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August 9, 2012

Ms. Sandra J. Paske
Secretary to the Commission
Public Service Commission of Wisconsin
P.O. Box 7854
Madison, WI 53707-7854

Dear Ms. Paske:

Application of Wisconsin Electric Power Company for a Certificate of Public Convenience and Necessity to Construct a Wind Electric Generation Facility and Associated Electric Facilities, to be known as the Glacier Hills Wind Park, Located in the towns of Randolph and Scott, Columbia County, Wisconsin
PSCW File 6630-CE-302

On January 22, 2010, the Commission issued its Final Decision approving the construction of a wind powered electric generating facility in Columbia County, known as the Glacier Hills Wind Park. In accordance with Condition 11 of the Order, the Company is submitting the post-construction noise study.

If you have any questions regarding this project, please contact Paul Farron at (414) 221-3958.

Very truly yours,

Roman A. Draba
Vice President, Regulatory Affairs and Policy

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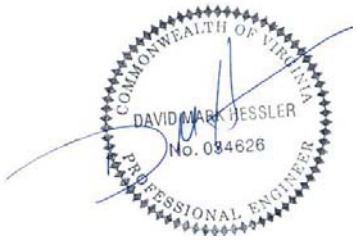
SURVEY OF OPERATIONAL SOUND LEVELS
GLACIER HILLS WIND PARK

COLUMBIA COUNTY, WI

PREPARED FOR:

We Energies



Prepared by:

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1.0 INTRODUCTION

Hessler Associates, Inc. has been retained by We Energies to conduct a field survey of the sound levels produced by the newly operational Glacier Hills Wind Park (GHWP) located in the towns of Scott and Randolph in Columbia County, Wisconsin. The principal objective of the study was to evaluate compliance with applicable State and local noise limits contained, respectively, in the Certificate of Public Convenience and Necessity (CPCN) and a Joint Development Agreement (JDA) with the Town of Scott. In general, both documents limit the project's sound emissions to 50 dBA at non-participating residences, although a more stringent limit of 45 dBA becomes effective if the sound is tonal or gives rise to a complaint at any particular residence.

The survey methodology followed "Operational Sound Level Survey Test Protocol" (2/2/12) approved in advance by the Wisconsin Public Service Commission (Appendix A), which was based on:

- The latest State guidelines for such a survey ("Measurement Protocol for Sound and Vibration Assessment of Proposed and Existing Electric Power Plants (Appendix B)
- The test procedures outlined in the Joint Development Agreement (JDA)
- Supplemental long-term measurements at 11 on-site and 4 off-site monitoring stations

The survey was conducted under what may be considered typical wintertime conditions over a three week period starting on February 8 and ending on March 1, 2012.

1.1 EXECUTIVE SUMMARY

An extensive field survey has been carried out to measure the sound levels produced by the Glacier Hill Wind Park in order to evaluate compliance with noise limits contained in the project's Certificate of Public Convenience and Necessity (CPCN) and the Joint Development Agreement (JDA) with the Town of Scott. The sound emissions from the project are essentially limited to 50 dBA by both agreements. A lower limit of 45 dBA would apply if the sound emissions were tonal in character or in the event of a complaint. At the time of the survey two noise complaints had been received and sound level monitoring stations were placed at those residences to evaluate compliance with the 45 dBA limit.

In accordance with the test protocol approved in advance by the Wisconsin Public Service Commission, several different measurement approaches were taken in order to follow the test procedures mandated in the JDA and in the latest version of the State's noise assessment protocol for electrical generating facilities. Short-term measurements were made at four principal design points, Sites 1 – 4, that were selected during the pre-construction background sound survey as locations with exposures to project noise replicating the exposure of the nearest non-participating residences. The essential results of these measurements relative to the applicable noise limits are briefly summarized in Table 1.1.1 and discussed in further detail below.

Table 1.1.1 *Summary of Measured Project-Only Sound Levels Relative to Applicable Noise Limits at Principal Design Points (Sites 1 through 4) Based on Revised PSC Test Protocol*

Measurement Location	Maximum Measured Project-Only Sound Levels, dBA	Tone Observed	Applicable CPCN and JDA Noise Limit	Compliance with Applicable Noise Limit
Site 1	40.5 - 42.6	No	50	Yes
Site 2	35.7 - 38.1	No	50	Yes
Site 3	39.9 - 40.6	Yes	45	Yes
Site 4	37.7 - 37.8	No	50	Yes

These short-term sampling procedures were supplemented with a long-term monitoring program designed to capture a wide variety of wind and weather conditions at a large sampling of the nearest non-participating residences, including the two complaint locations.

Local Joint Development Agreement

The first measurement approach dictated by the JDA was to measure the total sound level (both background and project sound) with the project operating at Sites 1 – 4 at four times of day (morning, midday, evening and nighttime) over three different days. These results, expressed in terms of the L90 sound level, are summarized in the following table. Measurements were taken during three different wind conditions on 2/8, 2/9 and 3/1.

Table 1.1.2 *Total Measured Sound Levels (L90, dBA) per JDA Test Procedure (Includes both Project and Background Noise)*

Site	Time of Day	Moderate Winds (2/8)	High Winds (2/9)	Light Winds (3/1)	Tone Observed
1	Morning	38.6	41.5	40.9	No
	Midday	36.9	45.7	32.9	No
	Evening	38.6	43.2	31.5	No
	Night	43.2	43.3	36.3	No
2	Morning	33.3	36.6	35.2	No
	Midday	31.1	37.7	26.4	No
	Evening	33.3	39.5	27.4	No
	Night	36.6	39.1	30.3	No
3	Morning	35.6	38.3	33.5	No
	Midday	32.3	41.4	30.3	No
	Evening	39.1	41.6	26.3	No
	Night	38.9	41.5*	24.3	*Tone observed at 160 Hz (2/9)
4	Morning	35	39	37.7	No
	Midday	38.1	41	33.3	No
	Evening	39.1	44.2	34.8	No
	Night	35.8	38.6	24.4	No

In general, these results indicate full compliance with the Town of Scott Joint Development Agreement limit of 50 dBA even without making any adjustment for background noise. In the single instance where a tone was observed the total sound level was well below (41.5 dBA) the more stringent 45 dBA limit that would apply under those circumstances.

State Public Service Commission Test Protocol

The second approach, deriving from the updated PSC test procedure, was to take measurements at Sites 1 – 4 at three different times of day measuring first the operational sound level and then, a short time later, the background level with all units within about a mile of each measurement positions temporarily shut down. The results for each site are summarized in the following tables.

Table 1.1.3 *Summary of Site 1 On-Off Measurements*

Sample Time and Ave. 80 m Wind Speed	Measure	A-weighted Sound Level, dBA		Nominal Project-Only Sound Level, dBA	C-weighted Sound Level, dBC	
		Project On	Project Off		Project On	Project Off
Midday 2:30 p.m. 9 m/s	Leq	49.7	49.2		66.5	66.4
	L10	52.2	52.7		69.1	70.8
	L50	48.5	47.3		64.1	62.7
	L90	45.7	42.8	**42.6**	61.5	57.9
Evening 7:20 p.m. 8.9 m/s	Leq	44.5	42.0		62.7	61.5
	L10	45.8	45.0		64.3	63.4
	L50	44.3	41.8		62.2	58.9
	L90	43.2	39.8	**40.5**	60.6	56.6
Night 11:30 p.m. 7.7 m/s	Leq	44.6	40.5		61.5	56.7
	L10	45.8	42.3		62.9	58.5
	L50	44.3	40.1		60.9	56.2
	L90	43.3	38.2	**41.7**	59.1	54.4

Table 1.1.4 *Summary of Site 2 On-Off Measurements*

Sample Time and Ave. 80 m Wind Speed	Measure	A-weighted Sound Level, dBA		Nominal Project-Only Sound Level, dBA	C-weighted Sound Level, dBC	
		Project On	Project Off		Project On	Project Off
Midday 1:50 p.m. 8.2 m/s	Leq	45.3	44.7		63.8	63.9
	L10	42.1	39.9		66.8	67.5
	L50	39.1	35.5		61.2	60.9
	L90	37.7	33.4	**35.7**	57.2	55.4
Evening 6:40 p.m. 9.6 m/s	Leq	42.4	38.6		65.3	62.8
	L10	42.8	37.7		68.1	66.4
	L50	40.7	35.5		61.4	58.3
	L90	39.5	33.8	**38.1**	57.5	52.9
Night 11:30 p.m. 7.7 m/s	Leq	40.5	35.0		64.7	62.6
	L10	41.7	36.8		68.2	66.0
	L50	40.3	34.5		61.4	58.8
	L90	39.1	32.8	**37.9**	57.0	52.5

