located approximately 4 miles away, and were used as an estimation of on-site wind conditions. Since the wind did not reach speeds high enough for design wind speed operating conditions during the measurement periods, ambient L_{90} sound levels had to be extrapolated from the data for these conditions.

The environmental sound meter used by Atlantic Design Engineers for the on-site measurements was a Quest Technologies model Q2900 Sound Level Meter with an inherent data logger and supporting software. The measurement range for the meter is between 0 and 140 dBA. This model meets or exceeds all requirements set forth in the American National Standards Institute (ANSI) Standards for General Purpose Type 2 accuracy. Prior to the studies, the Q2900 SLM was laboratory calibrated as per ANSI recommendations. The meter was equipped with an environmental windscreen during each of the studies in order to negate the effects of air movement. All the data that was logged on-site was downloaded (via Questsuite Software) to a computer following the 24-hour studies for further analysis and storage.

The test results for the relevant sound parameters measured over 24 hours are presented in Figures 3-8. From February 10 to February 11, the first study was performed at Location A. The skies were partly cloudy with the temperature in the 30's and the winds were fairly calm (0-5 mph). From February 12 to February 13, the second study was performed at Location B. The skies were cloudy and there were periods of light rain with temperatures in the 30's and the wind was moderate (3-13 mph).

6. **PROJECTED SOUND LEVELS**

6.1 Methodology

Future sound levels for the Douglas Woods Wind Farm were projected using a module of the WindPRO software called "Decibel". This module creates a sophisticated 3-D model for outdoor sound propagation and attenuation based on the international norm "DIN ISO 9613-2 Acoustics." This sound emission for the Nordex N100 turbines is inherent in the WindPRO's software library of turbines specifications.

Four nearby residential properties were chosen as "receptors" to calculate the increase in noise levels over ambient conditions due to the turbines. These receptor locations are:

- A – Nearest residence on Old Douglas Road
- A1 – Nearest residence on Webster Street
- B - Residences along Blueberry Hill
- B1 - Nearest residences on Dream Street

For Receptors A and A1 the ambient noise levels from Sound Level Monitoring Location A were used and for Receptors B and B1, the ambient noise levels from Sound Level Monitoring Locations B were used.

6.2 WindPRO Parameters

Calculation Model

For the noise calculation model, a wind speed range from 3 meters per second to 10 meters per second was chosen for the calculations because the cut-in speed for the proposed turbine is 3 meters per second and 10 meters per second is the speed at which the turbine's sound power level is greatest.

Ground Attenuation

The General method was chosen with a Ground Factor of 1.0. The value of 1.0 is representative of a porous ground surface. The General method is used for flat terrain or terrain with a constant slope.

Type of Demand

The option "WTG plus ambient noise is compared to ambient noise plus margin" was used for the calculations in order to determine compliance with the State DEP noise increase allowance of 10 dBA. Under this scenario, the noise level calculated at the receptor is the background noise plus the noise contribution from the turbine. This sum is

compared to a noise “demand” that consists of the background noise plus a margin of 10 dBA.

6.3 Results

Based on the noise data collected from our study, wind speed data obtained from the Cross Street Weather Station, and the mono noise specifications provided for the Nordex N100 wind turbines, the projected sound levels at Locations A & B with the turbines operating at both the cut in wind speeds as well as design wind speeds are projected as follows:

Cut in Wind Speed Operating Condition

Location	Ambient L90 Level (dBA)	Wind Turbine Sound (dBA)	Combined Sound Level (dBA)	Net Increase (dBA)
A	32.5	32.5	35.5	3.0
A1	32.5	33.1	35.8	3.3
B	35.4	33.9	37.7	2.3
B1	35.4	36.6	39.1	3.7

Design Wind Speed Operating Conditions

Location	Ambient L90 Level (dBA)	Wind Turbine Sound (dBA)	Combined Sound Level (dBA)	Net Increase (dBA)
A	38.1	41.5	43.1	5.0
A1	38.1	42.0	43.5	5.4
B	47.9	42.9	49.1	1.2
B1	47.9	45.6	49.9	2.0

These results are shown in Figures 3 through 8. The Windpro calculations along with a graphic depiction of the turbine generated sound and charts showing how most of the proposed sound levels fall within the allowable 10 dBA increase are provided in Appendix A.

7. CONCLUSIONS

The study's conclusions are as follows:

- The Douglas Woods Wind Farm complies with the Massachusetts Department of Environmental Protection Noise Policy by not increasing noise levels at the nearby residential properties more than 10 decibels. The turbine is expected to increase the ambient L_{90} sound level by a range of 1.2 dBA to 5.4 dBA at nearby residential properties, well below the DEP allowable. In addition, the Nordex N100 Wind Turbines are not anticipated to produce any audible "pure tones". Sound emissions from modern wind turbines are mostly comprised of broadband tones.



