ACOUSTIC STUDY OF THREE WIND TURBINES

SCITUATE, MASSACHUSETTS

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TECH ENVIRONMENTAL
Air Quality, Odor Control, and Noise Solutions

ACOUSTIC STUDY OF

THREE WIND TURBINES

SCITUATE, MASSACHUSETTS

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1.0 EXECUTIVE SUMMARY

The town proposes to locate a wind turbine near the Scituate wastewater treatment plant. A study of the noise effects from three potential makes of a wind turbine (General Electric, Fuhrlander, Gamesa) on nearby areas was performed. Two potential turbine locations were modeled at the plant site. Acoustic modeling was done for design wind speed operating conditions for the sound power levels of each potential turbine, which produces the loudest sound levels at the site. The "design wind speed condition" in this study refers to the lowest wind speed at which the maximum sound power level is first produced. Existing sound levels on the site and in nearby residential areas were measured over the period of 18 February 2008 through 22 February 2008.

The study's conclusions are as follows:

- The wind turbine Project complies with the Massachusetts DEP and Town of Scituate Noise Policies concerning the increases in total sound level at all nearby residential properties for all turbine makes.
- The wind turbine Project complies with the Massachusetts DEP Noise Policy concerning pure tones for one of the turbines (Gamesa). It is anticipated that it will comply for the other two; however it could not be verified due to the unavailability of octave band sound power data. (It could not be obtained from the manufacturers.)
- A project at Location 2 is expected to produce lower sound levels at the nearby residential locations than Location 1 for all turbines, by about 4-5 decibels. However, areas to the west would experience higher sound levels by about 4 decibels.
- The Project would increase the ambient L_{90} sound level[1] by 0 dBA to 9 dBA at the nearest residences, depending on turbine type and location. The GE turbine would increase L_{90} sound levels 0 to 6 dBA, the Fuhrlander turbine would increase L_{90} levels 0 to 1 dBA, and the Gamesa would increase L_{90} levels 0 to 9 dBA.
- The Project will be audible at certain times in the closest areas to the east of the turbine towers for certain turbine types and locations. When three conditions all occur: 1) residents in these abutting areas are downwind, 2) ambient sound levels are low, and 3) wind speeds are high enough for wind turbine operation, then the "swishing" sound characteristic of wind turbine will be audible outdoors for certain locations and turbine types. Project sounds should not be audible indoors anywhere.

[1] The L_{90} sound level represents the quietest 10 percent of any time period.

2.0 COMMON MEASURES OF COMMUNITY SOUND

All sounds originate with a source – a human voice, vehicles on a roadway, or an airplane overhead. The sound energy moves from the source to a person's ears as sound waves, which are minute variations in air pressure. The loudness of a sound depends on the sound pressure level, defined as the ratio of two pressures: the measured sound pressure from the source divided by a reference pressure (the quietest sound we can hear). The unit of sound pressure is the decibel (dB). The decibel scale is logarithmic to accommodate the wide range of sound intensities to which the human ear is subjected. On this scale, the quietest sound we can hear is 0 dB, while the loudest is 120 dB. Most sounds we hear in our daily lives have sound pressure levels in the range of 30 dB to 100 dB.

A property of the decibel scale is that the sound pressure levels of two separate sounds are not directly additive. For example, if a sound of 70 dB is added to another sound of 70 dB, the total is only a 3-decibel increase (or 73 dB), not a doubling to 140 dB. In terms of the human perception of sound, a halving or doubling of loudness requires changes in the sound pressure level of about 10 dB; 3 dB is the minimum perceptible change for broadband sounds, i.e. sounds that include all frequencies. Typical sound levels associated with various activities and environments are presented in Table 1. The distance to a major road often determines the acoustic environment in a rural area such as the Scituate site, as roadway traffic establishes the background sound levels.

Sound exposure in a community is commonly expressed in terms of the A-weighted sound level (dBA); A-weighting approximates the frequency response of the human ear. Levels of many sounds change from moment to moment. Some are sharp impulses lasting one second or less, while others rise and fall over much longer periods of time. There are various measures of sound pressure designed for different purposes. To establish the background ambient sound level in an area, the $\mathbf{L_{90}}$ metric, which is the sound level exceeded 90 percent of the time, is typically used. The $\mathbf{L_{90}}$ can also be thought of as the level representing the quietest 10 percent of any time period and is a broadband sound pressure measure. The $\mathbf{L_{eq}}$, or equivalent sound level, is the steady-state sound level over a period of time that has the same acoustic energy as the fluctuating sounds that actually occurred during that same period. It is commonly referred to as the average sound level. Sound level measurements typically include an analysis of the sound spectrum into its various frequency components to determine tonal

characteristics. The unit of frequency is Hertz (Hz), measuring the cycles per second of the sound pressure waves, and typically the frequency analysis examines eleven octave bands from 16 to 16,000 Hz.

TABLE 1

VARIOUS INDOOR AND OUTDOOR SOUND LEVELS

Outdoor Sound Levels	Sound Pressure (μPa)		Sound Level (dBA)	Indoor Sound Levels
	6,324,555	-	110	Rock Band at 5 m
Jet Over-Flight at 300 m		-	105	
	2,000,000	-	100	Inside New York Subway Train
Gas Lawn Mower at 1 m		-	95	
	632,456	-	90	Food Blender at 1 m
Diesel Truck at 15 m		-	85	
Noisy Urban Area--Daytime	200,000	-	80	Garbage Disposal at 1 m
		-	75	Shouting at 1 m
Gas Lawn Mower at 30 m	63,246	-	70	Vacuum Cleaner at 3 m
Suburban Commercial Area		-	65	Normal Speech at 1 m
Quiet Urban Area -- Daytime	20,000	-	60	
		-	55	Quiet Conversation at 1m
Quiet Urban Area--Nighttime	6,325	-	50	Dishwasher Next Room
		-	45	
Suburban Area--Nighttime	2,000	-	40	Empty Theater or Library
		-	35	
Rural Area--Nighttime	632	-	30	Quiet Bedroom at Night
		-	25	Empty Concert Hall
Rustling Leaves	200	-	20	Average Whisper
		-	15	Broadcast and Recording Studios
	63	-	10	
		-	5	Human Breathing
Reference Pressure Level	20	-	0	Threshold of Hearing

Notes:
μPa - Micropascals describe sound pressure levels (force/area).
dBA - A-weighted decibels describe sound pressure on a logarithmic scale with respect to 20 μPa.

3.0 NOISE REGULATIONS AND CRITERIA

3.1 Massachusetts DEP Noise Policy

The Department of Environmental Protection (DEP) regulates noise through 310 CMR 7.10, "Air Pollution Control". The regulations are included in Appendix A. In these regulations "air contaminant" is defined to include noise and a condition of "air pollution" includes the presence of an air contaminant in such concentration and duration as to "cause a nuisance" or "unreasonably interfere with the comfortable enjoyment of life and property". Regulation 7.10 prohibits "unnecessary emissions" of noise. The DEP Noise Policy (Policy Statement 90-001, February 1, 1990) interprets a violation of this noise regulation to have occurred if the sound source causes either:

1) An increase in the broadband sound pressure level of more than 10 dBA above the ambient, or

2) A "pure tone" condition.[2]

The ambient background level is defined by DEP as the lowest L_{90} level measured during equipment operating hours.