Table 1.1.5 *Summary of Site 3 On-Off Measurements*

Sample Time and Ave. 80 m Wind Speed	Measure	A-weighted Sound Level, dBA		Nominal Project-Only Sound Level, dBA	C-weighted Sound Level, dBC	
		Project On	Project Off		Project On	Project Off
Midday 1:20 p.m. 8.9 m/s	Leq	43.1	42.1		65.3	65.8
	L10	44.5	43.7		68.2	69.2
	L50	42.9	38.6		62.7	62.6
	L90	41.4	36.1	**39.9**	60.2	58.2
Evening 6:00 p.m. 9.5 m/s	Leq	50.1	38.8		65.3	65.2
	L10	46.3	40.5		68.3	68.5
	L50	43.4	38.0		61.3	60.7
	L90	41.6	36.0	**40.2**	58.6	54.9
Night 11:30 p.m. 8.0 m/s	Leq	43.2	38.1		64.4	60.6
	L10	44.6	39.6		67.6	63.9
	L50	42.9	36.2		60.8	56.8
	L90	41.5	34.1	**40.6**	57.5	53.6

Table 1.1.6 *Summary of Site 4 On-Off Measurements*

Sample Time and Ave. 80 m Wind Speed	Measure	A-weighted Sound Level, dBA		Nominal Project-Only Sound Level, dBA	C-weighted Sound Level, dBC	
		Project On	Project Off		Project On	Project Off
Midday 12:40 p.m. 8.3 m/s	Leq	47.4	47.3		65.5	65.5
	L10	50.8	51.5		68.5	69.8
	L50	45.2	43.7		62.0	61.7
	L90	41.0	38.3	**37.7**	57.9	55.1
Evening 5:20 p.m. 11.8 m/s	Leq	51.1	49.1		68.5	64.8
	L10	54.6	52.4		71.8	68.3
	L50	49.3	46.9		66.5	62.2
	L90	44.2	43.1	**37.7**	61.2	57.1
Night 9:40 p.m. 8.8 m/s	Leq	45.8	41.6		59.2	54.1
	L10	49.7	44.5		61.0	57.7
	L50	42.2	33.3		57.7	50.7
	L90	38.6	30.7	**37.8**	55.4	47.1

These results indicate that the L90 sound level, the best indicator of project sound exclusive of contamination from both audible noise events and microphone self-noise, was well below 50 dBA at all positions after correction for background noise. At Site 3 a mild tone was detected during the nighttime measurement (only) but, as mentioned above, the overall sound level was well below the more stringent 45 dBA limit that would apply.

Long-term Measurements

As a supplement to these two short-term measurement approaches, long-term monitors were set-up at or near 10 non-participating residences with maximum proximity/exposure to project noise and at the nearest participating residence. A total of over 2400 10 minute samples were taken on a

continuous day and night basis over a 17 day period at each of the monitoring stations. The survey was carried out from February 8 to February 25, 2012 during wintertime conditions. A number of high wind periods, wind directions and atmospheric conditions were captured during the survey. Essentially all of the turbines were in normal operation during the survey.

Four positions were set-up off the site in the four cardinal directions to develop a time history of the approximate background level that was likely occurring on the site in the area surrounded by these monitors at any given time during the survey. This approximate background level was then subtracted from the total levels measured at the on-site locations to derive the *apparent* project-only sound level. It is very important to note that this technique tends to yield highly conservative results and overestimate the project sound level because any sound level measured at an on-site receptor that is 3 dBA higher than the approximate background level is assumed to be attributable to the project. Consequently, unrelated but sustained noise from such things as nearby trees rustling in the wind, planes flying over, farm activity, etc. can be easily misconstrued as project noise. Thus the results from this approach must be considered the maximum sound level that could *possibly* have been generated by the project but any given noise peak cannot be conclusively attributed to the project.

The specific results for the 11 on-site receptor locations are tabulated below. The measured performance relative to the fundamental limit of 50 dBA is expressed in terms of the percentage of the time the *apparent* project sound level was below that limit. In accordance with the test protocol, a value of 95% or greater is considered compliant. The compliance rate with the more stringent limit of 45 dBA, which applies in cases where a noise complaint has been lodged, is also given for reference wherever a reasonably credible result could be obtained. As discussed above, any significant source of local background noise can easily skew the results or make it impossible to quantify the project-only sound level because the signal (project) to noise (background) ratio is too low. In general, the closer the threshold level gets to the normal background level the harder it is to clearly detect the project. Consequently, a reliable or meaningful result could not be obtained with respect to the relatively low 45 dBA criterion in all cases.

Table 1.1.7 *Summary of Long-Term Results at On-Site Receptor Positions*

Measurement Position	Apparent Compliance Rate with Basic Limit of 50 dBA	Apparent Compliance Rate with Secondary Limit of 45 dBA	Comments	Overall Compliance with Applicable Limit
1	**>97.6%**	Project sound level undetectable	Local sound levels dominated by traffic noise	Yes
2	**>99.5%**	Project sound level undetectable	Local sound levels dominated by traffic noise	Yes
3	**100%**	100%		Yes
4	**99.1%**	Project sound level not clearly discernible	Local sound levels dominated by tree rustle	Yes
5	100%	**99.9%**	Complaint received but in compliance with 45 dBA limit	Yes
6	100%	**100%**	Complaint received but in compliance with 45 dBA limit	Yes
7	**100%**	98.5%		Yes
8	**100%**	99.9%		Yes
9	**100%**	94.7%	Result possibly elevated due to local tree rustle noise	Yes
10	**99.3%**	Project sound level not clearly discernible	Local sound levels often dominated by unidentified man-made noise	Yes
11	**>99.5%**	n/a Participating Residence	Local sound levels dominated by traffic noise	Yes

Since the apparent project sound level, probably including at least some background interference, was found to be lower than the 50 dBA limit more than 95% of the time in all cases it can be concluded that the project is in compliance with the basic State and local noise requirements. In the two instances where noise complaints were known to have been received prior to the survey, at Positions 5 and 6, the measured levels were, conservatively, found to be compliant with the more stringent 45 dBA sound level.

2.0 SURVEY METHODOLOGY

2.1 GENERAL APPROACH

The principal technical challenge in carrying out such a survey centers around separating the project-only sound level, due exclusively to the turbines, from the concurrent background noise level associated with such things as trees rustling, cars passing by, planes flying over, etc. At typical setback distances project and non-project sound levels are often of similar magnitudes, meaning that the total measured sound level is strongly influenced by both sources and cannot be simply taken at face value as being entirely due to the project.

The quantity sought in this study is the project-only sound level since that is the value limited by the applicable noise limits. Under most circumstances the background sound level is too high to directly measure project-only noise and the only practical way of determining the project's actual sound level is to measure the total sound; measure, estimate, or otherwise deduce the background level occurring under identical wind and atmospheric conditions; and then subtract the background level from the total to derive the project-only level.

For this survey the total sound level was measured day and night over a 17 day period by continuously recording sound level monitors at 11 points of interest within the site area and the background level was measured by 4 additional monitors located outside of the site area in the four cardinal directions. By averaging the sound levels at these four diametrically opposed locations a continuous record of the likely background level within the site area was created allowing all of the on-site measurements to be corrected for background contamination.

Background levels were also determined on a short-term, spot sampling basis on a moderately windy day by temporarily shutting down all the units within several miles of 4 pre-determined measurement sites distributed throughout the project area. The sound levels measured during these shutdown periods were used in conjunction with operational sound levels measured under identical conditions a few minutes earlier to derive the project-only sound level.