Figure 1 - Wind Turbine Locations

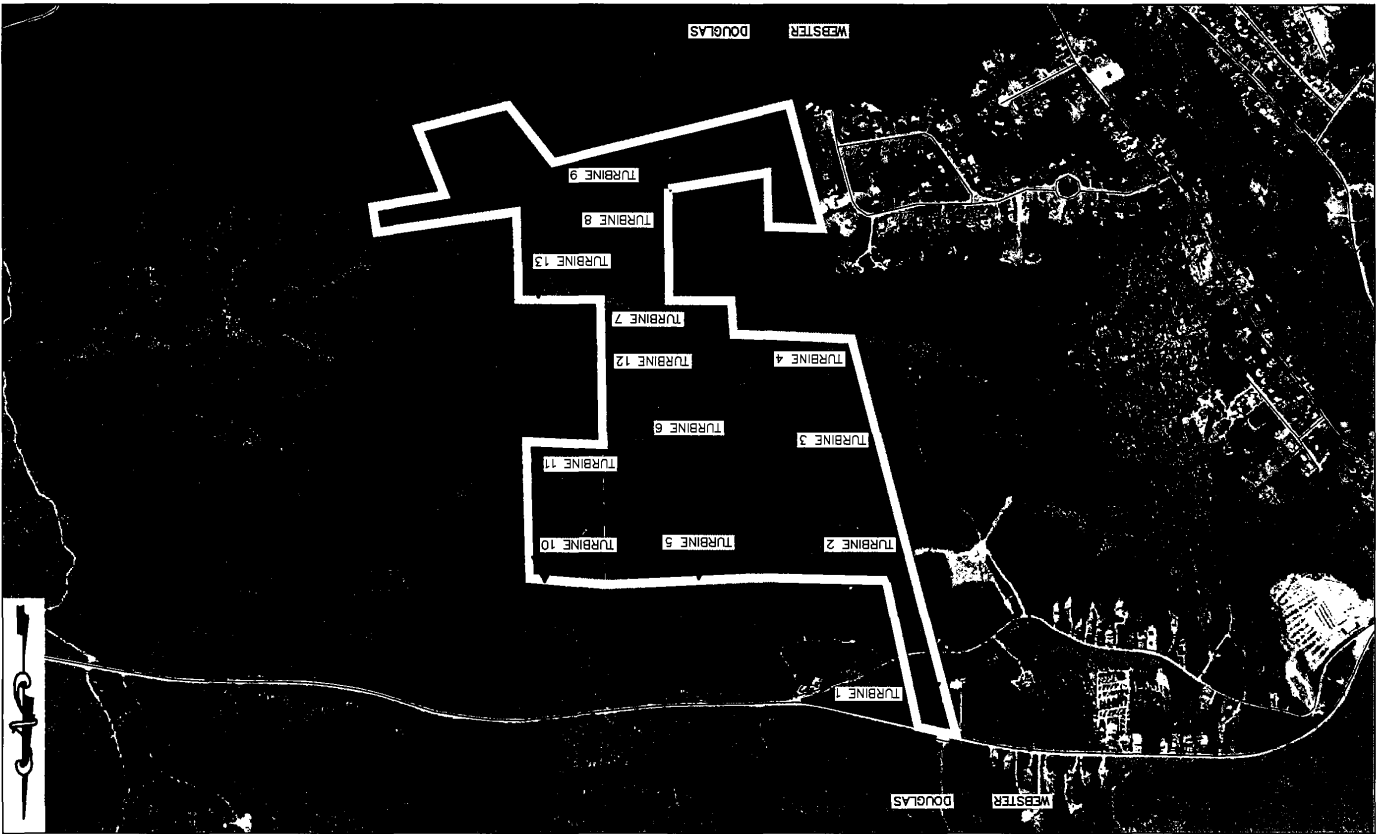
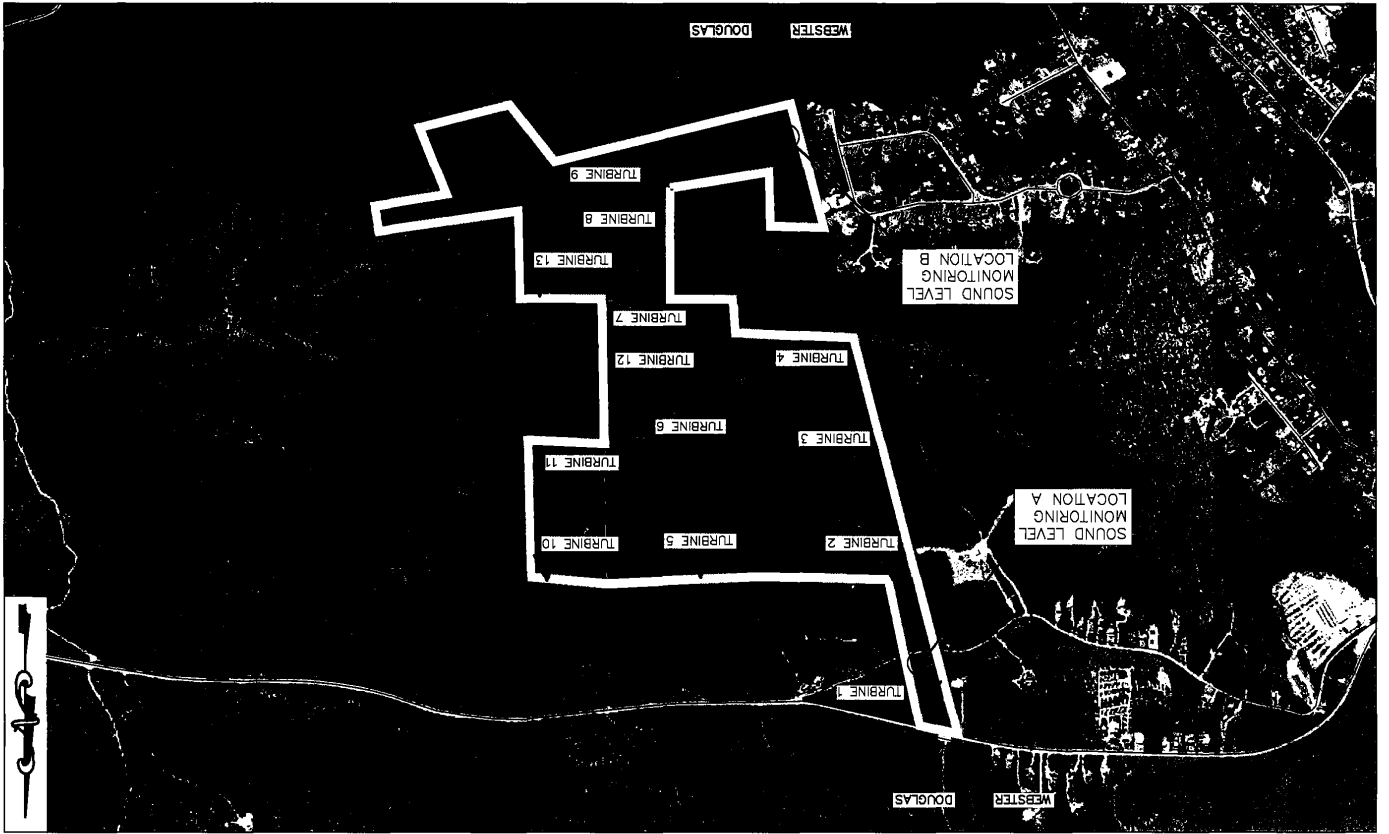
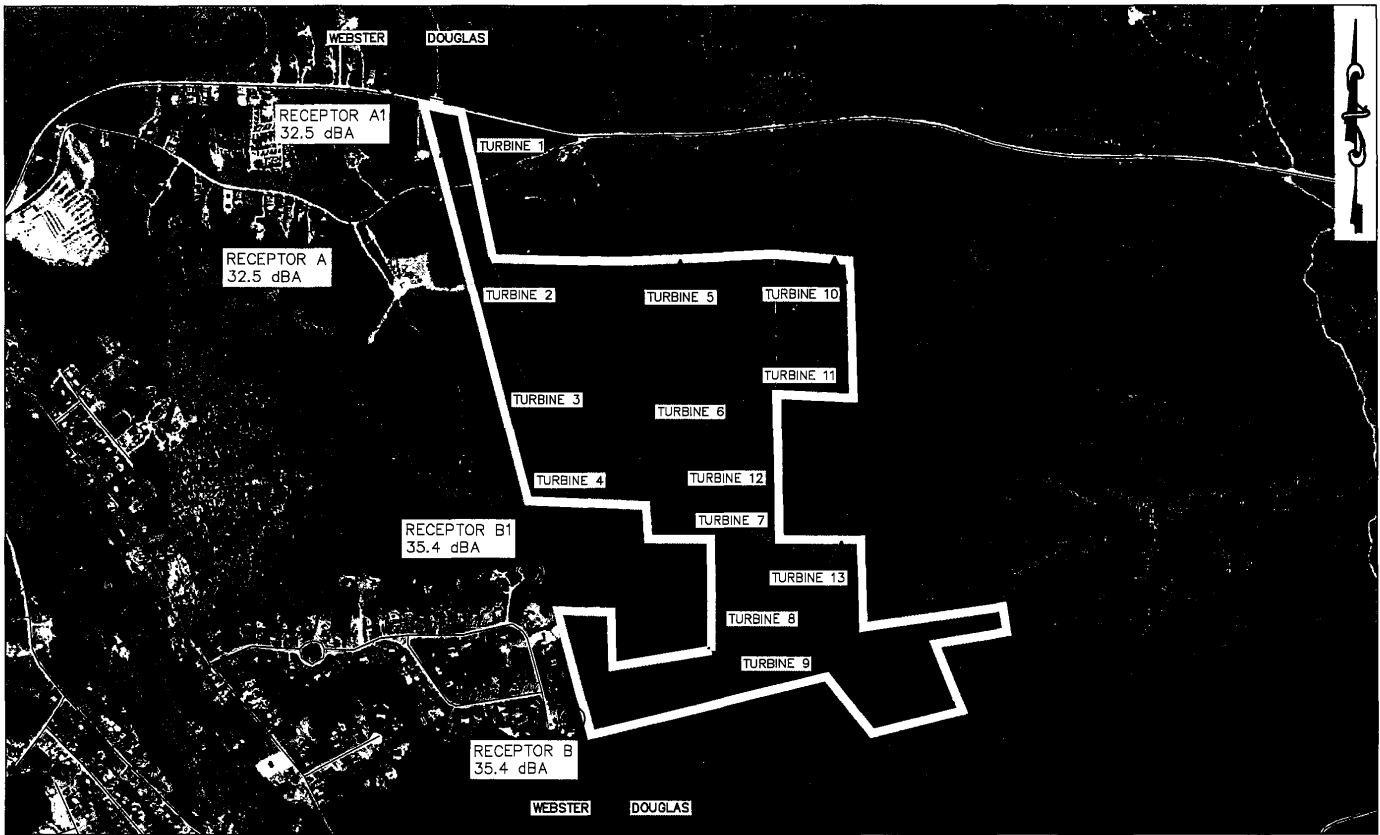




Figure 2 - Sound Level Monitoring Locations





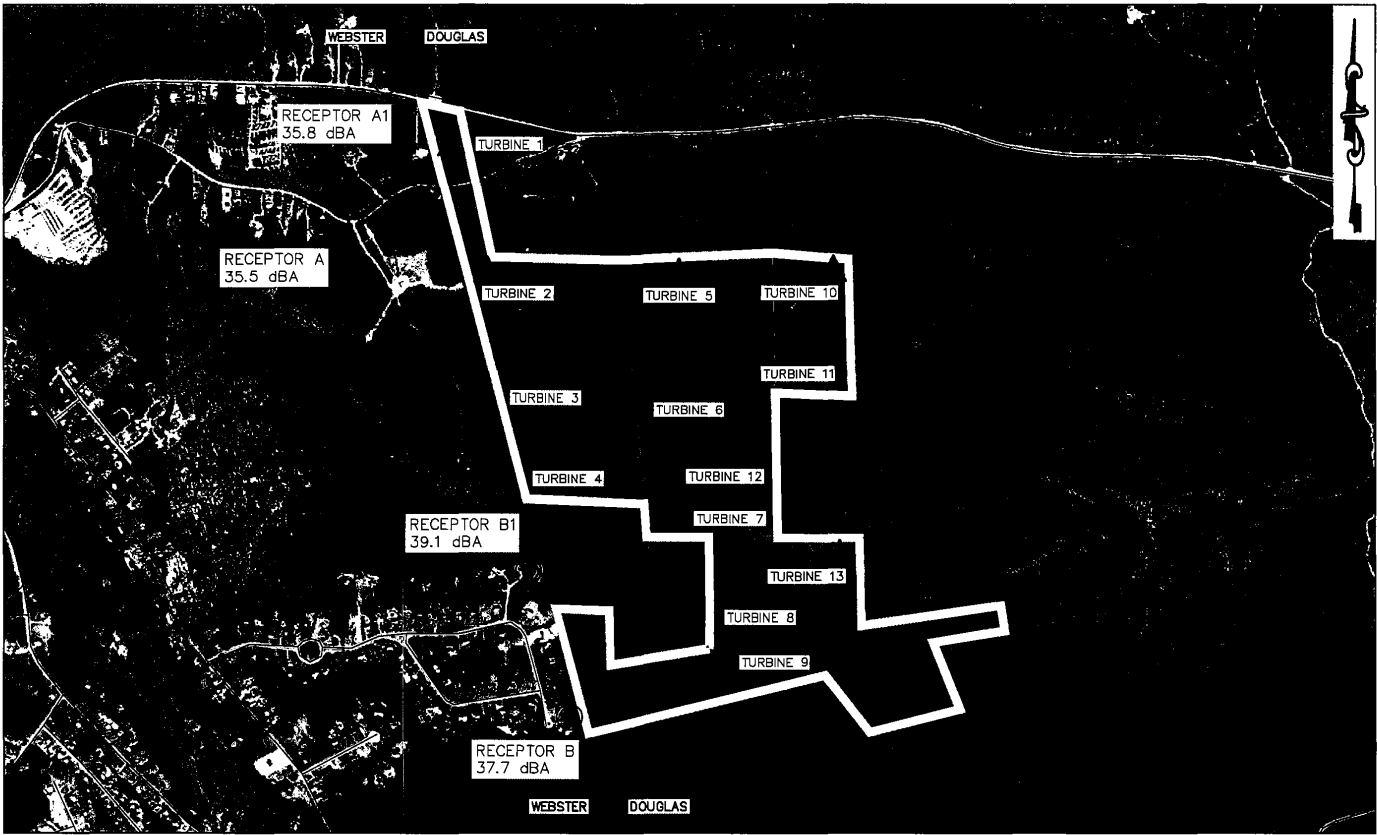
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Figure 3 - Background Sound Levels at a Wind Speed of 3 m/s