For the wind turbines examined in this report, operation occurs whenever the wind speed at the reference hub height is greater than the turbine cut-in wind speed, which is usually about 4-5 m/sec. The design wind speed is usually a hub height wind speed of 8 m/s or greater, as specified by the manufacturer. This is also the wind speed at which the turbine sound usually most greatly exceeds the background sound level, and is therefore most appropriate for sound impact evaluation. Cut-in wind speed data for each turbine were not available; however, design wind speed data were obtained from manufacturers for each of the three turbines to be modeled. The Gamesa G87 wind turbine produces a maximum sound power level of 105 dBA at a wind speed of 10 m/sec.; the Fuhrlander FL 600 turbine produces a maximum sound power level of 93 dBA at a wind speed of 11 m/sec; and the GE 1.5 SLE produces a maximum sound power level of 104 dBA at a wind speed of 8 m/sec. The Gamesa and Fuhrlander power levels were conservatively assumed to first occur at 8 m/sec hub height wind speed.

[2]A "pure tone" condition occurs when any octave band sound pressure level exceeds both of the two adjacent octave band sound pressure levels by 3 dB or more.

3.2 Town of Scituate Noise By Law

The town of Scituate has recently amended their By-Law, Section 740.6 Noise Level Standards. It is now identical to the MADEP regulations, and is given below:

"The wind facility and associated equipment shall conform with the provisions of the Department of Environmental Protection Division of Air Quality Noise Regulations (310 CMR 7.10). An analysis prepared by a registered qualified engineer will be required to demonstrate compliance with the above standards; or take any other action relative thereto."

4.0 AMBIENT SOUND LEVEL AND WIND MEASUREMENTS

The Scituate wind turbine will be located on town land near the existing wastewater treatment plant. Figure 1 presents the potential turbine tower locations (T1 and T2), the short term sound monitoring locations (S1-S3), the long term monitoring location (L), and the meteorological tower (M). Turbine Location T1 is about 300 feet west of the wastewater treatment plant and about 300 feet south of Driftway Road. Turbine Location T2 is about 500 feet south of Driftway Road near the center of the sand pit area. The closest residences are east of the project site along Driftway Road. A golf course abuts the site to the north and southeast; to the west, a park is located along Driftway Road.

The DEP Noise Policy defines the ambient sound level as the lowest L_{90} level measured during hours when the new source (wind turbine in this case) could "unreasonably interfere with enjoyment of life and property". At residential areas, this could include any time of day, and would especially include late at night when sound background levels are usually at their lowest. At non-residential areas, this would correspond to times when the area under study was in normal use.

Wind measurements were made on-site during the entire measurement period. A 10-meter tower with a wind vane anemometer (R.M. Young Co. Model 3002) was used to record wind speed and direction at the long-term monitoring site, and one-hour averages were recorded by a data logger (R.M. Young Model 26700). The meteorological station was set up on an open location at the wastewater treatment plant, as shown in Figure 1. The measured on-site wind data are included in Appendix B.

To estimate when the wind would be blowing and at what speed, the measured on-site wind speed at the tower above a ground elevation of 15 feet M.S.L. was extrapolated to the average wind turbine hub height for the three potential turbines of 63 meters (207 feet) above a ground elevation of 15 feet M.S.L. using a reference roughness length of 0.3, corresponding to a wooded area.[3] The result of this calculation states that wind speeds at the average hub height are about 1.5 times greater than the 10-meter wind speeds measured on-site.

[3] International Electrotechnical Commission, International Standard IEC 61400-11, "Wind turbine generator systems-Part 11: Acoustic sound measurements techniques," 2006, page 20.

The long-term sound monitoring station was placed at the nearest residence to the east along Driftway Road, at Latitude 42^0 10' 36.3", Longitude 70^0 43' 35.9" Long-term sound level monitoring was performed from 5:00 P.M. February 18, 2008 to 12:00 P.M., February 22, 2008 to document L_{90} and L_{eq} hourly sound levels, day and night, over a range of wind conditions. When the long-term sound monitoring station was set up, skies were partly cloudy, the temperature was about 40^0 F and the winds were gusty (5-10 mph from the southwest), and there was little snow cover. The audible sounds in the residential areas were the wastewater treatment plant, traffic on Driftway Road, wind in the trees, and small aircraft (the mulching plant was not audible).

Supplemental short-term (30 minute) sound monitoring, day and night, was done in the areas surrounding the plant on February 18-19, 2008. This was done during winds of about 5-20 mph, during the day, and under similar wind levels, about 5-20 mph at night. The short-term monitoring locations are labeled #S1 through #S3 on Figure 1, and are listed below in Table 2. Note that the expected uses are different at each location; Receptors S1 and S2 have daytime use only, while receptor S3 is near a residential area with 24 hour usage.

TABLE 3
SHORT TERM MEASUREMENT LOCATION SUMMARY

Residential Location	Receptor #
Park Along Driftway Road	S1
Golf Course to North of Site	S2
Property Line Southeast, North of Clubhouse	S3

All sound level measurements were taken with Larson Davis Model 824 and CEL Model 593 real-time sound level analyzers, which are equipped with precision condenser microphones having an operating range of 5 dB to 140 dB, and an overall frequency range of 3.5 to 20,000 Hz. These meters meet or exceed all requirements set forth in the American National Standards Institute (ANSI) Standards for Type 1 for quality and accuracy. Prior to and immediately following both measurement sessions, the sound analyzers were calibrated (no level adjustment was required) with an ANSI Type 1 calibrator which has an accuracy traceable to the National Institute of Standards and Technology (NIST). All instrumentation was laboratory calibrated per ANSI recommendations. For all measurement sessions,