2.2 SITE DESCRIPTION AND MEASUREMENT POSITIONS

The Glacier Hills Wind Park consists of 90 Vestas V90-1.8 MW wind turbines, each with an 90 m three-bladed rotor on an 80 m tubular tower. The turbines are distributed groups of various sizes somewhat irregularly over a project area that is very roughly 9 miles east to west and about 4 miles north to south. The site area is rural in nature and consists primarily of open farmland and low density residential development, which is distributed fairly uniformly over the project area. The topography is generally flat with a few rolling hills of only moderate height. There are no substantially sheltered valleys or homes, however, and turbines are usually visible in several directions from any given residence.

Graphics A and B are maps of the project area showing the turbines, residences and the sound measurement positions, which are individually described below.

2.2.1 *Off-Site Background Positions*

Graphic A is an overview of the project area and its surroundings that shows the off-site background monitoring positions used in the long-term study: Positions NB, EB, WB, and SB - for North Background, East Background, etc. Each of these positions is between 1.5 and 2.5 miles from the nearest turbine and/or the project perimeter. These locations were chosen to be far enough away so that no significant project noise would be detected and close enough so that the measured sound levels would be representative of the site area. All four positions are in fairly quiet settings away from any major roads or other sources of unusual background noise.

North Background (NB) – [0332086,4833529][i]
Monitor NB was located at a farm house on Jones Road (1400 ft. north of N County Line Road) approximately 1.5 miles north of T55. This location is completely isolated from any significant traffic noise, since Jones Road is essentially a driveway to the residence and even N County Line Road is lightly traveled.

Figure 2.2.1.1 *Monitor NB Looking S down Jones Road towards Project*

[i] Monitor location coordinates in meters with reference to UTM NAD83, typical.

East Background (EB) – [0339167,4827339]
Monitor EB was attached to a tree in a remote area along Canada Island Road (a lightly traveled tertiary road) about 1000 ft. NW of a farm at W11826 Canada Island Road. This position is 2 miles east of the project perimeter.

Figure 2.2.1.2 *Monitor EB (on tree in R Ctr) Looking NW up Canada Island Road*

West Background (WB) – [0318996,4828224]
Monitor WB was attached to a utility pole on the north side of Barden Road a short distance west of a house at W4905. This position is 1.9 miles from T70, the westernmost unit in the project, in a location that is sheltered from any noise from Highway 41, about ¾ mile to the east, by the intervening terrain and woods.

Figure 2.2.1.3 *Monitor WB Looking E towards Project*

South Background (SB) – [0326476,4820417]
Monitor SB was attached to a utility pole on the west side of Welsh Prairie Road about 600 ft. north of its intersection with Old B Road. This location is remote from any main roads and is 3 miles south of the southern project perimeter.

Figure 2.2.1.4 *Monitor SB Looking S towards Welsh Prairie School (at Intersection of Welsh Prairie and Old B Roads)*

2.2.2 *Short-Term Measurement Positions, Sites 1 – 4*

Sites 1 through 4 are the measurement locations used during the pre-construction, background sound level survey carried out in 2008. In accordance with the Test Protocol, all short-term manned samples were taken at these positions. These locations, which are shown in Graphic B, were originally selected to uniformly cover the site area and represent settings typical of residences with maximum exposure to project noise relative to the site plan at the time of the 2008 survey. Although changes have occurred in the turbine layout, these positions are still representative of typical residential exposure distances; however, one position (Site 3) is now considerably within the minimum 1250 ft. setback distance (at only 910 ft.) and can be considered a highly conservative assessment point.

Site 1 – N8103 E. Friesland Road – [0334674,4826693]
Site 1 is at a currently unoccupied house on west side of E. Friesland Road in the center of very large group of turbines. Because of this location's proximity to numerous turbines and the expectation of fairly high sound levels, this property was purchased by the project. Measurements were taken in the driveway of the house about 30 ft. back from E. Friesland Road. As is typical with most residences in the area, there are a number of large trees immediately around the house, which were quite audible during windy conditions. The United Wisconsin Grain Producers ethanol plant is 3700 ft. west of this location and was audible at times.

Site 2 – County Road M – [0330290,4827947]
Site 2 is in an open field in the midst of another large group of turbines. The specific position was at a turn out on the east side of CR M 1300 ft. south of its intersection with Friesland Road. This location is essentially at the minimum setback distance (to residences) of 1250 ft. from the nearest unit (T42).

Figure 2.2.2.1 *Site 2 Looking SE*

Site 3 – Inglehart Road – [0328314,4830344]
Site 3 was in an open area just off the east side Inglehart Road about 1000 ft. south of its intersection with CR E. The nearest turbine (T50) visible in Figure 2.2.2.2 below was 278 m (910 ft.) away, which is considerably closer than the project's minimum setback distance to residences of 1250 ft. Unit T49 is only slightly further away to SW.

Figure 2.2.2.2 *Site 3 Looking SE towards T50 and T135*

Site 4 – Larson Road – [0323353,4826363]
Site 4, on the west side of Larson Road, is only 370 ft. south of State Hwy 33, which is a very busy main road that transects the project area. In 2008 this location was selected because there were a number of residences along Hwy 33 in this area in close proximity to a numerous turbines. Some of these units were eliminated or relocated since that time, although there is large group to the south of Site 4. The nearest unit (T3) is fairly close at 400 m (1310 ft.) away; however, traffic noise from Hwy 33 is the dominant feature at this position.

Figure 2.2.2.3 *Site 4 Looking SW*

2.2.3 *Long-Term Monitor Positions 1 - 11*

In order to supplement the four principal measurement sites described above and take measurements at or near residences with maximum exposure to the as-built project layout, 11 additional monitoring stations were set up to record sound levels day and night on a continuous basis over a 17 day period – thereby capturing a comprehensive variety of wind and weather conditions. These positions represent the 10 closest non-participating residences and single closest participating residence at Position 11.

Position 1 – N7902 E. Friesland Road – [0334741, 4825859]
Monitor 1 was located in the backyard of the house on the corner of Hwy 33 and E. Friesland Road. The monitor was 130 ft. from centerline of Hwy 33 and largely dominated by traffic noise.

Figure 2.2.3.1a *Monitor 1 Looking SW towards House and Intersection of E. Friesland Road and Hwy 33*

Figure 2.2.3.1b *Monitor 1 Looking W towards Ethanol Plant*

Position 2 – Near N7755 Krueger Road – [0333888, 4825449]
Monitor 2 was located on a utility pole 600 ft. north of a non-participating residence on Krueger Road (permission could not be obtained to measure at the house itself). This location is approximately 1080 ft. south of Hwy 33 and also very strongly affected by traffic noise.

Figure 2.2.3.2 *Monitor 2 Looking S towards Nearest House on Kreuger Road*

Position 3 – Near W1819 County Road E – [0330882, 4830731]
Monitor 3 was located on a utility pole near a railroad crossing on County Highway E. There are several non-participating properties in this immediate area that are not too far from turbines.

Figure 2.2.3.3 *Monitor 3 Looking SE towards T96*

Position 4 – W2182 Friesland Road – [0329571, 4828306]
Monitor 4 was located on a tree in front of a non-participating residence on Friesland Road about ½ mile NW of manned measurement Site 2. There are a number of turbines to the south of this position. Two meters were initially set up simply for redundancy but one was moved on the 14th day of the survey (2/22) to Position 11.

Figure 2.2.3.4 *Monitor 4 Looking NW*

Position 5 – 9093 N County Road E – [0327825, 4830829]
Monitor 5 was set up in the front yard of a non-participating home, which is at the minimum set back distance of 1250 ft. from T48. Somewhat unusually for the area, the house is surrounded by woods. This position is 2200 ft. NW of manned measurement Site 3.

Figure 2.2.3.5 *Monitor 5 Looking W*

Position 6 – W2741 County Road E – [0327295,4831207]
Monitor 6 was set up adjacent to a non-participating residence on County Road E that is about 404 m (1325 ft.) N of T47 and several other units. As illustrated in Figure 2.2.3.6, the meter was located at the edge of an open field along with an anemometer to measure wind speed at microphone height (1 m).

Figure 2.2.3.6 *Anemometer and Monitor 6 Looking W*

Position 7 – N8448 Larson Road – [0323641, 4828355]
Monitor 7 was set up at a non-participating farm house on Larson Road that is just west of a group of 6 units.