P.O. Box 1051 Sandwich, MA 02563

tel. (508) 866-8282 fax. (508) 866-8898



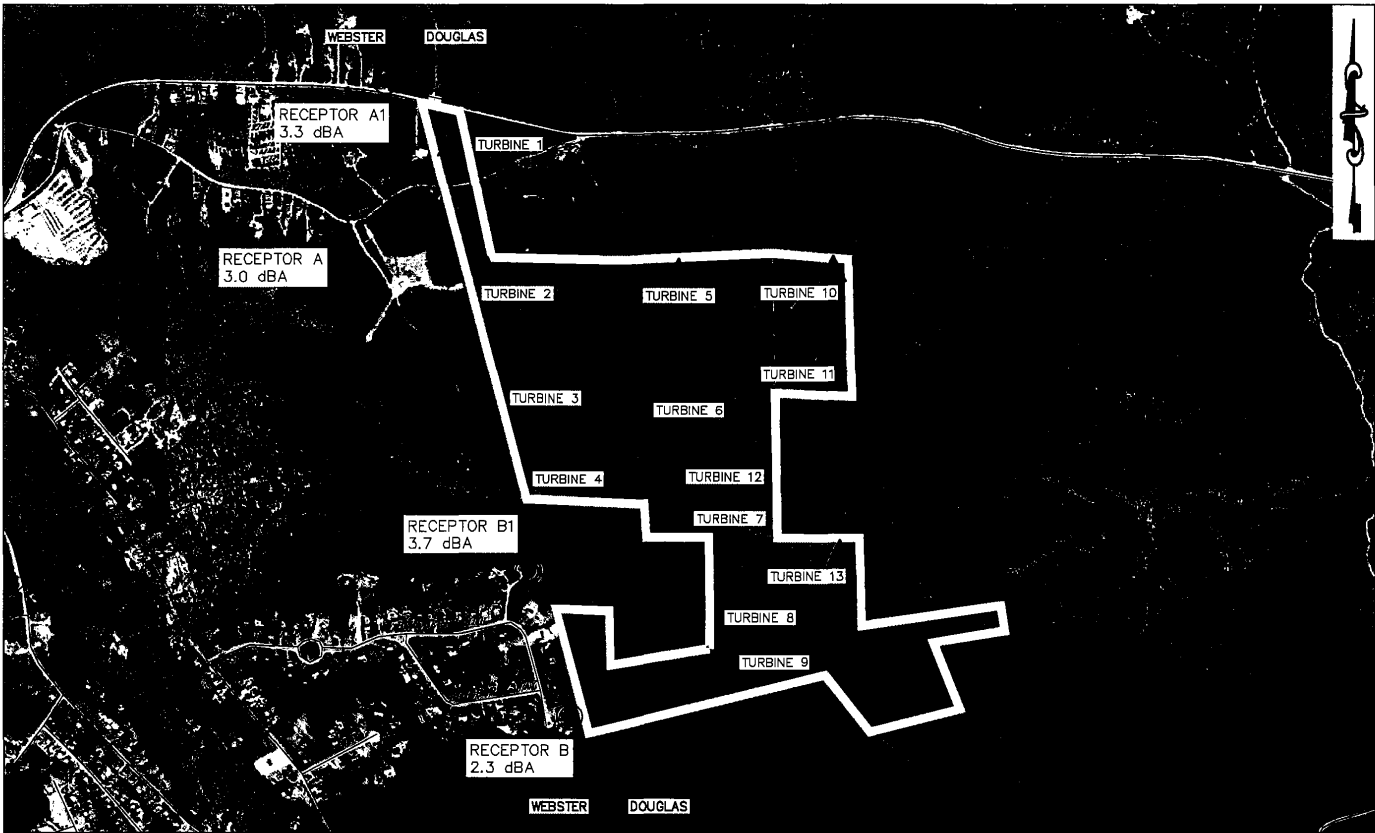
Atlantic
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Figure 4 - Sound Levels with the Turbine Operating at a Wind Speed of 3 m/s

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tel. (508) 898-6282 fax. (508) 898-6898



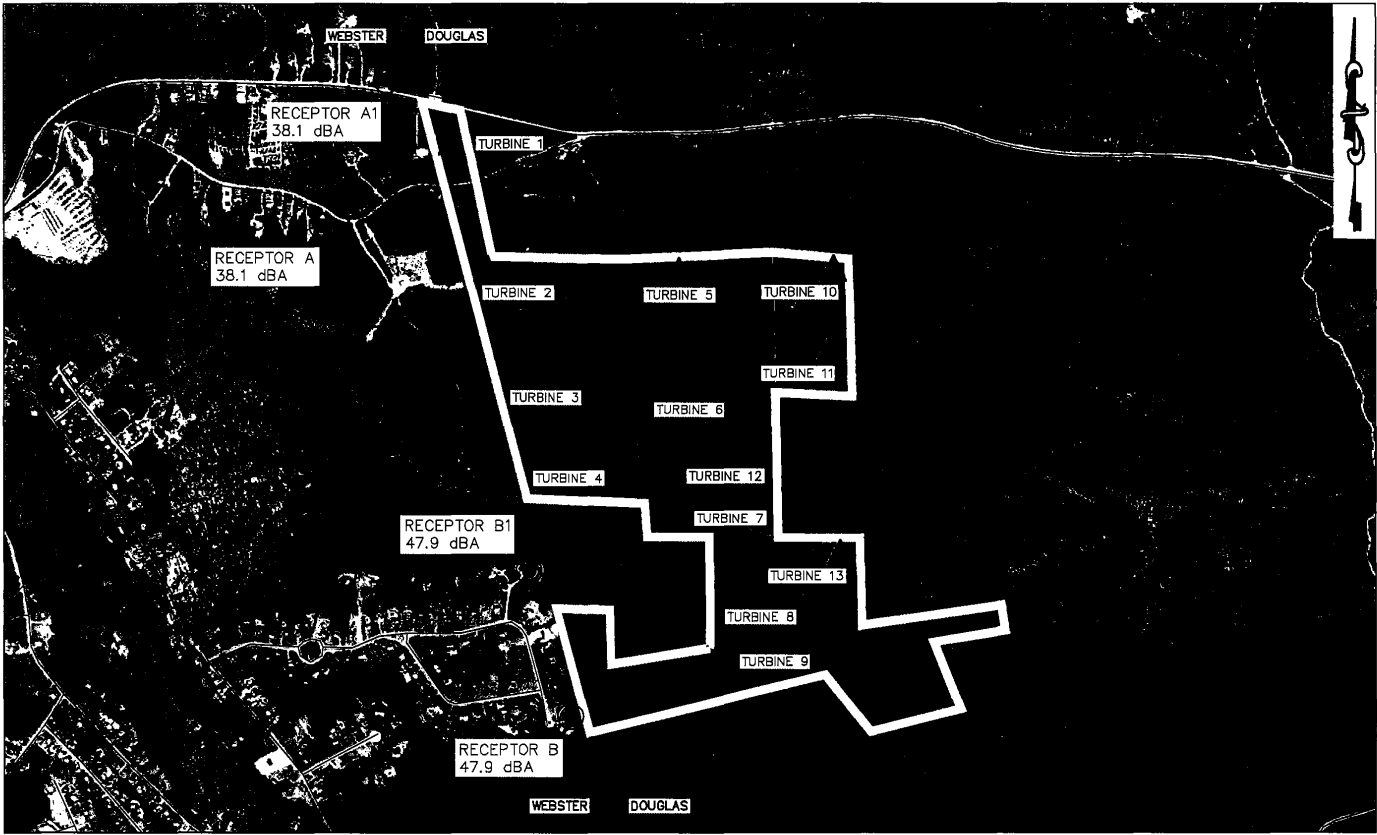
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Figure 5 - Sound Increase from Turbines at a Wind Speed of 3 m/s

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tel. (508) 888-6282 fax. (508) 888-6899