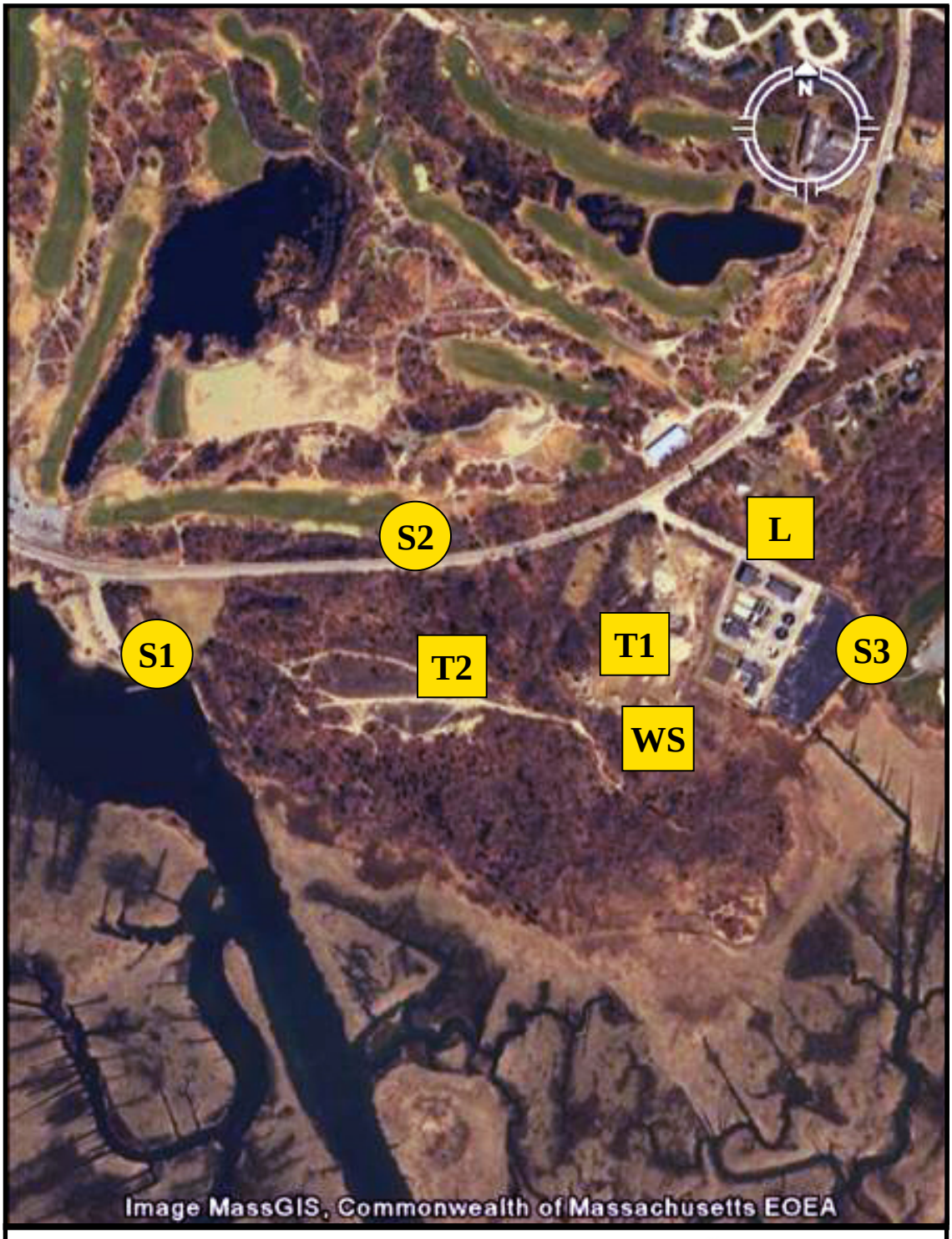

Figure 1.
Site View Showing Turbine Locations (T1 and T2), Long Term Monitoring Location (L), Short Term Monitoring Locations (S1-S3), and Wind Speed Gauge Location (WS)

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the microphone was fitted with an environmental windscreen to negate the effect of air movement and tripod- mounted at the height of 1.3 meters above grade, and measurements were made away from any vertical reflecting surfaces in compliance with ANSI Standard S12.9.[4] All data were downloaded to a computer following the measurement session. The sound data are summarized in Appendix B.

Appendix B-1 summarizes the hourly measurements of L_{90} sound levels at the long-term monitoring station and the estimated hourly average wind speed at hub height. The values that are in bold text correspond to hours when the wind turbines would likely be operating (hub height wind speeds of 4 m/s or greater). The values that are in bold and italic text correspond to hours when the wind turbines would be near the design wind speed (hub height wind speeds of about 8 m/s or greater). The data in Appendix B-1 reveal 1-hour L_{90} sound levels as low as 35 dBA and as high as 52 dBA, with sound levels in the 36-45 dBA range most of the time. These measured levels are typical for a rural area.

During times when the winds were calm (less than 1 mph), the measured L_{90} levels ranged from 37 to 38 dBA. During the measurement period, there were 35 hours when hub height winds were above the typical cut-in wind speed of 4 m/sec and the wind turbines could have been operating. Hub height winds were in the range of 4-10 m/s and averaged 6.4 m/sec for these hours; the corresponding L_{90} levels averaged 41 dBA, with the lowest L_{90} being 35 dBA. Winds were measured at or above the typical design wind condition of 8 m/s at hub height for about 3.5 hours; the L_{90} sound level was 41 dBA, or 2 dBA higher than under the typical cut-in wind speed condition during this time. Nighttime L_{90} levels (between midnight and 6:00 A.M.) averaged about 36 dBA when the wind was blowing above the cut-in speed; it averaged about 6 m/sec during this time. This is the level which will be used for the DEP compliance verification at the nearest residences. It is conservative, as it includes the quietest nighttime hours and hours when the turbines would be operating below the design speed.

For the purpose of the DEP Noise Policy compliance demonstration at other locations, the wind levels were about 5-20 mph for most of the daytime measurements and nighttime measurements. Short-term measurements made in the residential areas established that L_{90} sound levels in the residential areas are comparable to those at the long-term monitoring station (the minimum measured L_{90} level in the residential area of 40 dBA compares to 36 dBA at the long-term station).

[4] Acoustical Society of America, ANSI Standard S12.9-1992/Part 2, "Quantities and Procedures for Description and Measurement of Environmental Sound. Part 2: Measurement of Long-Term Wind-Area Sound."

5.0 CALCULATED FUTURE SOUND LEVELS

5.1 Methodology

Future sound level effects from the three potential Scituate wind turbines on nearby residences were calculated with the Cadna/A acoustic model. Cadna/A is a sophisticated 3-D model for sound propagation and attenuation based on International Standard ISO 9613[5]. Atmospheric absorption, the process by which sound energy is absorbed by the air, was calculated using ANSI S1.26-1995.[6] Absorption of sound assumed standard day conditions and is significant at large distances. Ground surfaces were assumed to be soft surfaces, typical of grass and wooded areas, resulting in absorption of most sound waves.[7] This is a reasonable assumption for the model predictions at the closest residences, as the land between the turbine towers and those homes is undeveloped and has a soft ground surface. Digital terrain heights were extracted from MassGIS. The model assumes favorable sound propagation, as occurs under downwind conditions or a ground-based temperature inversion, such as might occur on a clear night. At other times, atmospheric turbulence and wind shadow effects will reduce sound levels by 5 to 20 dBA from those presented below.

5.2 Results and Conclusions

Figures 2 – 7 show color-coded decibel contours (5 feet above ground level) for the operation of the Scituate wind turbines and their sound effects on nearby property. The first set of contours is for the GE turbine; the second is for the Fuhrlander; the third is for the Gamesa. The GE turbine is at a hub height of 62 meters; the Fuhrlander at a hub height of 50 meters, and the Gamesa at a hub height of 80 meters. Both potential turbine locations are shown. The turbine sound will be audible to nearby residents in areas with low sound background for some turbines and site locations. Note that Figures 2 through 7 assume the sound receiving location is always downwind of the wind turbine, and the figures present a composite worst-case in which all locations are simultaneously downwind of the wind turbine.

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[5] International Standard, ISO 9613-2, Acoustics – Attenuation of Sound During Propagation Outdoors, -- Part 2 General Method of Calculation.

[6] American National Standards Institute, ANSI S1.26-1995, American National Standard Method for the Calculation of the Absorption of Sound by the Atmosphere, 1995.

[7] Ground absorption factor G set equal to 1.0 in Cadna-A.

The acoustic modeling results in Figures 2-7 and in Tables 4-9 reveal that the Scituate wind turbines will comply with the DEP and Town of Scituate Noise Policies regarding the increase in total broadband sound level at all locations. The project will increase background L_{90} sound levels by 0-9 dBA in the nearest residential areas at the design wind speed condition. If the single lowest L_{90} level of 35 dBA measured at the long-term monitoring station for winds at or above 4 m/sec is used as the "ambient L_{90} level" in Table 3, the increase from project operations would still be below 10 dBA, again in compliance with the DEP Noise Policy.