Figure 2.2.3.7 *Monitor 7 Looking W towards House*

Position 8 – Near 4115 Crown Road (Cambria) – [0321948, 4827363]
Monitor 8 was located in an open field on the north side of Crown Road opposite a group of non-participating residences. The instrument was 358 m (1175 ft.) south of the nearest turbine (T71) and several hundred feet closer than the houses themselves.

Figure 2.2.3.8 *Monitor 8 Looking SE towards Crown Road and Houses Beyond*

Position 9 – Near N7665 Larson Road – [0323323, 4825150]
Monitor 9 was located on a utility pole just north of a group of non-participating homes near the junction of Larson and Vaughn Roads that are roughly at the minimum setback distance of 1250 ft. The monitor itself was 338 m (1110 ft.) south of the nearest turbine (T14).

Figure 2.2.3.9a *Monitor 9 Looking SW towards Nearest Farm*

Figure 2.2.3.9b *Monitor 9 Looking NW towards T14 (1110 ft. Away)*

Position 10 – W2663 Vaughn Road – [0327497, 4824810]
Monitor 10 was set up in the yard of a non-participating house on Vaughn Road a short distance south of several units. An anemometer was also installed at this location on the southern edge of the project area.

Figure 2.2.3.10 *Monitor 10 Looking W towards House*

Position 11 – W638 E. Friesland Road – [0335740, 4825463]
Monitor 11 was attached to a tree in the front yard of the nearest participating house to any turbine. This monitor only operated at this location for last three days of the survey from 2/22 to 2/25.

2.3 INSTRUMENTATION AND MEASUREMENT TECHNIQUE

Rion NL Series sound level meters (NL-21, and NL-22) ANSI Type 1 and 2 (respectively) sound level meters were used at 13 of the 15 total positions and Norsonic 140, ANSI Type 1 precision, 1/3 octave band analyzers was used at Position NB and at Position 5 as a supplemental frequency analyzer. Each meter was enclosed in a watertight case and either fitted with a 12" lateral microphone boom or supported on a temporary post with the microphone at the top.

The microphones were protected from wind-induced self-noise by oversized 180 mm (7 in.) diameter weather-treated windscreens (ACO Model WS7-80T) and were situated at a fairly low elevation of about 1 m above grade to minimize their exposure to wind. Wind speed normally diminishes rapidly close to the ground, theoretically going to zero at the surface. At a height of 1 m the wind speed is typically low – in the 3 to 4 m/s range - even during periods of fairly high wind. Wind tunnel experiments[1] for this type of windscreen demonstrate that self-generated wind noise affects only the lower frequencies and, except in extremely high wind conditions, has little or no influence on the measured A-weighted level (the principal quantity sought in the survey). The wind speed at microphone height was measured during the survey using two Rainwise WindLog™ anemometers and will be used to apply any necessary correction to the measured results per Ref. 2.

All equipment was field calibrated at the beginning of the survey and again at the end of the survey. The observed calibration drift of all the instruments was less than +/- 0.4 dB.

A number of statistical sound levels were measured in consecutive 10 minute intervals over the entire survey. Of these, the residual, or L90, level (the sound level exceeded 90% of the time) is the most meaningful quantity for this type of survey[2] because it captures the consistently present sound level that existed during each 10 minute period in the absence of sporadic and extraneous noise events, such as cars passing by or dogs barking. Other measures, such as the Leq, or average sound level, would be strongly affected by these contaminating noises and the survey results would be clouded by numerous irrelevant noise spikes, whereas the L90 acts to filter out contamination and provides a much clearer picture of what actually occurred.

2.4 SURVEY WEATHER CONDITIONS

A comprehensive variety of winter weather conditions occurred during the survey period including several periods of very high wind and a wide array of wind directions and temperatures. During the manned measurements, which occurred on Feb. 8 – 10 and on Mar. 1, a full range of wind speeds occurred from right around cut-in to sustained speeds of over 16 m/s (36 mph), with much higher gusts. A sudden storm front passed over the site on the morning of Feb. 10 bringing high winds and blizzard conditions. Light or moderate snow was reported on about half of the other days during the monitoring survey but there was no liquid precipitation. The basic weather parameters during the survey period as observed in Juneau, roughly 20 miles to the southeast, are shown below for general reference.

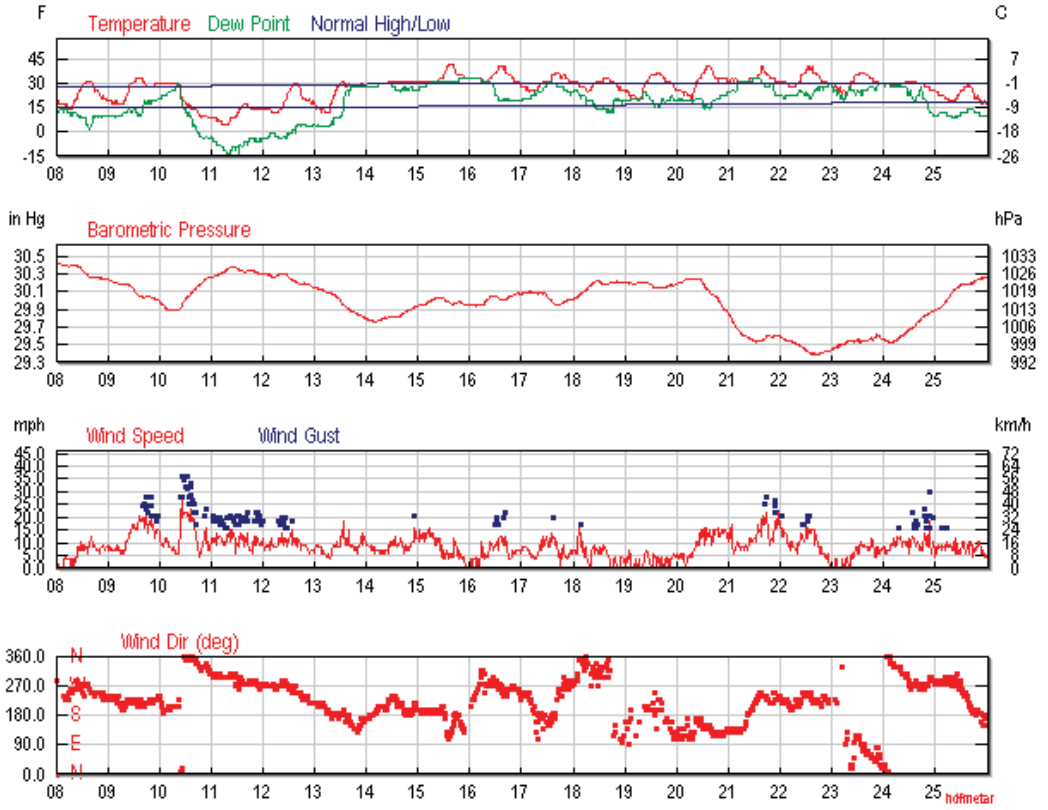


Figure 2.4.1 *General Survey Weather Conditions as Observed in Juneau, WI.*

The specific wind conditions at the site itself were measured by the turbine nacelle anemometers at a height of 80 m above ground level and by additional weather stations set up at microphone height, or 1 m above grade, at Positions 6 in the northern part of the site and 10 in the southern part. The hub height wind speed recorded by the four turbines closest to Sites 1 – 4, and therefore

evenly distributed over the site area, are shown below. The similarity in speeds at these dispersed points, some miles from each other, suggests that the wind conditions at any given time were essentially uniform over the project area.