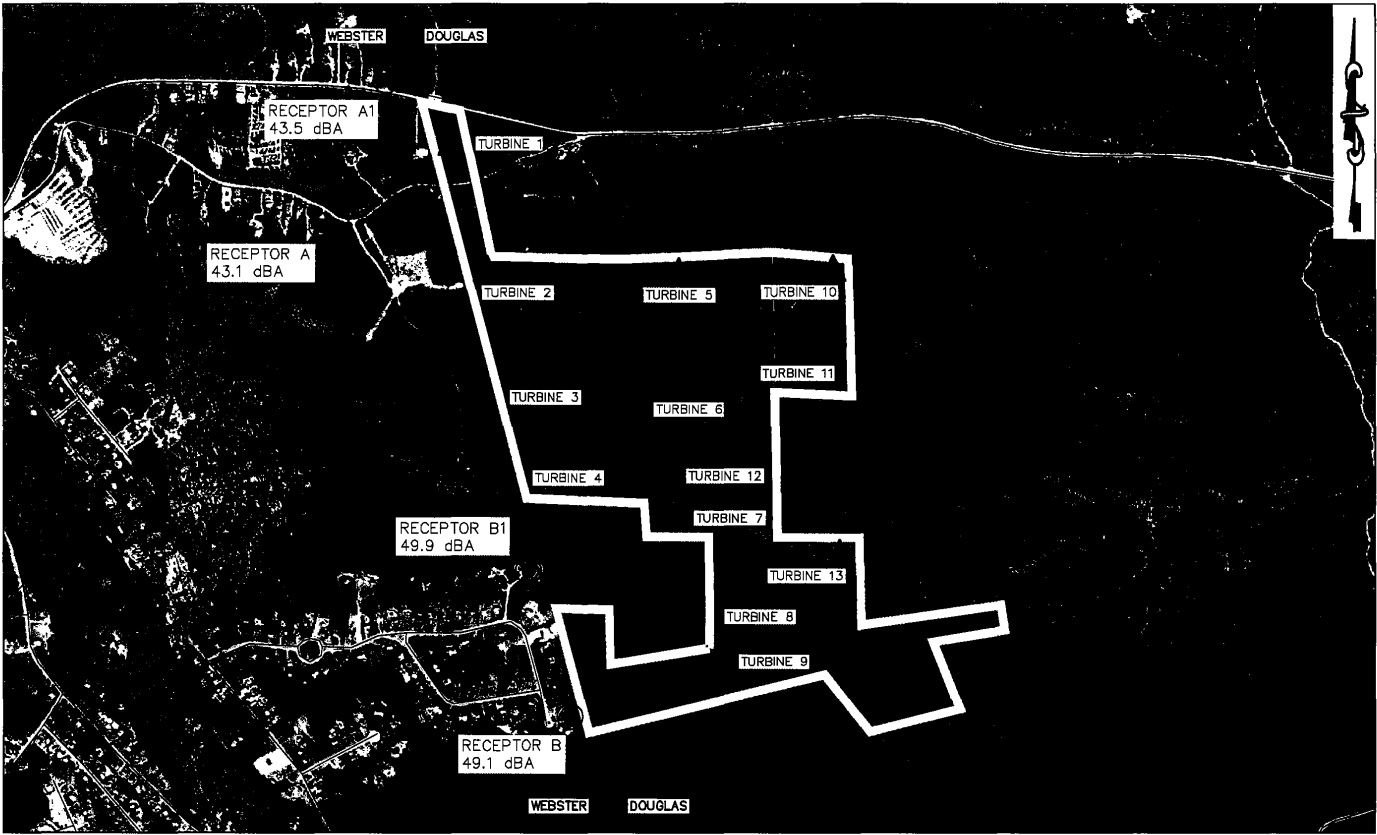
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Figure 6 - Background Sound Levels at a Wind Speed of 10 m/s

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tel. (508) 886-6282 fax. (508) 886-6690



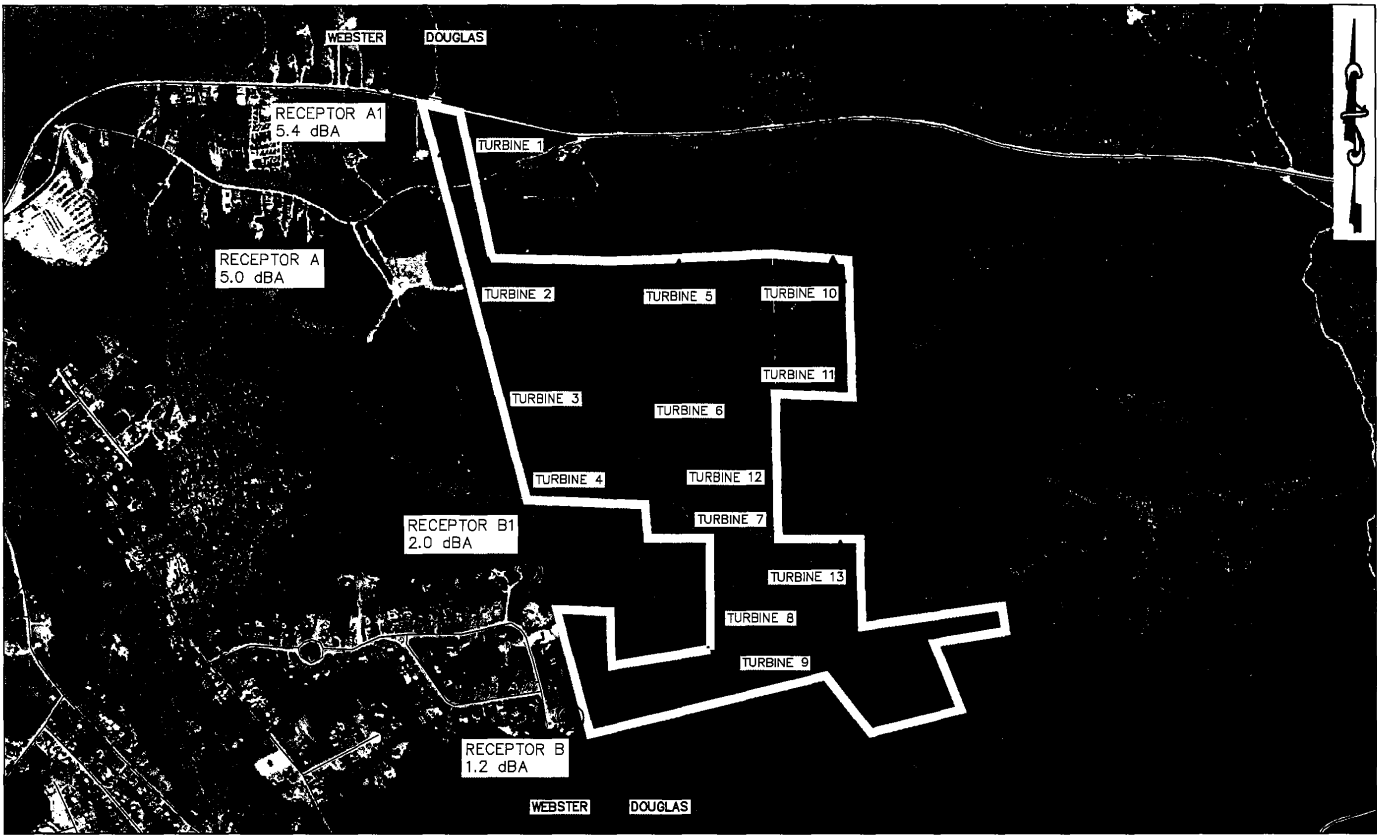
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Figure 7 - Sound Levels with the Turbine Operating at a Wind Speed of 10 m/s

P.O. Box 1051 Barnstable, MA 02603

tel. (508) 699-0202 fax. (508) 699-0800



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Figure 8 - Sound Increase from Turbines at a Wind Speed of 10 m/s

P.O. Box 1051 Barnstable, MA 02703

tel. (508) 888-0282 fax. (508) 888-0890

APPENDIX A
WindPro Calculations

Project:
2596 Douglas 2-16-09 Final1

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DECIBEL - Main Result

Noise calculation model:

ISO 9613-2 General

Wind speed:

3.0 m/s - 10.0 m/s, step 1.0 m/s

Ground attenuation:

General, Ground factor: 1.0

Meteorological coefficient, C0:

0.0 dB

Type of demand in calculation:

2: WTG plus ambient noise is compared to ambient noise plus margin (FR et

Noise values in calculation:

All noise values are 90% exceedence values (L90)

Pure tones:

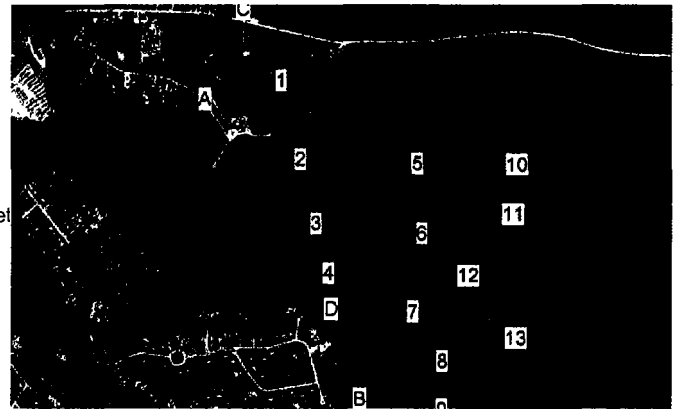
Pure and Impulse tone penalty are added to WTG source noise