Although all of the turbines would be in compliance with the DEP noise policy regarding the total sound level increase, it should be noted that the perceived loudness would vary depending on turbine type or location. The Fuhrlander would be almost inaudible at most residential receptors when placed at either turbine location. By contrast, the GE and Gamesa turbines would both be clearly audible above background at night at Location 1. Although the Gamesa appears to meet the DEP noise policy limits at Location 1, if this location and turbine are selected an additional noise analysis will be needed after final design parameters have been determined, because of the projected 9 dBA increase.

Sound from turbine Location 2 will be considerably lower at the nearby residences for both the GE and Gamesa units. At Location 2, the Gamesa turbine would also be clearly audible under most conditions; however, the GE would not be as noticeable. Sound levels from all turbines will be higher on the golf course to the north and also at the park on the water for Location 2; however, they will not be significantly higher than existing levels at these receptors.

Octave band data were not available for either the Fuhrlander or the GE turbines. An examination of data from the Gamesa turbine reveals that it complies with the DEP octave band requirement; however, it has distinctly higher sound levels at about a thousand cycles per second (1000 Hz.). Compliance of the GE 1.5 SLE and Fuhrlander turbines could not be directly verified. It would appear that the generally low sound levels from the Fuhrlander would make it very unlikely that a pure tone would be measureable at any relevant location from this turbine. No definite statement regarding octave band sound from the GE turbine can be made; however, since it is quieter than the Gamesa, it would probably also comply with the pure tone regulation.

TABLE 4

DEP NOISE POLICY COMPLIANCE SUMMARY FOR THE GE 1.5 SLE AT LOCATION 1 UNDER DESIGN WIND SPEED OPERATIONS (dBA)

Residential Location	Ambient L_{90} Level	Maximum Project Sound	Combined Sound Level	Net Increase
Park Along Driftway Road	48	33	48	0
Golf Course to North of Site	52	38	52	0
Property Line South, North of Clubhouse	40	39	43	3
Closest Residence on Driftway	36	40	42	6

Note: DEP Noise policy limits the increase in the ambient level to 10 dBA.

TABLE 5

DEP NOISE POLICY COMPLIANCE SUMMARY FOR THE GE 1.5 SLE AT LOCATION 2 UNDER DESIGN WIND SPEED OPERATIONS (dBA)

Residential Location	Ambient L_{90} Level	Maximum Project Sound	Combined Sound Level	Net Increase
Park Along Driftway Road	48	37	48	0
Golf Course to North of Site	52	42	53	1
Property Line South, North of Clubhouse	40	34	41	1
Closest Residence on Driftway	36	36	39	3

Note: DEP Noise policy limits the increase in the ambient level to 10 dBA.

TABLE 6

DEP NOISE POLICY COMPLIANCE SUMMARY FOR THE FUHRLANDER FL 600 AT LOCATION 1 UNDER DESIGN WIND SPEED OPERATIONS (dBA)

Residential Location	Ambient L_{90} Level	Maximum Project Sound	Combined Sound Level	Net Increase
Park Along Driftway Road	48	22	48	0
Golf Course to North of Site	52	27	52	0
Property Line South, North of Clubhouse	40	28	40	0
Closest Residence on Driftway	36	29	37	1

Note: DEP Noise policy limits the increase in the ambient level to 10 dBA.

TABLE 7

DEP NOISE POLICY COMPLIANCE SUMMARY FOR THE FUHRLANDER FL 600 AT LOCATION 2 UNDER DESIGN WIND SPEED OPERATIONS (dBA)

Residential Location	Ambient L_{90} Level	Maximum Project Sound	Combined Sound Level	Net Increase
Park Along Driftway Road	48	26	48	0
Golf Course to North of Site	52	31	52	0
Property Line South, North of Clubhouse	40	23	40	0
Closest Residence on Driftway	36	25	36	0

Note: DEP Noise policy limits the increase in the ambient level to 10 dBA.

TABLE 8

DEP NOISE POLICY COMPLIANCE SUMMARY FOR THE GAMESA G87 AT LOCATION 1 UNDER DESIGN WIND SPEED OPERATIONS (dBA)

Residential Location	Ambient L_{90} Level	Maximum Project Sound	Combined Sound Level	Net Increase
Park Along Driftway Road	48	37	48	0
Golf Course to North of Site	52	42	52	0
Property Line South, North of Clubhouse	40	42	44	4
Closest Residence on Driftway	36	44	45	9

Note: DEP Noise policy limits the increase in the ambient level to 10 dBA.

TABLE 9

DEP NOISE POLICY COMPLIANCE SUMMARY FOR THE GAMESA G87 AT LOCATION 2 UNDER DESIGN WIND SPEED OPERATIONS (dBA)

Residential Location	Ambient L_{90} Level	Maximum Project Sound	Combined Sound Level	Net Increase
Park Along Driftway Road	48	41	49	1
Golf Course to North of Site	52	46	53	1
Property Line South, North of Clubhouse	40	37	42	2
Closest Residence on Driftway	36	39	41	5

Note: DEP Noise policy limits the increase in the ambient level to 10 dBA.