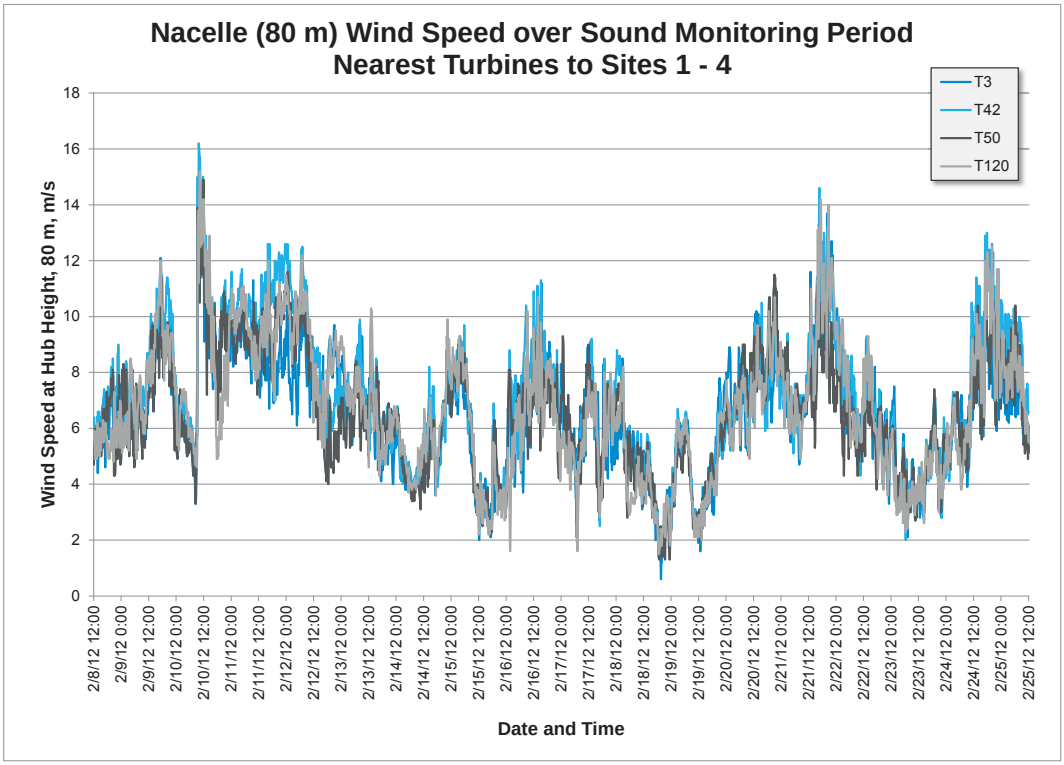


Figure 2.4.2

The wind speed at 1 m above grade (microphone height) is plotted below.

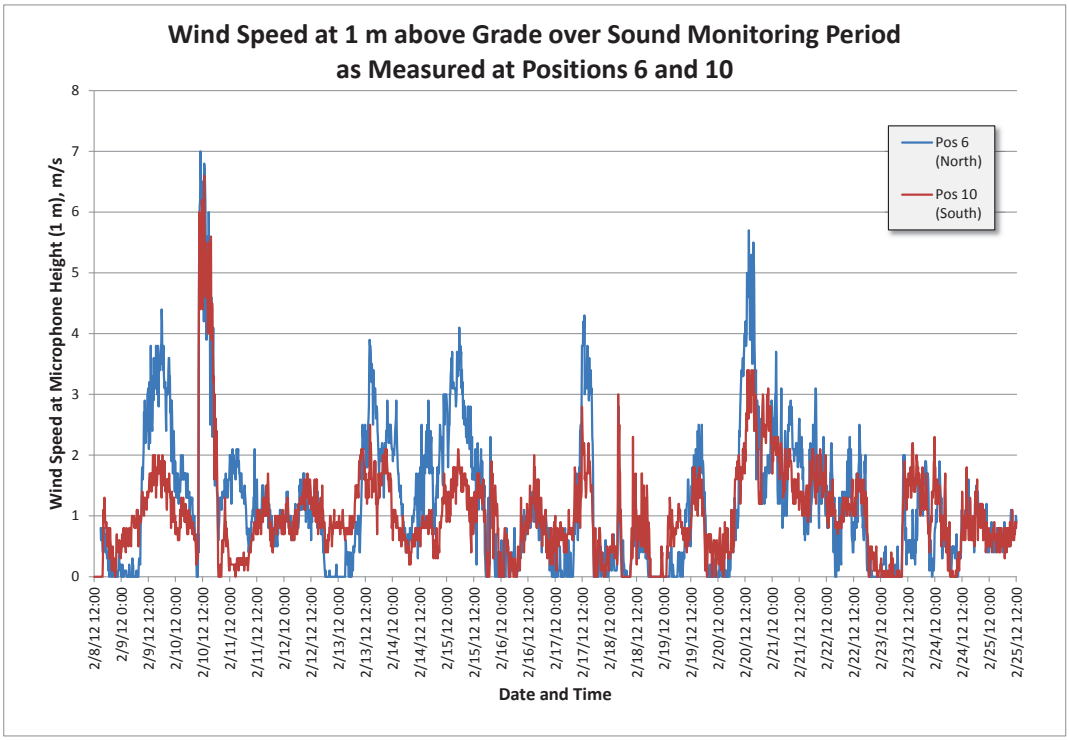


Figure 2.4.3

This figure shows that the wind speed at microphone height was relatively low - generally below 3 m/s and only rarely exceeding 4 m/s.

Wind direction, as measured by the Position 10 weather station, is plotted below.

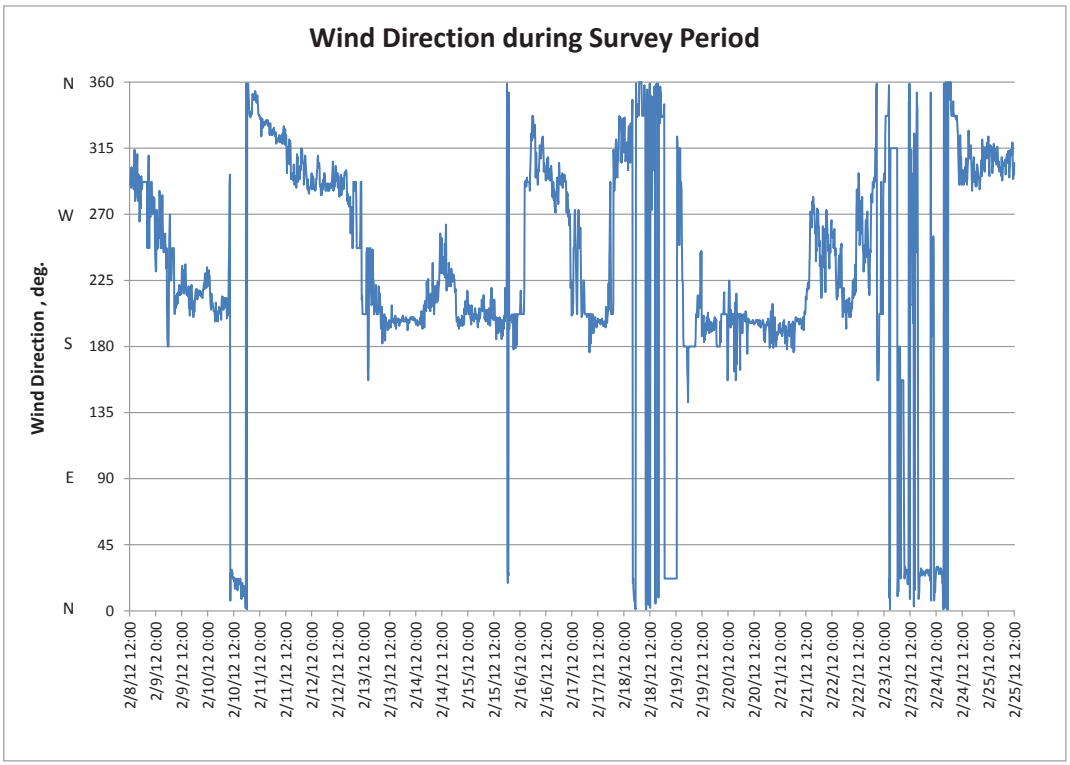


Figure 2.4.4

3.0 SURVEY RESULTS

3.1 APPLICABLE NOISE LIMITS

Sound emissions from the project are limited by the Certificate of Public Convenience and Necessity (CPCN) Order (Sections 10 and 11) and by the terms of the Joint Development Agreement (JDA) with the Town of Scott (Section 13). Both documents are fundamentally the same in intent and limit project noise to 50 dBA at adjacent non-participating residences or other potentially sensitive receptors.

A provision in the CPCN lowers the permissible nighttime (10 p.m. to 6 a.m.) sound level to 45 dBA during the warmer months of the year (April 1 to September 30 only) if a complaint about nighttime noise is received at a particular receptor. To our knowledge, complaints have been received from two non-participating residences and sound monitors were set up at both properties to evaluate compliance with the lower 45 dBA limit (Positions 5 and 6).