Height above ground level, when no value in NSA object:

1.5 m Allow override of model height with height from NSA object

Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:

0.0 dB(A)



Scale 1:35,000
▲ New WTG ■ Noise sensitive area

WTGs

No	Geo DMS: WGS 84			Row data/Description	WTG type			Power, rated	Rotor diameter	Hub height	Noise data		First wind speed [m/s]	LwaRef [dB(A)]	Last wind speed [m/s]	LwaRef [dB(A)]	Pure tones	Oclave data
	Longitude	Latitude	Z		Valid	Manufact.	Type-generator				Creator	Name						
1	-71°48'57.75" East	42°03'24.08" North	257.3	T1	Yes	NORDEX	N100-2,500	2,500	99.8	100.0	EMD	Level 0 - calculated noise data	3.0	98.5	10.0	107.5	0 dB	Generic *)
2	-71°48'53.14" East	42°03'11.98" North	264.0	T2	Yes	NORDEX	N100-2,500	2,500	99.8	100.0	EMD	Level 0 - calculated noise data	3.0	98.5	10.0	107.5	0 dB	Generic *)
3	-71°48'49.58" East	42°03'02.01" North	262.3	T3	Yes	NORDEX	N100-2,500	2,500	99.8	100.0	EMD	Level 0 - calculated noise data	3.0	98.5	10.0	107.5	0 dB	Generic *)
4	-71°48'46.58" East	42°02'54.30" North	272.8	T4	Yes	NORDEX	N100-2,500	2,500	99.8	100.0	EMD	Level 0 - calculated noise data	3.0	98.5	10.0	107.5	0 dB	Generic *)
5	-71°48'28.69" East	42°03'11.84" North	251.3	T5	Yes	NORDEX	N100-2,500	2,500	99.8	100.0	EMD	Level 0 - calculated noise data	3.0	98.5	10.0	107.5	0 dB	Generic *)
6	-71°48'27.36" East	42°03'00.92" North	254.8	T6	Yes	NORDEX	N100-2,500	2,500	99.8	100.0	EMD	Level 0 - calculated noise data	3.0	98.5	10.0	107.5	0 dB	Generic *)
7	-71°48'28.62" East	42°02'48.62" North	258.0	T7	Yes	NORDEX	N100-2,500	2,500	99.8	100.0	EMD	Level 0 - calculated noise data	3.0	98.5	10.0	107.5	0 dB	Generic *)
8	-71°48'22.08" East	42°02'41.10" North	254.8	T8	Yes	NORDEX	N100-2,500	2,500	99.8	100.0	EMD	Level 0 - calculated noise data	3.0	98.5	10.0	107.5	0 dB	Generic *)
9	-71°48'21.87" East	42°02'33.57" North	246.0	T9	Yes	NORDEX	N100-2,500	2,500	99.8	100.0	EMD	Level 0 - calculated noise data	3.0	98.5	10.0	107.5	0 dB	Generic *)
10	-71°48'09.03" East	42°03'12.17" North	244.9	T10	Yes	NORDEX	N100-2,500	2,500	99.8	100.0	EMD	Level 0 - calculated noise data	3.0	98.5	10.0	107.5	0 dB	Generic *)
11	-71°48'09.53" East	42°03'04.42" North	248.7	T11	Yes	NORDEX	N100-2,500	2,500	99.8	100.0	EMD	Level 0 - calculated noise data	3.0	98.5	10.0	107.5	0 dB	Generic *)
12	-71°48'18.50" East	42°02'54.59" North	251.6	T12	Yes	NORDEX	N100-2,500	2,500	99.8	100.0	EMD	Level 0 - calculated noise data	3.0	98.5	10.0	107.5	0 dB	Generic *)
13	-71°48'08.08" East	42°02'45.05" North	238.7	T13	Yes	NORDEX	N100-2,500	2,500	99.8	100.0	EMD	Level 0 - calculated noise data	3.0	98.5	10.0	107.5	0 dB	Generic *)

*Notice: One or more noise data for this WTG is generic or input by user

Calculation Results

Sound Level

Noise sensitive area No.	Name	Geo DMS: WGS 84			Z	Imission height	Demands Sound Level				Demands fulfilled ? Noise
		Longitude	Latitude				Max Additional exposure	Max From WTGs	Max Ambient+WTGs	Max Additional exposure	
A	Location A	-71°49'14.02" East	42°03'17.38" North	243.2	1.5	10.0	41.5	43.1	6.8	Yes	
B	Location B	-71°48'39.50" East	42°02'31.30" North	246.9	1.5	10.0	42.9	49.1	2.3	Yes	
C	Location A1	-71°49'06.81" East	42°03'31.65" North	244.5	1.5	10.0	42.0	43.5	7.2	Yes	
D	Location B1	-71°48'46.27" East	42°02'45.25" North	261.1	1.5	10.0	45.6	49.9	3.7	Yes	

Distances (m)

WTG	A	B	C	D
1	427	1682	313	1227
2	507	1294	683	840
3	734	976	997	523
4	951	728	1243	279
5	1053	1276	1067	914
6	1184	956	1311	650

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DECIBEL - Main Result

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WTG	A	B	C	D
7	1368	590	1591	418
8	1635	501	1867	569
9	1805	410	2068	666
10	1499	1442	1455	1191
11	1532	1232	1559	1029
12	1454	865	1592	699
13	1812	836	1970	876

Project:
2596 Douglas 2-16-09 Final1

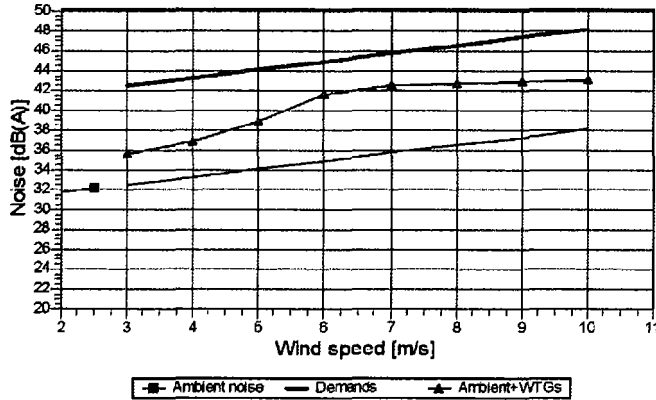
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DECIBEL - Detailed results

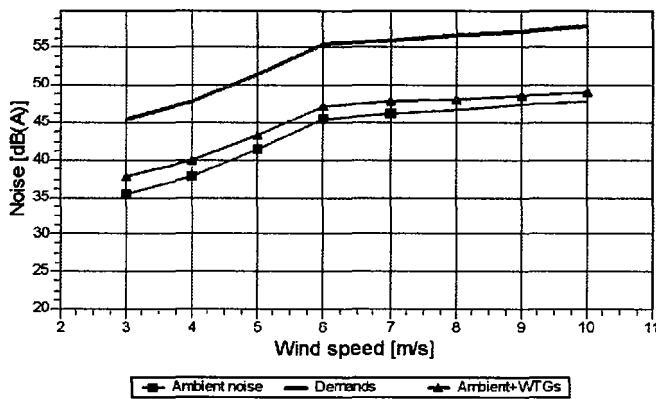
Noise calculation model: ISO 9613-2 General

Location A (A)



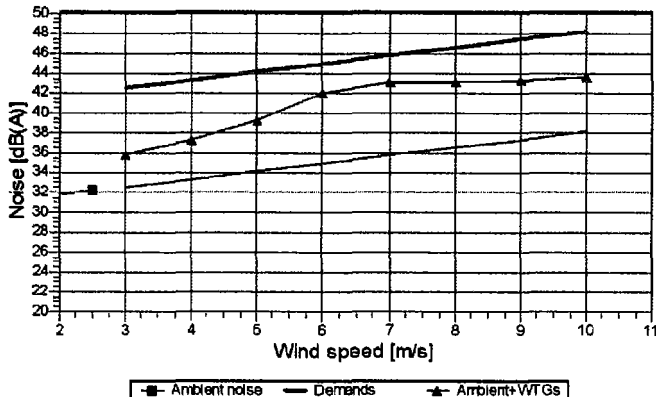
Wind speed	Ambient noise	Allowed addition exposure	Sound Level WTG noise	Ambient+WTGs	Result Additional exposure	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
3.0	32.5	10.0	32.5	35.5	3.0	Yes
4.0	33.3	10.0	34.5	36.9	3.6	Yes
5.0	34.1	10.0	37.0	38.8	4.7	Yes
6.0	34.9	10.0	40.5	41.5	6.6	Yes
7.0	35.7	10.0	41.5	42.5	6.8	Yes
8.0	36.5	10.0	41.5	42.7	6.2	Yes
9.0	37.3	10.0	41.5	42.9	5.6	Yes
10.0	38.1	10.0	41.5	43.1	5.0	Yes

Location B (B)