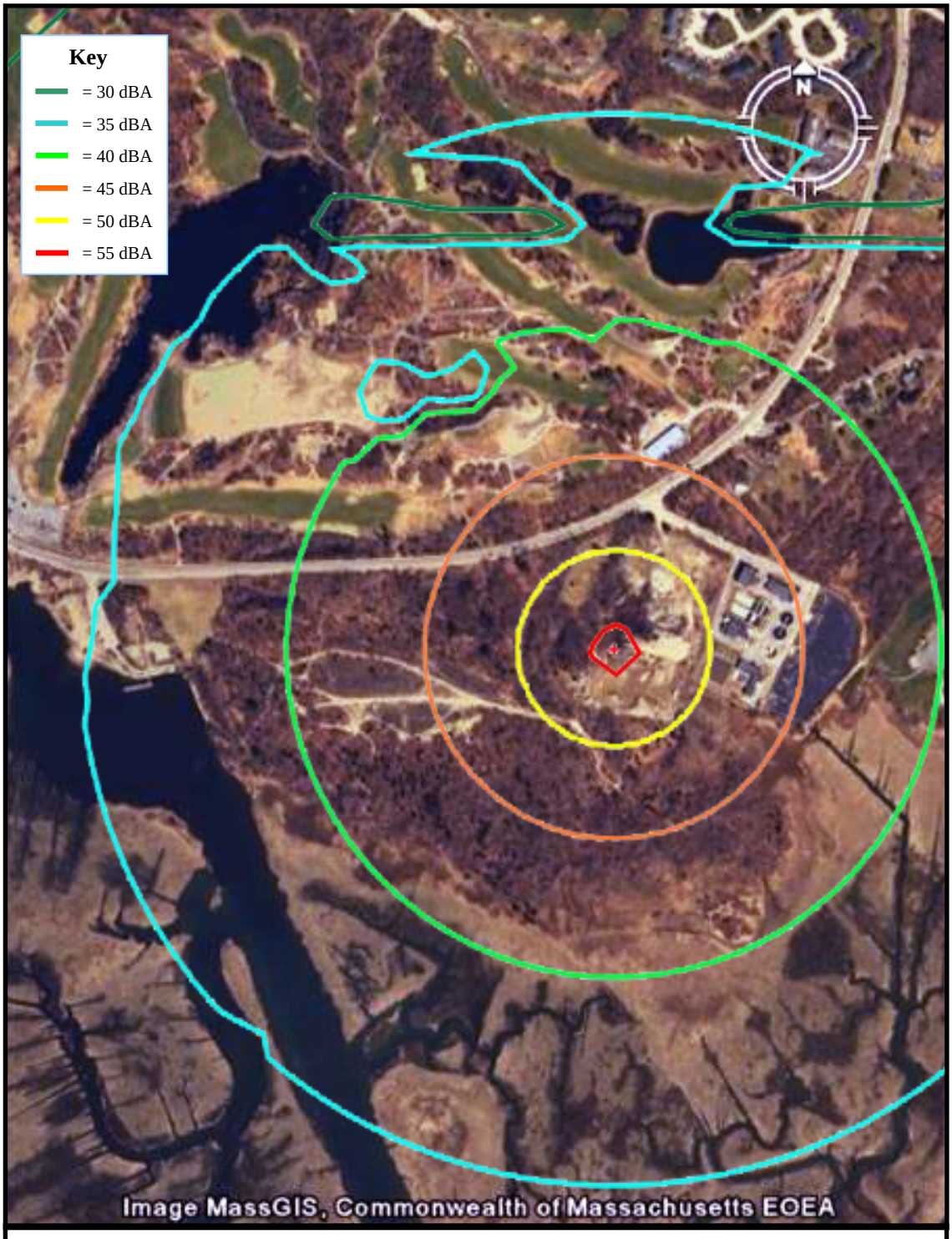

Figure 2.
GE 1.5 SLE Turbine Noise Contours – Location 1

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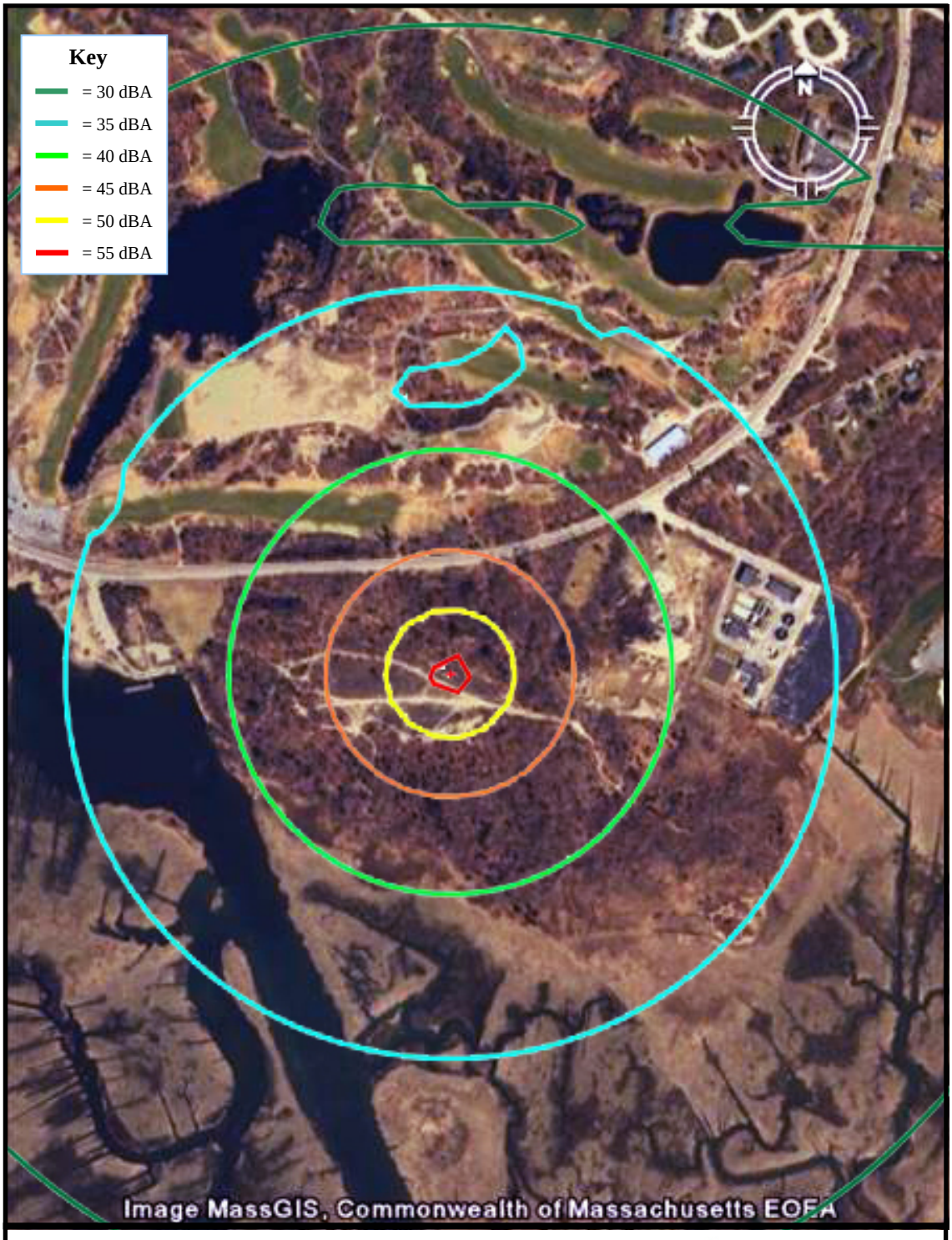