The agreement with the town also lowers the permissible sound level to 45 dBA if the project produces a prominent pure tone per the definition in Section 3.2.26 of EPA Report 550/9-76-003, which evaluates tones in terms of the prominence of a single 1/3 octave band above the average level of the two adjacent bands. More specifically, a prominent pure tone would be said to exist if the band containing the tone is higher than the average of the adjacent bands by the following frequency dependent amounts:

15 dB for frequencies lower than or equal to 125 Hz
8 dB for frequencies between 160 and 400 Hz, inclusive
5 dB for frequencies equal to or above 500 Hz

The local agreement generally follows the WPSC test protocol, before it was revised in May of 2010, by specifying that the measurements shall be taken as 10 minute L90 samples at 4 different times of the day (early morning, mid-day, early evening and night).

The town agreement requires three cycles of measurements, or 12 samples at each location, over three, not necessarily consecutive days, with the project operating. It is important to note that these measurements record the *total* sound level due to both the project and background noise and cannot be interpreted simply as the project sound level.

The revised State test protocol takes background noise into account by essentially requiring measurements at three different times of day with the project idle and with it operating, ideally under similar wind and weather conditions. This was accomplished in this survey measuring the project-on level at each of the four principal measurements sites and then repeating the measurement about 20 minutes later with all turbines within several miles of the measurement position temporarily shut down. Thus comparable conditions were obtained for both the on and off measurements.

3.2 SHORT-TERM MEASUREMENTS – TOTAL SOUND LEVEL

In accordance with the Joint Development Agreement, 10 minute samples were made at the four principal measurement locations, Sites 1 – 4, during the following four general time windows:

- Morning, 6 a.m. to 8 a.m.
- Afternoon, 12 noon to 2 p.m.
- Evening, 6 p.m. to 8 p.m.
- Night, 10 p.m. to 12 midnight

This cycle was repeated three times during the period from Feb. 8 to Feb. 10 and concluding on Mar. 1. The wind conditions over this period systematically covered a full range of wind speeds as illustrated in the following figure, which shows the nacelle wind speeds of the turbines closest to each measurement site and the times during which manned samples were taken.

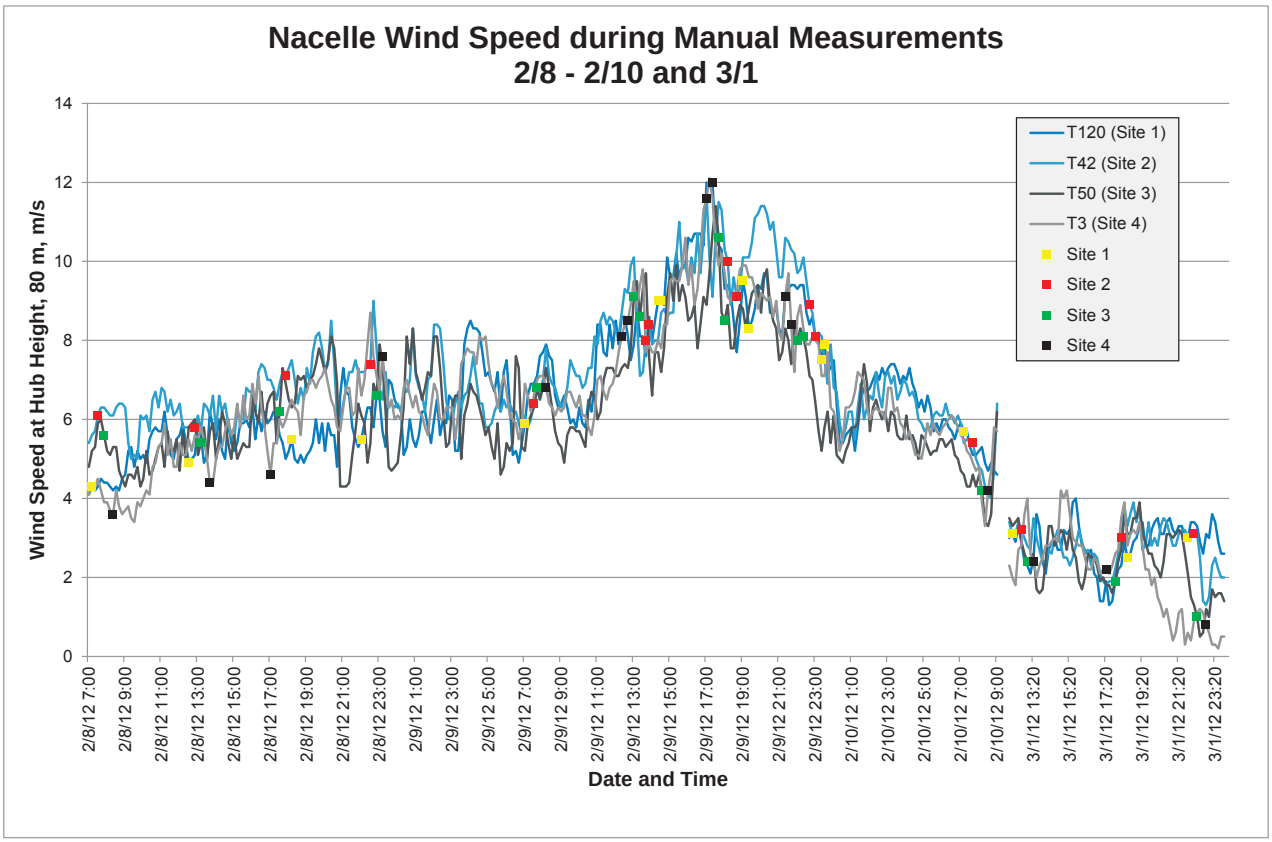


Figure 3.2.1

For simplicity, the measurements on Feb. 8 can be grouped together as representing moderate wind conditions, Feb. 9 high winds, and Mar. 1 light winds. The specific results for each position on each of these days are given in **Appendix A** in the form of a chart summarizing the frequency content of the A-weighted L90 measurements (to evaluate the potential presence of tones).

In all cases, the total, as-measured levels, without any correction for background, were found to be substantially less than the permissible limit of 50 dBA.

Most of the time the total sound level was in the 30's dBA and the maximum level measured at any position at any time was 45.7 dBA. In general, the frequency content was found to be free of any significant tones. Only one prominent tone was observed once at one position - or in 1 out of 36 samples over a wide range of conditions. The overall results are summarized graphically in Figure 3.2.2 and numerically in Table 3.2.1.