Wind speed	Ambient noise	Allowed addition exposure	Sound Level WTG noise	Ambient+WTGs	Result Additional exposure	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
3.0	35.4	10.0	33.9	37.7	2.3	Yes
4.0	37.8	10.0	35.9	40.0	2.2	Yes
5.0	41.5	10.0	38.4	43.2	1.7	Yes
6.0	45.5	10.0	41.9	47.1	1.6	Yes
7.0	46.1	10.0	42.9	47.8	1.7	Yes
8.0	46.7	10.0	42.9	48.2	1.5	Yes
9.0	47.3	10.0	42.9	48.6	1.3	Yes
10.0	47.9	10.0	42.9	49.1	1.2	Yes

Location A1 (C)



Wind speed	Ambient noise	Allowed addition exposure	Sound Level WTG noise	Ambient+WTGs	Result Additional exposure	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
3.0	32.5	10.0	33.1	35.8	3.3	Yes
4.0	33.3	10.0	35.1	37.3	4.0	Yes
5.0	34.1	10.0	37.5	39.2	5.1	Yes
6.0	34.9	10.0	41.0	42.0	7.1	Yes
7.0	35.7	10.0	42.0	42.9	7.2	Yes
8.0	36.5	10.0	42.0	43.1	6.6	Yes
9.0	37.3	10.0	42.0	43.3	6.0	Yes
10.0	38.1	10.0	42.0	43.5	5.4	Yes

Project:
2596 Douglas 2-16-09 Final1

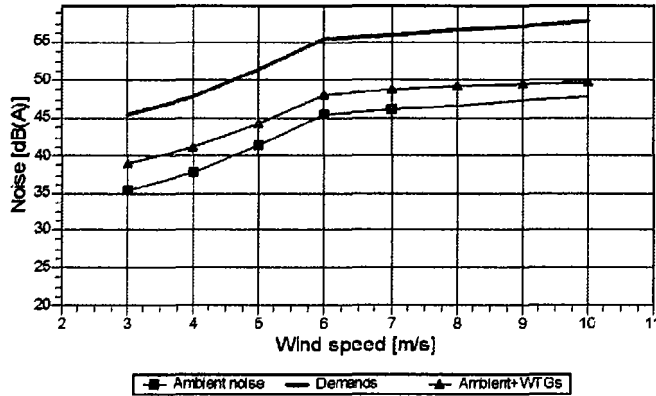
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DECIBEL - Detailed results

Noise calculation model: ISO 9613-2 General

Location B1 (D)



Wind speed	Ambient noise	Demands addition exposure	Sound Level WTG noise	Ambient+WTGs	Result Additional exposure	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
3.0	35.4	10.0	36.6	39.1	3.7	Yes
4.0	37.8	10.0	38.6	41.3	3.5	Yes
5.0	41.5	10.0	41.1	44.3	2.8	Yes
6.0	45.5	10.0	44.6	48.1	2.6	Yes
7.0	46.1	10.0	45.6	48.9	2.8	Yes
8.0	46.7	10.0	45.6	49.2	2.5	Yes
9.0	47.3	10.0	45.6	49.6	2.3	Yes
10.0	47.9	10.0	45.6	49.9	2.0	Yes

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DECIBEL - Assumptions for noise calculation

Noise calculation model: ISO 9613-2 General

Noise calculation model:

ISO 9613-2 General

Wind speed:

3.0 m/s - 10.0 m/s, step 1.0 m/s

Ground attenuation:

General, Ground factor: 1.0

Meteorological coefficient, C0:

0.0 dB

Type of demand in calculation:

2: WTG plus ambient noise is compared to ambient noise plus margin (FR etc.)

Noise values in calculation:

All noise values are 90% exceedance values (L90)

Pure tones:

Pure and Impulse tone penalty are added to WTG source noise

Height above ground level, when no value in NSA object:

1.5 m Allow override of model height with height from NSA object

Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:

0.0 dB(A)

Octave data required

Air absorption

63	125	250	500	1,000	2,000	4,000	8,000
[db/km]	[db/km]	[db/km]	[db/km]	[db/km]	[db/km]	[db/km]	[db/km]
0.1	0.4	1.0	1.9	3.7	9.7	32.8	117.0

WTG: NORDEX N100 2500 99.8 IO!

Noise: Level 0 - calculated noise data

Source Source/Date Creator Edited
NORDEX 07/16/2008 EMD 01/05/2009 4:14 PM
F008_228_A03_DE Rev. 01

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data								
					63	125	250	500	1000	2000	4000	8000	
					[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
From Windcat	100.0	3.0	98.5	No	Generic data 78.1	85.1	88.5	91.1	90.9	88.0	83.2	73.7	
From Windcat	100.0	4.0	100.5	No	Generic data 80.1	87.1	90.5	93.1	92.9	90.0	85.2	75.7	
From Windcat	100.0	5.0	103.0	No	Generic data 82.6	89.6	93.0	95.6	95.4	92.5	87.7	78.2	
From Windcat	100.0	6.0	106.5	No	Generic data 86.1	93.1	96.5	99.1	98.9	96.0	91.2	81.7	
From Windcat	100.0	7.0	107.5	No	Generic data 87.1	94.1	97.5	100.1	99.9	97.0	92.2	82.7	
From Windcat	100.0	8.0	107.5	No	Generic data 87.1	94.1	97.5	100.1	99.9	97.0	92.2	82.7	
From Windcat	100.0	9.0	107.5	No	Generic data 87.1	94.1	97.5	100.1	99.9	97.0	92.2	82.7	
From Windcat	100.0	10.0	107.5	No	Generic data 87.1	94.1	97.5	100.1	99.9	97.0	92.2	82.7	

NSA: Location A-A

Predefined calculation standard:

mission height(a.g.l.): Use standard value from calculation model

Ambient noise:

0.5 [m/s] 1.0 [m/s] 1.5 [m/s] 2.0 [m/s] 2.5 [m/s] 3.0 [m/s]
30.6 dB(A) 31.0 dB(A) 31.3 dB(A) 31.7 dB(A) 32.1 dB(A) 32.5 dB(A)

Margin or Allowed additional exposure: 10.0 dB(A)

Sound level always accepted: 0.0 dB(A)

Distance demand: 0.0 m

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DECIBEL - Assumptions for noise calculation

Noise calculation model: ISO 9613-2 General

NSA: Location B-B

Predefined calculation standard:

Imission height(a.g.l.)Use standard value from calculation model

Ambient noise:

3.0 [m/s] 4.0 [m/s] 5.0 [m/s] 6.0 [m/s] 7.0 [m/s]
35.4 dB(A) 37.8 dB(A) 41.5 dB(A) 45.5 dB(A) 46.1 dB(A)

Margin or Allowed additional exposure10.0 dB(A)

Sound level always accepted0.0 dB(A)

Distance demand:0.0 m

NSA: Location A1-C

Predefined calculation standard:

Imission height(a.g.l.)Use standard value from calculation model

Ambient noise:

0.5 [m/s] 1.0 [m/s] 1.5 [m/s] 2.0 [m/s] 2.5 [m/s] 3.0 [m/s]
30.6 dB(A) 31.0 dB(A) 31.3 dB(A) 31.7 dB(A) 32.1 dB(A) 32.5 dB(A)

Margin or Allowed additional exposure10.0 dB(A)

Sound level always accepted0.0 dB(A)

Distance demand:0.0 m

NSA: Location B1-D

Predefined calculation standard:

Imission height(a.g.l.)Use standard value from calculation model

Ambient noise:

3.0 [m/s] 4.0 [m/s] 5.0 [m/s] 6.0 [m/s] 7.0 [m/s]
35.4 dB(A) 37.8 dB(A) 41.5 dB(A) 45.5 dB(A) 46.1 dB(A)

Margin or Allowed additional exposure10.0 dB(A)

Sound level always accepted0.0 dB(A)