Figure 3.
GE 1.5 SLE Turbine Noise Contours– Location 2

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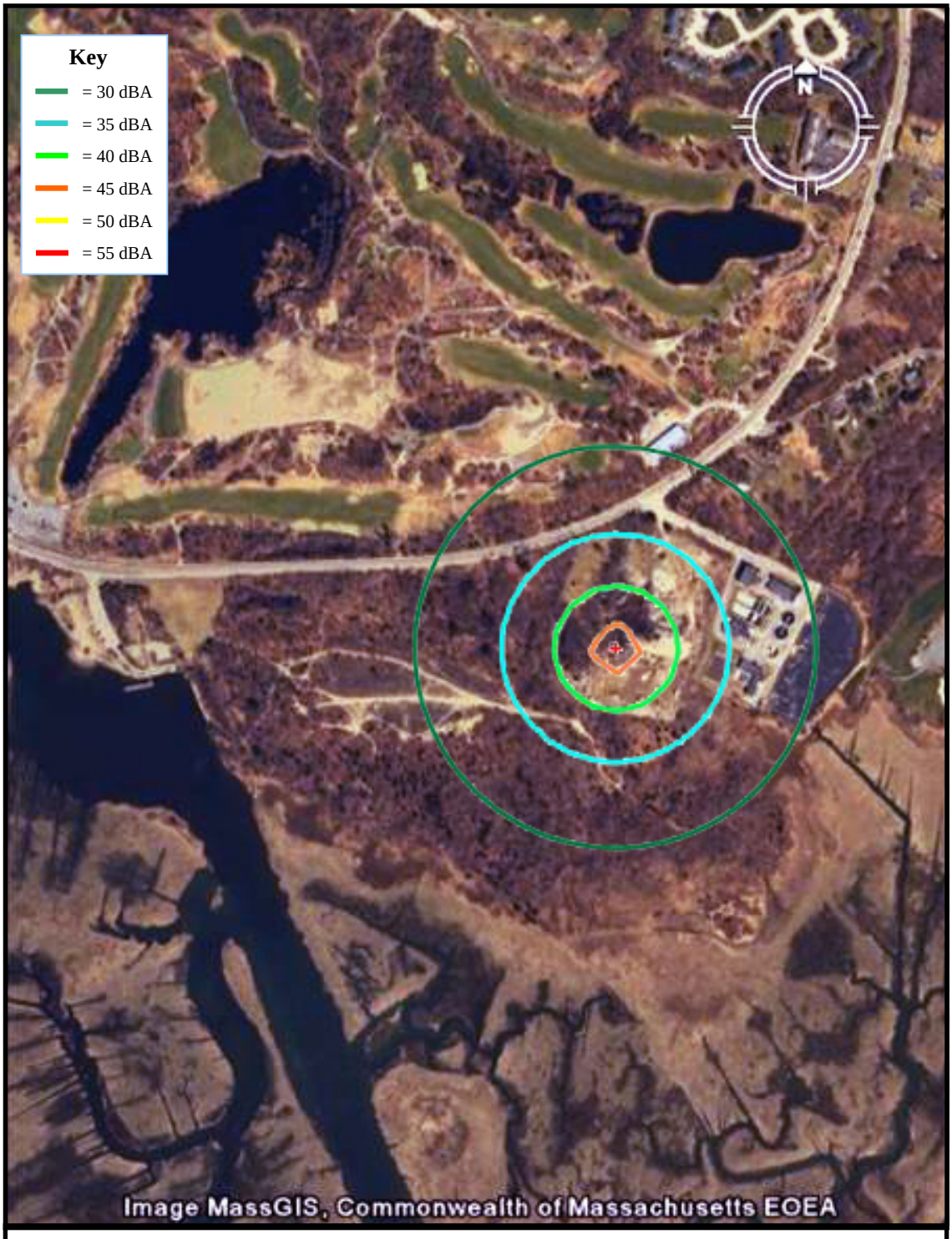

Figure 4.
Fuhrlander FL 600 Noise Contours - Location 1

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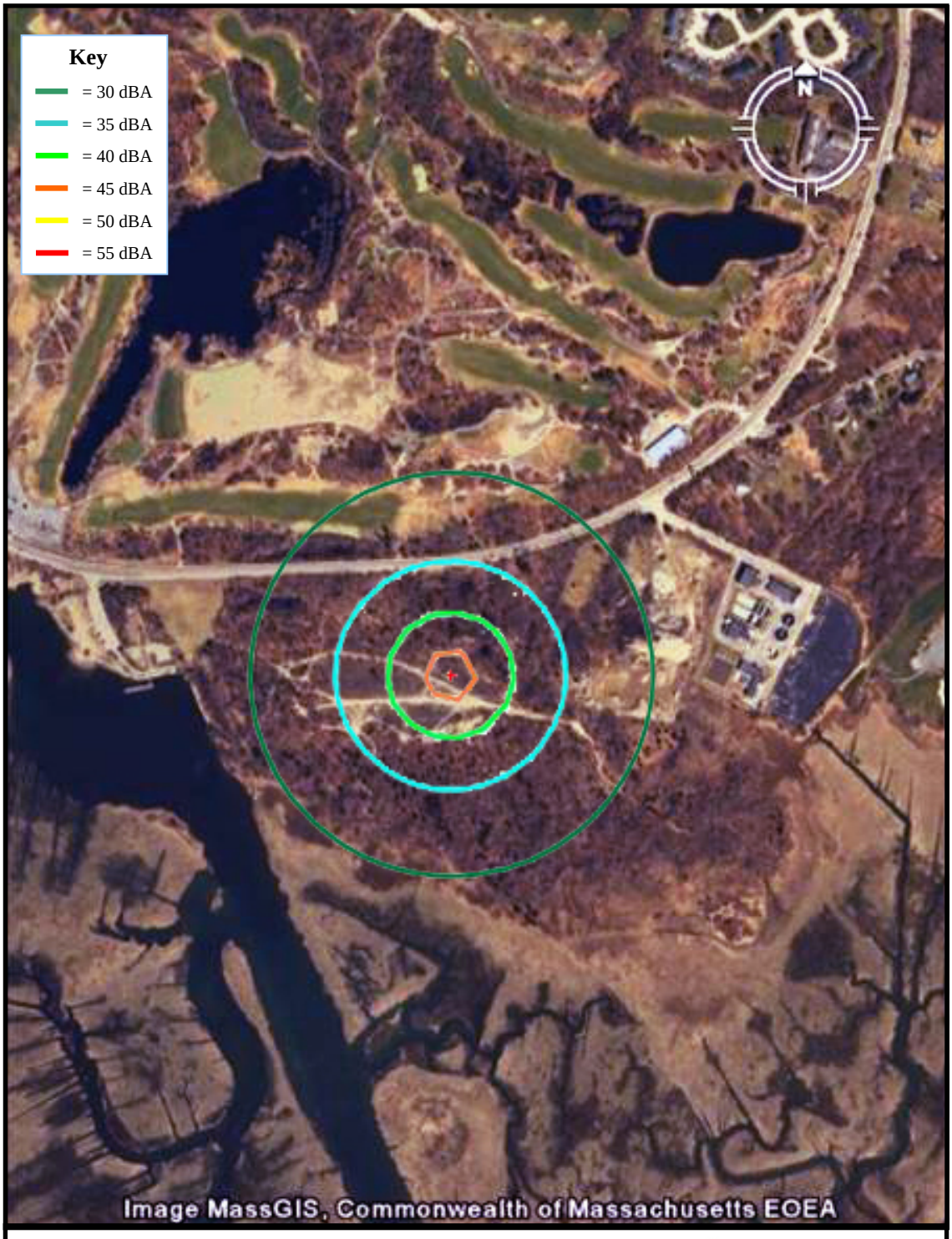