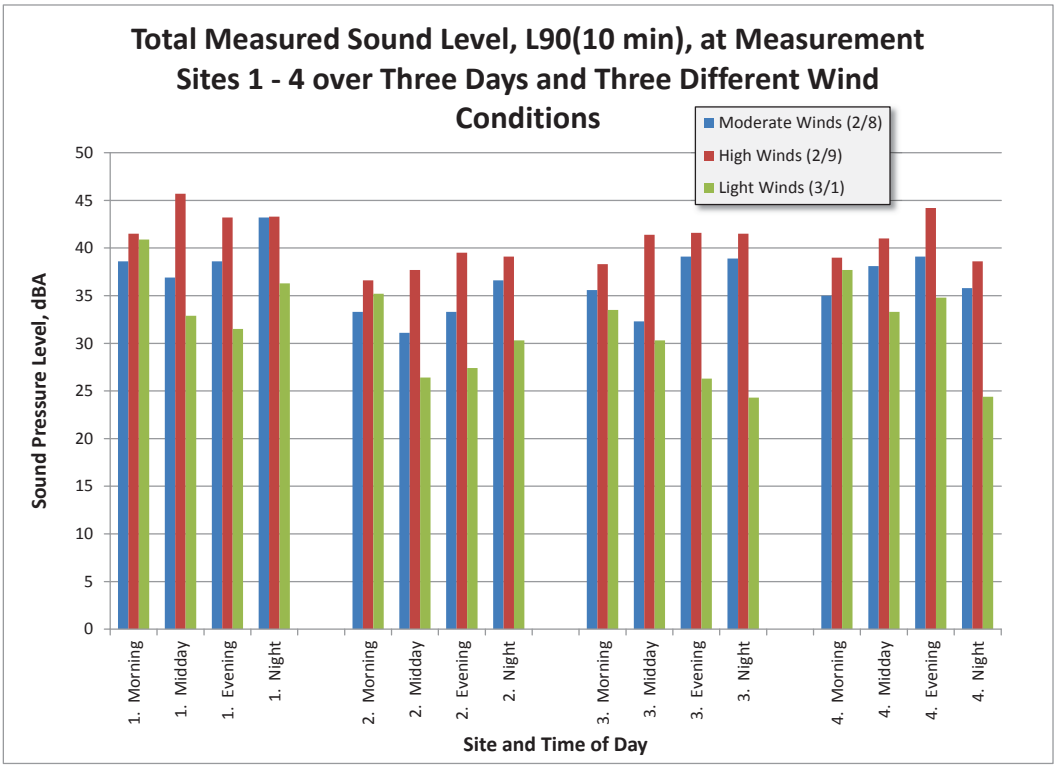


Figure 3.2.2

Table 3.2.1 *Summary of Short-term Samples, L90, dBA*

Site	Time of Day	Moderate Winds (2/8)	High Winds (2/9)	Light Winds (3/1)	Tone Observed
1	Morning	38.6	41.5	40.9	No
	Midday	36.9	45.7	32.9	No
	Evening	38.6	43.2	31.5	No
	Night	43.2	43.3	36.3	No
2	Morning	33.3	36.6	35.2	No
	Midday	31.1	37.7	26.4	No
	Evening	33.3	39.5	27.4	No
	Night	36.6	39.1	30.3	No
3	Morning	35.6	38.3	33.5	No
	Midday	32.3	41.4	30.3	No
	Evening	39.1	41.6	26.3	No
	Night	38.9	41.5*	24.3	*Tone observed at 160 Hz (2/9)
4	Morning	35	39	37.7	No
	Midday	38.1	41	33.3	No
	Evening	39.1	44.2	34.8	No
	Night	35.8	38.6	24.4	No

In general, these results indicate full compliance with the Town of Scott Joint Development Agreement limit of 50 dBA even without making any adjustment for background noise. In the

single instance where a tone was observed the total sound level was well below the more stringent 45 dBA limit that would apply under those circumstances.

3.3 SHORT-TERM MEASUREMENTS – ON-OFF SOUND LEVELS

In accordance with the latest sound assessment guidelines from the Wisconsin Public Service Commission (May 2010) a special series of measurements were made at the four principal measurement sites to evaluate the sound emissions due solely to the project by measuring both the operational sound level and the background level a few minutes later with all turbines within about 1 mile of the measurement point shutdown. This was done at three different times of day (midday, evening and night) on February 9th, which was one of the windier days of the survey. The results are given below for each position and include all of the required statistical measures (Leq, L10, L50 and L90) in terms of both their A and C-weighted overall values.

It is important to note, however, that all of these 8 measures except for the A-weighted L90 value do not capture the more or less steady project sound level in a meaningful or accurate way because there is an overwhelming tendency for these measures to be strongly affected (and elevated) by contaminating noise events, wind-driven microphone distortion or both. The effect of contamination on the A-weighted Leq and L10 levels is shown graphically in Figure 3.3.1 below where the average (Leq) level is largely a function of how many vehicles passed the measurement point during the sample and the L10 statistical essentially reflects the near-maximum sound peaks associated with those vehicles. The underlying steady sound level in between these events is captured by the L90.

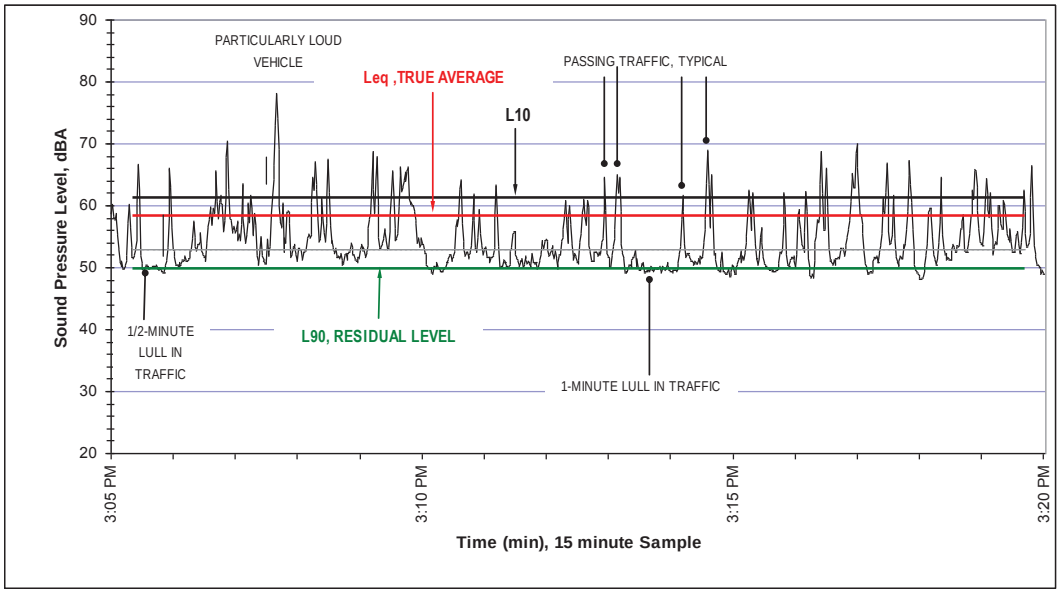


Figure 3.3.1

Valid C-weighted sound levels cannot be measured in windy conditions. As quantified in Ref. 2, the lower frequencies are affected by wind-induced self-noise resulting in a falsely elevated signal below about 100 Hz. This measurement error, which is not widely known, is one of the principal reasons wind turbines are mistakenly believed to produce high levels of low frequency noise. This distortion has a severe impact on C-weighted sound levels, which are essentially a measure of low frequency noise, and skews them upward. In general, meaningful C-weighted sound levels can only be measured under calm or near calm conditions. In this instance, all of the measured C-weighted levels are dominated by this false-signal noise as can be seen in several instances where

the C-weighted levels were higher during the project-off measurement than during the project-on sample. In short, C-weighted levels are reported here for informational purposes but should not be interpreted as being indicative of the project's actual sound emissions in the lower frequencies.

3.3.1 *Site 1*

The manned samples taken at Site 1 both with the project on and off are summarized in the table below. The nominal project-only sound level is calculated by logarithmically subtracting the L90 the project-off level from the L90 measurement taken about 10 to 20 minutes earlier with the project in normal operation. For the reasons discussed immediately above, meaningful project-only levels cannot be derived from the other A-weighted statistical measures (Leq, L10 and L50) or from the C-weighted levels. The average hub height wind speed during each measurement period is also given.

Table 3.3.1.1 *Summary of Site 1 On-Off Measurements*

Sample Time and Ave. 80 m Wind Speed	Measure	A-weighted Sound Level, dBA		Nominal Project-Only Sound Level, dBA	C-weighted Sound Level, dBC	
		Project On	Project Off		Project On	Project Off
Midday 2:30 p.m. 9 m/s	Leq	49.7	49.2		66.5	66.4
	L10	52.2	52.7		69.1	70.8
	L50	48.5	47.3		64.1	62.7
	L90	45.7	42.8	**42.6**	61.5	57.9
Evening 7:20 p.m. 8.9 m/s	Leq	44.5	42.0		62.7	61.5
	L10	45.8	45.0		64.3	63.4
	L50	44.3	41.8		62.2	58.9
	L90	43.2	39.8	**40.5**	60.6	56.6
Night 11:30 p.m. 7.7 m/s	Leq	44.6	40.5		61.5	56.7
	L10	45.8	42.3		62.9	58.5
	L50	44.3	40.1		60.9	56.2
	L90	43.3	38.2	**41.7**	59.1	54.4

The frequency spectra of the L90 measurements taken during each time of day are plotted below.