Distance demand:0.0 m

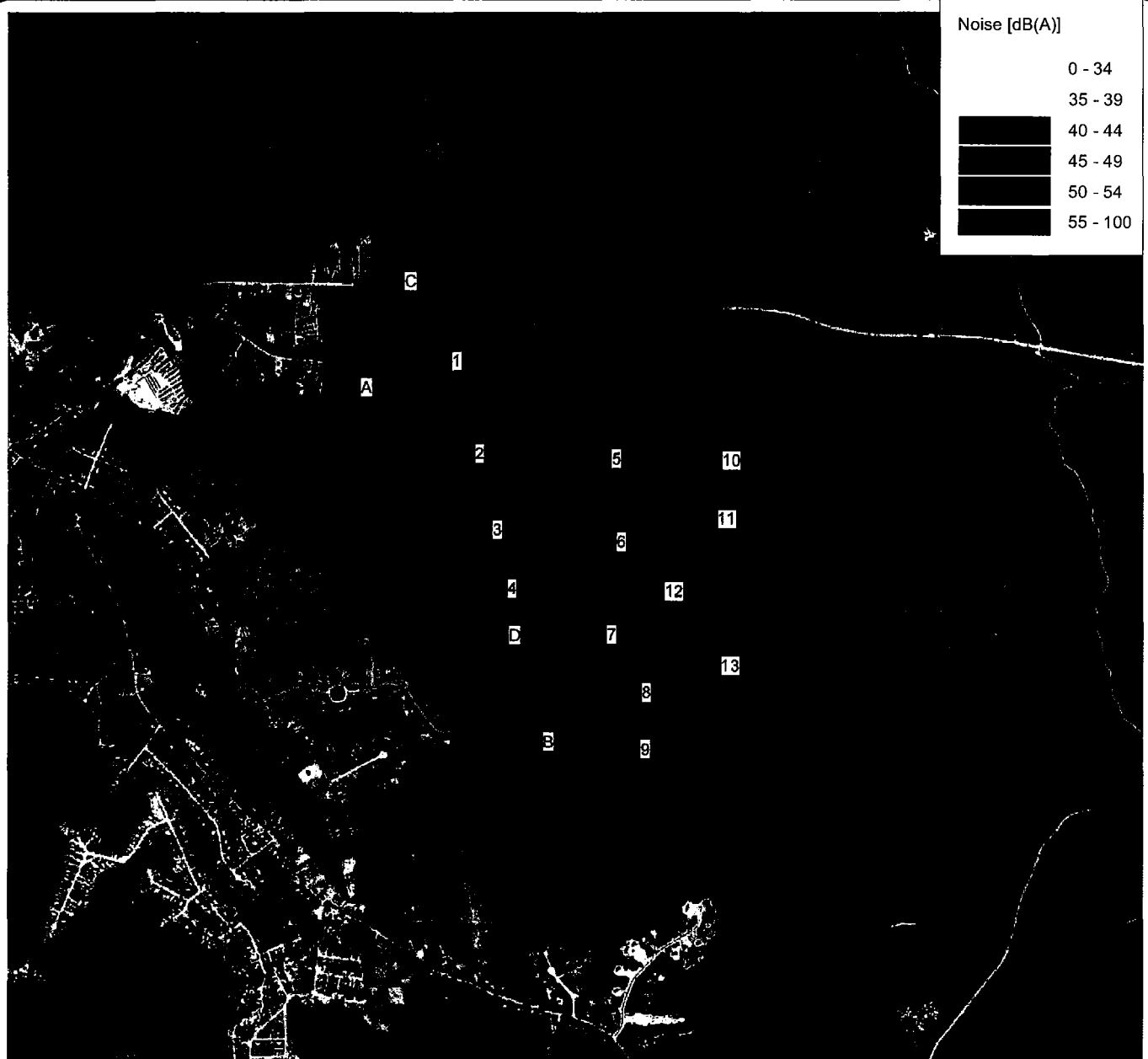
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DECIBEL - Bitmap map: 2596 AERIAL 5mile.jpg

File: 2596 AERIAL 5mile.jpg



0 250 500 750 1000m

Map: , Print scale 1:25,000, Map center Geo WGS 84 East: -71°48'32.88" North: 42°02'58.82"
Noise calculation model: ISO 9613-2 General. Wind speed: 8.0 m/s

▲ New WTG

■ Noise sensitive area

Height above sea level from active line object

35.0 dB(A)

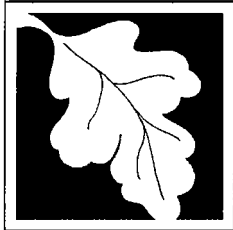
— 40.0 dB(A)

— 45.0 dB(A)

— 50.0 dB(A)

— 55.0 dB(A)

APPENDIX B
Bylaws & Legislation



Massachusetts
Department
of
ENVIRONMENTAL
PROTECTION

fact sheet

Noise

Background

Noise is a type of air pollution that results from sounds that cause a nuisance, are or could injure public health, or unreasonably interfere with the comfortable enjoyment of life, property, or the conduct of business.

Types of sounds that may cause noise include:

- "Loud" continuous sounds from industrial or commercial activity, demolition, or highly amplified music;
- Sounds in narrow frequency ranges such as "squealing" fans or other rotary equipment; and
- Intermittent or "impact" sounds such as those from pile drivers, jackhammers, slamming truck tailgates, public address systems, etc.

Policy

A noise source will be considered to be violating the Department's noise regulation (310 CMR 7.10) if the source:

1. Increases the broadband sound level by more than 10 dB(A) above ambient, or
2. Produce a "pure tone" condition – when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 decibels or more.

These criteria are measured both at the property line and at the nearest inhabited residence. "Ambient" is defined as the background A-weighted sound level that is exceeded 90% of the time, measured during equipment operating hours. "Ambient" may also be established by other means with consent of the Department.

For more information:

For complaints about specific noise sources, call the Board of Health for the municipality in which the noise source is located.

To learn more about responding to noise, odor and dust complaints or to request state assistance or support, please contact the service center in the nearest DEP regional office.

- Central Region, Worcester: (508) 792-7683
- Northeast Region, Wilmington: (978) 661-7677
- Southeast Region, Lakeville: (508) 946-2714
- Western Region, Springfield: (413) 755-2214

This Policy was originally adopted by the MA Department of Public Health in the early 1970's. It was reaffirmed by DEP's Division of Air Quality Control on February 1, 1990, and has remained in effect.

Massachusetts Department of
Environmental Protection
One Winter Street
Boston, MA 02108-4746

Commonwealth of
Massachusetts
Mitt Romney, Governor

Executive Office of
Environmental Affairs
Ellen Roy Herzfelder, Secretary

Department of
Environmental Protection
Edward P. Kuncze,
Acting Commissioner

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Toxics & Hazards

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Noise Pollution Policy Interpretation

Noise is a public health concern that falls within the scope of Massachusetts Department of Environmental Protection (MassDEP) authority as a form of regulated air pollution (M.G.L. Chapter 111, Sections 142A-M provide statutory authority for MassDEP's Air Pollution Control Regulations, 310 CMR 7.00).

Definitions (310 CMR 7.00)

- *Noise* is defined as "sound of sufficient intensity and/or duration as to cause a condition of air pollution."
- *Air pollution* means "the presence in the ambient air space of one or more air contaminants or combinations thereof in such concentrations and of such duration as to: (a) cause a nuisance; (b) be injurious, or be on the basis of current information, potentially injurious to human health or animal life, to vegetation, or to property; or (c) unreasonably interfere with the comfortable enjoyment of life and property or the conduct of business."

When Does MassDEP Evaluate Noise Impacts?

MassDEP evaluates how noise may affect people when 1) the agency reviews applications for approval under its air pollution regulations (310 CMR 7.02) for construction of facilities that will generate more than threshold amounts of pollutants such as nitrogen dioxide, sulfur dioxide, carbon monoxide, volatile organic compounds, particulate matter, and substances that are toxic in air; and 2) the agency responds to complaints from the public about noise generated by an existing source:

- When reviewing applications for pre-construction approval of new sources of air pollution, MassDEP examines the potential increase in sound levels over ambient conditions and the impacts of noise at both the source's property line and at the nearest residence or other sensitive receptor (e.g., schools, hospitals) located in the area surrounding the facility and occupied at the time of the permit review. *Please note: MassDEP requires that an air approval be obtained when a proposed facility is expected to emit more than threshold amounts of specific pollutants. If noise is the only air pollutant expected to be emitted by a facility, a pre-construction air approval is not required.*
- When MassDEP responds to a complaint about an existing source of noise, it focuses on protecting affected people at their residences and in other buildings that are occupied by sensitive receptors from nuisances and the public health effects of the noise. *Please note: An existing source of sound may or may not have needed a MassDEP air approval before it was built.*

Where Are MassDEP's Noise Criteria Applied?

The MassDEP noise pollution policy describes criteria that MassDEP uses to evaluate noise impacts at both the property line and the nearest occupied residence or other sensitive receptor. When noise is found to be a nuisance or a threat to health, MassDEP requires the source to mitigate its noise.

Noise levels that exceed the criteria at the source's property line by themselves do not necessarily

result in a violation or a condition of air pollution under MassDEP regulations (see 310 CMR 7.10 U). The agency also considers the effect of noise on the nearest occupied residence and/or building housing sensitive receptors:

- In responding to complaints, MassDEP measures noise levels at the complainant's location and at other nearby locations that may be affected (e.g., residences and/or buildings with other sensitive receptors). If the noise level at a sensitive receptor's location is more than 10 dB, MassDEP requires the noise source to mitigate its impact.
- A new noise source will be required to mitigate its noise if levels are projected to be more than 10 dB at the nearest residence or building housing sensitive receptors.
- A new noise source that would be located in an area that is not likely to be developed for residential use in the future (e.g., due to abutting wetlands or similarly undevelopable areas), or in a commercial or industrial area with no sensitive receptors may not be required to mitigate its noise impact on those areas, even though projected noise levels at the facility's property line may exceed 10 dB. However, a new noise source that would be located in an area in which housing or buildings containing other sensitive receptors could be developed in the future may be required to mitigate its noise impact in these areas.

This policy has been designed to protect affected residents and other sensitive occupants of nearby property, but not necessarily uninhabited areas in and around the source's property. Sources of noise may need to implement mitigation if residences or buildings occupied by sensitive receptors are developed where they may be affected by the source's noise.