Figure 5.
Fuhrlander FL 600 Noise Contours -Location 2

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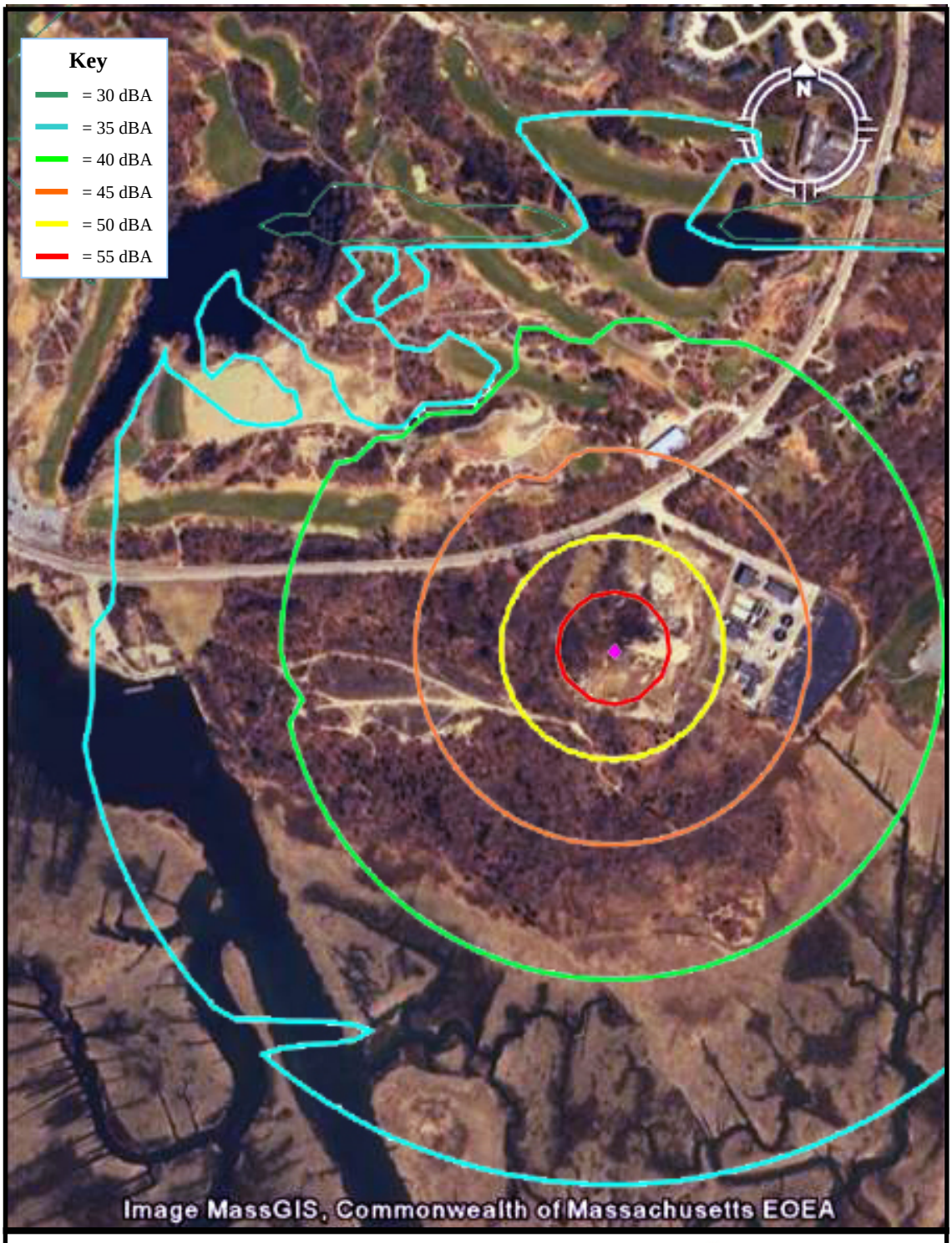

Figure 6.
Gamesa G87 Noise Contours - Location 1

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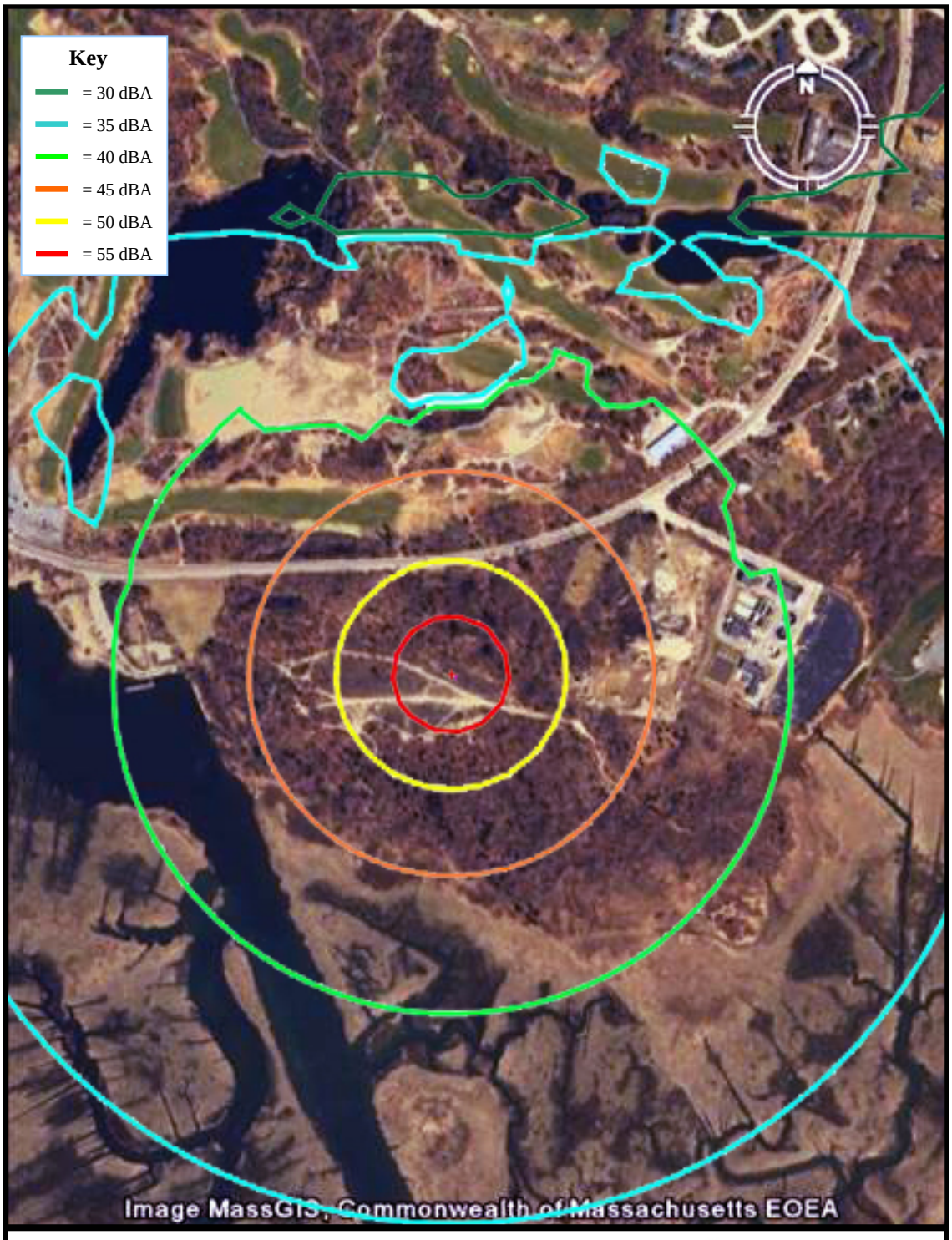

Figure 7.
Gamesa G87 Noise Contours - Location 2

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APPENDIX A

MASSACHUSETTS DEP NOISE POLICY

MADEP NOISE POLICY

Sound

Background

Sound 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 sound 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 sound source will be considered to be violating the Department's sound 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 sound sources, call the Board of Health for the municipality in which the sound source is located. To learn more about responding to sound, 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.

APPENDIX B

MEASURED SOUND LEVEL AND WIND DATA

APPENDIX B-1

MEASURED AMBIENT SOUND LEVELS AND MEASURED WIND SPEEDS NEAR SCITUATE WIND TURBINE SITES

Date	Starting-Time for Hour (EDT)	1-Hour L_{90} Sound Level (dBA)	Hourly Average Wind Speed at 63m Hub Height (m/s)
2/19/2008	***17:00***	***43***	***8.0***
2/19/2008	***18:00***	***43***	***7.7***
2/19/2008	***19:00***	***42***	***8.6***
2/19/2008	**20:00**	**39**	**5.5**
2/19/2008	21:00	39	2.3
2/19/2008	22:00	38	2.0
2/19/2008	**23:00**	**38**	**4.8**
2/20/2008	**0:00**	**38**	**7.3**
2/20/2008	**1:00**	**37**	**6.4**
2/20/2008	**2:00**	**36**	**6.5**
2/20/2008	**3:00**	**35**	**6.1**
2/20/2008	**4:00**	**36**	**5.2**
2/20/2008	**5:00**	**37**	**4.2**
2/20/2008	**6:00**	**40**	**5.0**
2/20/2008	**7:00**	**42**	**5.9**
2/20/2008	**8:00**	**47**	**6.9**
2/20/2008	**9:00**	**52**	**6.1**
2/20/2008	**10:00**	**46**	**6.2**
2/20/2008	**11:00**	**41**	**6.5**
2/20/2008	**12:00**	**43**	**7.0**
2/20/2008	***13:00***	***43***	***7.6***
2/20/2008	***14:00***	***43***	***7.8***
2/20/2008	**15:00**	**42**	**6.7**
2/20/2008	**16:00**	**42**	**5.1**
2/20/2008	17:00	41	3.1
2/20/2008	18:00	40	2.4
2/20/2008	19:00	39	3.7
2/20/2008	**20:00**	**39**	**4.1**
2/20/2008	21:00	38	3.1
2/20/2008	22:00	37	3.9
2/20/2008	23:00	36	3.5
2/21/2008	0:00	36	3.1
2/21/2008	1:00	36	3.1
2/21/2008	2:00	36	3.1
2/21/2008	3:00	36	3.0

Date	Starting-Time for Hour (EDT)	1-Hour L_{90} Sound Level (dBA)	Hourly Average Wind Speed at 63m Hub Height (m/s)
2/21/2008	4:00	36	3.5
2/21/2008	**5:00**	**36**	**4.3**
2/21/2008	6:00	44	2.4
2/21/2008	7:00	41	3.0
2/21/2008	**8:00**	**42**	**4.6**
2/21/2008	**9:00**	**42**	**6.3**
2/21/2008	**10:00**	**43**	**6.1**
2/21/2008	**11:00**	**42**	**5.7**
2/21/2008	**12:00**	**42**	**6.1**
2/21/2008	**13:00**	**41**	**6.0**
2/21/2008	**14:00**	**41**	**5.8**
2/21/2008	**15:00**	**40**	**5.1**
2/21/2008	**16:00**	**40**	**5.0**
2/21/2008	17:00	40	3.7
2/21/2008	18:00	39	2.6
2/21/2008	19:00	39	2.0
2/21/2008	20:00	39	2.3
2/21/2008	21:00	39	1.8
2/21/2008	22:00	39	1.5
2/21/2008	23:00	38	1.5
2/22/2008	0:00	38	1.7
2/22/2008	1:00	36	1.9
2/22/2008	2:00	35	2.2
2/22/2008	3:00	36	1.1
2/22/2008	4:00	36	1.0
2/22/2008	5:00	37	.4
2/22/2008	6:00	38	.4
2/22/2008	7:00	41	2.9
2/22/2008	8:00	42	2.3
2/22/2008	9:00	42	2.7
2/22/2008	**10:00**	**43**	**4.8**
2/22/2008	**11:00**	**43**	**6.1**

Note: Values in bold text correspond to hours when wind turbine would likely be operating (hub height wind speeds near or above 4 m/s

APPENDIX B-2

MEASURED SHORT TERM AMBIENT SOUND LEVELS AT LOCATIONS NEAR SCITUATE WIND TURBINE SITES

Scituate Sound Monitoring Notes – Scituate, MA – February 19, 2008

Daytime Measurements

LOCATION #1
Park at Driftway Pier

Run Start	**Run End**
2:30 PM	3:00 PM

WEATHER:			
Temperature	**Humidity**	**Wind**	**Sky**
45°F	36%	10-20 mph W/SW	Partly Cloudy

SOUND:

Source

- Wind (dominated sound environment)
- Cars on Driftway
- People walking through park
- Seagulls

RESULTS:			
L_{eq} (dBA)	**L_{90} (dBA)**	**L_{50} (dBA)**	**L_{10} (dBA)**
53.9	48	52	57

Scituate Sound Monitoring Notes – Scituate, MA – February 19, 2008
Daytime Measurements

LOCATION #2
Near Driftway (15 feet from the road)

Run Start	**Run End**
3:07 PM	3:37 PM

WEATHER:			
Temperature	**Humidity**	**Wind**	**Sky**
43°F	35%	5-20 mph W/SW	Partly Cloudy

SOUND:

Source

- Traffic on Driftway (light to moderate)
- Wind
- Trees in wind

RESULTS:			
L_{eq} (dBA)	**L_{90} (dBA)**	**L_{50} (dBA)**	**L_{10} (dBA)**
69.5	52	64	74

Scituate Sound Monitoring Notes – Scituate, MA – February 19, 2008

Daytime Measurements

LOCATION #3
Eastern property of WTF

Run Start	**Run End**
5:21 PM	5:51 PM

WEATHER:			
Temperature	**Humidity**	**Wind**	**Sky**
39°F	30%	6-15 mph W/SW	Partly Cloudy

SOUND:

Source

- Water treatment facility (aeration tanks)
- Wind
- Beach grass on golf course in wind
- Larger trucks on Driftway

RESULTS:			
L_{eq} (dBA)	**L_{90} (dBA)**	**L_{50} (dBA)**	**L_{10} (dBA)**
47	44	46	49

Scituate Sound Monitoring Notes – Scituate, MA – February 19, 2008
Nighttime Measurements

LOCATION #1
Park at Driftway Pier

Run Start	**Run End**
11:30 PM	12:00 AM

WEATHER:			
Temperature	**Humidity**	**Wind**	**Sky**
29°F	73%	10-25 mph W/SW	Snowing Heavily

SOUND:

Source

- Wind
- Trees in wind
- Traffic on Driftway
- Water hitting the shore

RESULTS:			
L_{eq} (dBA)	**L_{90} (dBA)**	**L_{50} (dBA)**	**L_{10} (dBA)**
41.7	32	38	45

Scituate Sound Monitoring Notes – Scituate, MA – February 19, 2008
Nighttime Measurements

LOCATION #2
Next to Driftway

Run Start	**Run End**
12:07 AM	12:37 AM

WEATHER:			
Temperature	**Humidity**	**Wind**	**Sky**
26°F	80%	5-20 mph W/SW	Partly Cloudy

SOUND:

Source

- Wind
- Trees in wind
- Traffic on Driftway (very light)

RESULTS:			
L_{eq} (dBA)	**L_{90} (dBA)**	**L_{50} (dBA)**	**L_{10} (dBA)**
51.9	29	40	50

Scituate Sound Monitoring Notes – Scituate, MA – February 19, 2008
Nighttime Measurements

LOCATION #3
Eastern property line of WTF

Run Start	**Run End**
1:15 AM	1:45 AM

WEATHER:			
Temperature	**Humidity**	**Wind**	**Sky**
24°F	66%	10-20 mph W/SW	Clear

SOUND:

Source

- Wind
- Water treatment facility
- Beach grass in wind
- Ducks

RESULTS:			
L_{eq} (dBA)	**L_{90} (dBA)**	**L_{50} (dBA)**	**L_{10} (dBA)**
42.4	40	41	44