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310 CMR 7.00: AIR POLLUTION CONTROL

Section

- 7.00: Statutory Authority; Legend; Preamble; Definitions
 - 7.01: General Regulations to Prevent Air Pollution
 - 7.02: U Plan Approval and Emission Limitations List
 - 7.03: U Plan Approval Application Exemption Construction Requirements
 - 7.04: U Fossil Fuel Utilization Facilities
 - 7.05: U Fuels All Districts
 - 7.06: U Visible Emissions
 - 7.07: U Open Burning
 - 7.08: U Incinerators
 - 7.09: U Dust, Odor, Construction and Demolition
 - 7.10: U Noise
 - 7.11: U Transportation Media
 - 7.12: U Source Registration
 - 7.13: U Stack Testing
 - 7.14: U Monitoring Devices and Reports
 - 7.15: U Asbestos
 - 7.16: U Reduction of Single Occupant Commuter Vehicle Use
 - 7.17: U Conversions to Coal
 - 7.18: U Volatile and Halogenated Organic Compounds
 - 7.19: U Reasonably Available Control Technology (RACT) for Sources of Oxides of Nitrogen (NO_x)
 - 7.21: Sulfur Dioxide Emissions Limitations
 - 7.22: Sulfur Dioxide Emissions Reductions for the Purpose of Reducing Acid Rain
 - 7.24: U Organic Material Storage and Distribution
 - 7.25: U Best Available Controls for Consumer and Commercial Products
 - 7.26: Industry Performance Standards
 - 7.27: NO_x Allowance Program
 - 7.28: NO_x Allowance Trading Program
 - 7.29: Emissions Standards for Power Plants
 - 7.30: MB Massport/Logan Airport Parking Freeze
 - 7.31: MB City of Boston/East Boston Parking Freeze
 - 7.32: Massachusetts Clean Air Interstate Rule (Mass CAIR)
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 - 7.36: U Transit System Improvements
 - 7.37: MB High Occupancy Vehicle Lanes
 - 7.38: Certification of Tunnel Ventilation Systems in the Metropolitan Boston Air Pollution Control District
 - 7.40: U Low Emission Vehicle Program
 - 7.45: The Massachusetts Green Fleet Program
 - 7.50: U Variances
 - 7.51: U Hearings Relative to Orders and Approvals
 - 7.52: U Enforcement Provisions
 - 7.54: U Large Combustion Emission Units
 - 7.60: U Severability
 - 7.70: Massachusetts CO₂ Budget Trading Program
- Appendix A: EMISSION OFFSETS AND NONATTAINMENT REVIEW
Appendix B: U EMISSIONS BANKING, TRADING, AND AVERAGING
Appendix C: OPERATING PERMIT PROGRAM

STATUTORY AUTHORITY

All provisions of 310 CMR 7.00 are adopted pursuant to the authority granted by M.G.L. c. 111, §§ 142A through 142J. In addition, 310 CMR 7.08(2) is adopted pursuant to the authority granted by M.G.L. c. 111, § 150A and the following provisions of 310 CMR 7.00 are adopted pursuant to the authority granted by M.G.L. c. 21C, §§ 4 and 6 and by M.G.L. c. 21E, § 6.

- (1) The following definitions in 310 CMR 7.00:
 - (a) COMBUSTION EFFICIENCY (C.E.).
 - (b) FUEL, including the definition of HAZARDOUS WASTE FUEL and USED OIL FUEL.
 - (c) GENERATOR.
 - (d) HAZARDOUS WASTE.

DEFINITIONS: continued

MOTOR VEHICLE FUEL DISPENSING FACILITY means any facility where motor vehicle fuel is dispensed into motor vehicle fuel tanks or portable containers from a storage tank with a capacity of 250 gallons or more.

MOTOR VEHICLE PARKING SPACE means any space which is used for the purpose of parking motor vehicles (whether or not demarcated as such), and whether or not a fee has been charged for its use; except those parking spaces used by residents, on street parking spaces, parking spaces designated by the City of Boston as parking for residents only shall not be considered as motor vehicle parking spaces. Nor shall parking spaces used for the purpose of the temporary storage of motor vehicles for sale, or parking spaces owned or operated by the Massachusetts Bay Transit Authority and used solely by transit users be considered motor vehicle parking spaces.

MOTOR VEHICLE POLLUTION CONTROL SYSTEM means the combination of emission-related parts which controls air pollutant emissions from a motor vehicle or motor vehicle engine.

MW means megawatt or a unit of electrical power equal to one million watts.

NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAPS) means those standards adopted by the U.S. Environmental Protection Agency and contained in the CFR Title 40, Part 61, and subsequent revisions as specified in the Regulations. Any emission testing to be compared with NESHAPS must be conducted in accordance with applicable procedures as specified in said CFR, Title 40, Part 61, or amendments thereto, or by another method which has been demonstrated to the satisfaction of the Department as being equivalent.

NATURAL DRAFT OPENING means any permanent opening in an enclosure that remains open during operation of the emission unit and is not connected to a duct in which a fan is installed.

NATURAL FINISH HARDWOOD PLYWOOD PANELS means panels whose original grain pattern is enhanced by essentially transparent finishes which are frequently supplemented by fillers and toners.

NEW SOURCE PERFORMANCE STANDARDS (NSPS) means Standards of Performance for New Stationary Sources adopted by the U.S. Environmental Protection Agency and contained in 40 CFR 60, and subsequent revisions as specified in the Regulations. Any emission testing to be compared with NSPS must be conducted in accordance with applicable procedures as specified in 40 CFR 60, or by another method which has been demonstrated to the satisfaction of the Department as being equivalent.

NEW VEHICLE means any passenger car or light duty truck with 7,500 miles or fewer on its odometer. As used in 310 CMR 7.45: NEW VEHICLE means any motor vehicle not previously titled for registration.

NEWSPAPER PRINTING is a non-heatset web offset lithographic process.

NO-BUILD ALTERNATIVE means the project roadway, the appurtenant highway network and roadway operational characteristics that would exist if the project were not built and assuming the level of development and services (e.g., transit) which physically exist at the time of analysis or for which construction has commenced and completion and full utilization is expected prior to the projected completion date of the project under review.

NOISE means sound of sufficient intensity and/or duration as to cause or contribute to a condition of air pollution.

NONATTAINMENT AREA means an area designated by the EPA as not meeting the National Ambient Air Quality Standard for a criteria pollutant pursuant to the Clean Air Act, § 107 (42 U.S.C. 7407) and 40 CFR Part 81. The current Massachusetts attainment status is published at 40 CFR 81.322, Subpart C - Section 107 Attainment Status Designations.

310 CMR: DEPARTMENT OF ENVIRONMENTAL PROTECTION

7.09: continued

(3) No person responsible for an area where construction or demolition has taken place shall cause, suffer, allow, or permit particulate emissions therefrom to cause or contribute to a condition of air pollution by failure to seed, pave, cover, wet, or otherwise treat said area to prevent excessive emissions of particulate matter.

(4) No person shall cause, suffer, allow, or permit the handling, transportation, or storage of any material in a manner that results or may result in emissions therefrom which cause or contribute to a condition of air pollution.

(5) No persons responsible for any construction or demolition of a structure that contains friable asbestos material shall fail to comply with 310 CMR 7.09(2) and 310 CMR 7.02. (National Emission Standards for Hazardous Pollutants)

(6) No person shall cause, suffer, allow, or permit the operation of mechanized street sweeping equipment that is not equipped with a suitable dust collection or dust suppression system which is maintained in good operating condition and is operated continuously while the street sweeping equipment is in use to prevent conditions of air pollution.

(7) 310 CMR 7.09(1) through 7.09(4) and 7.09(6) are subject to the enforcement provisions specified in 310 CMR 7.52.

7.10: U Noise

(1) No person owning, leasing, or controlling a source of sound shall willfully, negligently, or through failure to provide necessary equipment, service, or maintenance or to take necessary precautions cause, suffer, allow, or permit unnecessary emissions from said source of sound that may cause noise.

(2) 310 CMR 7.10(1) shall pertain to, but shall not be limited to, prolonged unattended sounding of burglar alarms, construction and demolition equipment which characteristically emit sound but which may be fitted and accommodated with equipment such as enclosures to suppress sound or may be operated in a manner so as to suppress sound, suppressible and preventable industrial and commercial sources of sound, and other man-made sounds that cause noise.

(3) 310 CMR 7.10(1) shall not apply to sounds emitted during and associated with:

- (a) parades, public gatherings, or sporting events, for which permits have been issued provided that said parades, public gatherings, or sporting events in one city or town do not cause noise in another city or town;
- (b) emergency police, fire, and ambulance vehicles;
- (c) police, fire, and civil and national defense activities;
- (d) domestic equipment such as lawn mowers and power saws between the hours of 7:00 A.M. and 9:00 P.M.

(4) 310 CMR 7.10(1) is subject to the enforcement provisions specified in 310 CMR 7.52.

7.11: U Transportation Media

(1) Motor Vehicles.

(a) All motor vehicles registered in the Commonwealth shall comply with pertinent regulations of the Registry of Motor Vehicles relative to exhaust and sound emissions.

(b) No person shall cause, suffer, allow, or permit the unnecessary operation of the engine of a motor vehicle while said vehicle is stopped for a foreseeable period of time in excess of five minutes. 310 CMR 17.11 shall not apply to:

1. vehicles being serviced, provided that operation of the engine is essential to the proper repair thereof, or