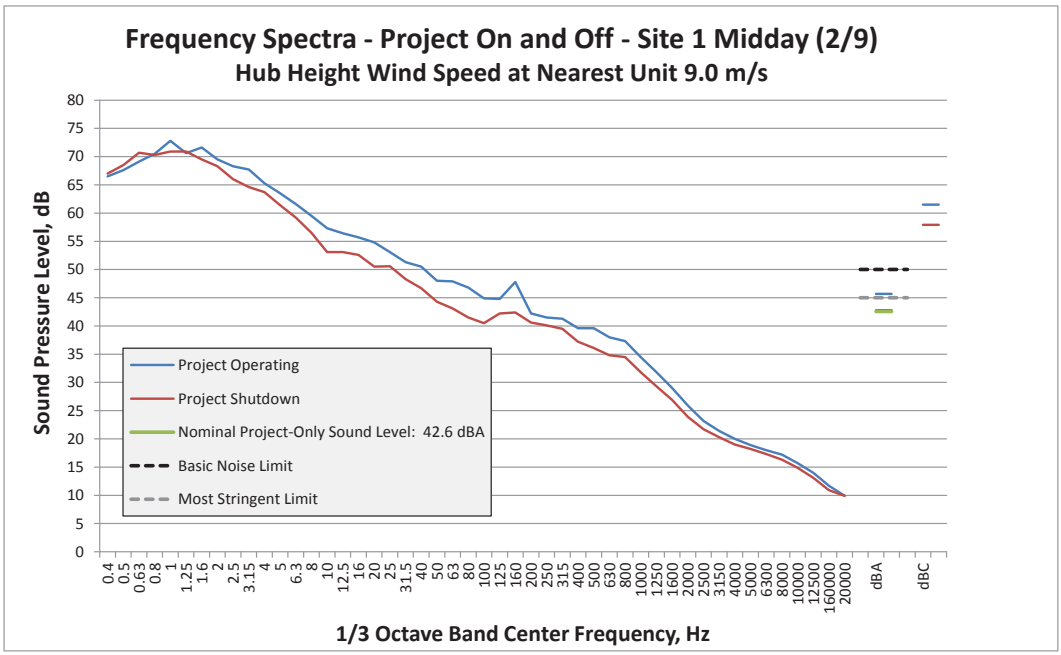


Figure 3.3.1.1

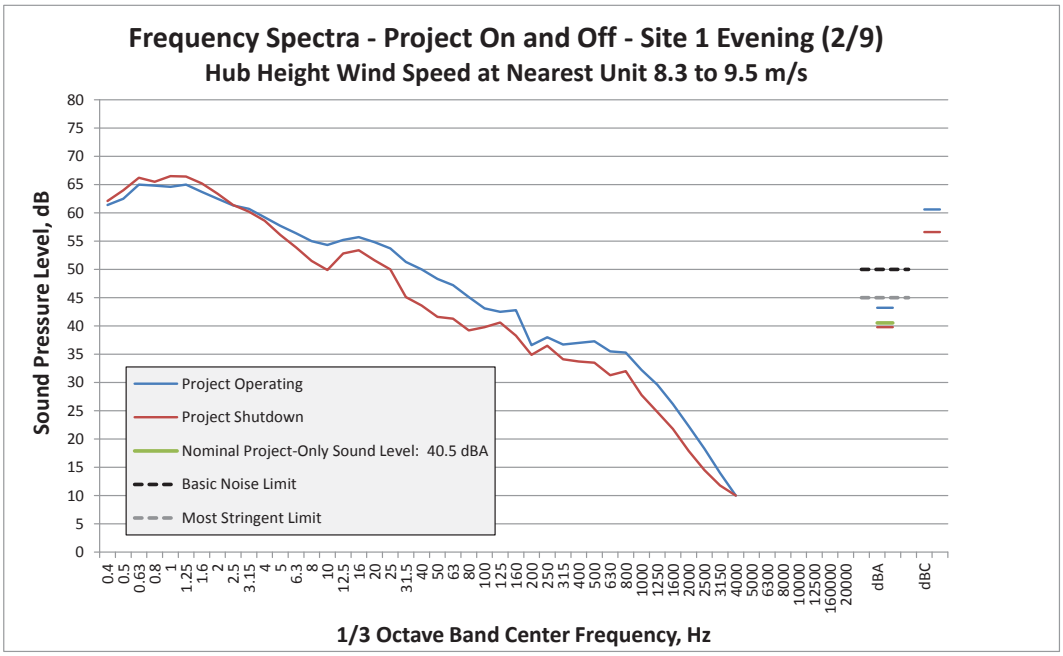


Figure 3.3.1.2

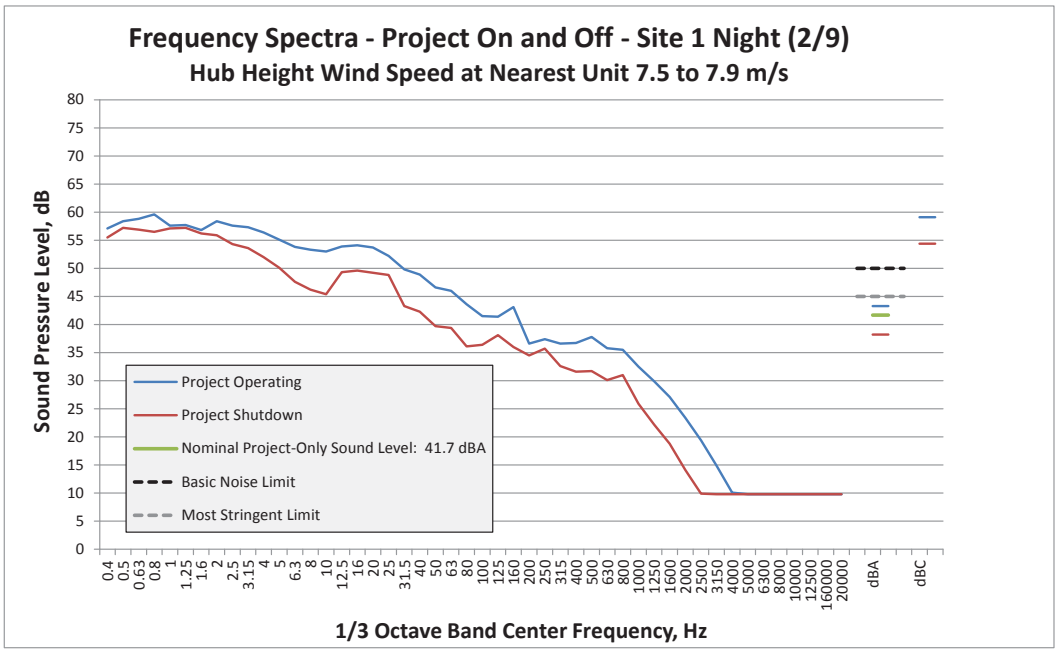


Figure 3.3.1.3

As can be seen from Table 3.3.1.1 the calculated project-only levels are well below the basic 50 dBA noise limit mandated by the State and below the more stringent limit 45 dBA that would be applicable if the sound contained a prominent tone or in the event of a complaint. There are no prominent tones in the project-on spectra above.

3.3.2 *Site 2*

The manned samples taken at Site 2 both with the project on and off are summarized in the table below.

Table 3.3.2.1 *Summary of Site 2 On-Off Measurements*

Sample Time and Ave. 80 m Wind Speed	Measure	A-weighted Sound Level, dBA		Nominal Project-Only Sound Level, dBA	C-weighted Sound Level, dBC	
		Project On	Project Off		Project On	Project Off
Midday 1:50 p.m. 8.2 m/s	Leq	45.3	44.7		63.8	63.9
	L10	42.1	39.9		66.8	67.5
	L50	39.1	35.5		61.2	60.9
	L90	37.7	33.4	**35.7**	57.2	55.4
Evening 6:40 p.m. 9.6 m/s	Leq	42.4	38.6		65.3	62.8
	L10	42.8	37.7		68.1	66.4
	L50	40.7	35.5		61.4	58.3
	L90	39.5	33.8	**38.1**	57.5	52.9
Night 11:30 p.m. 7.7 m/s	Leq	40.5	35.0		64.7	62.6
	L10	41.7	36.8		68.2	66.0
	L50	40.3	34.5		61.4	58.8
	L90	39.1	32.8	**37.9**	57.0	52.5

The frequency spectra of the L90 measurements taken during each time of day are plotted below.

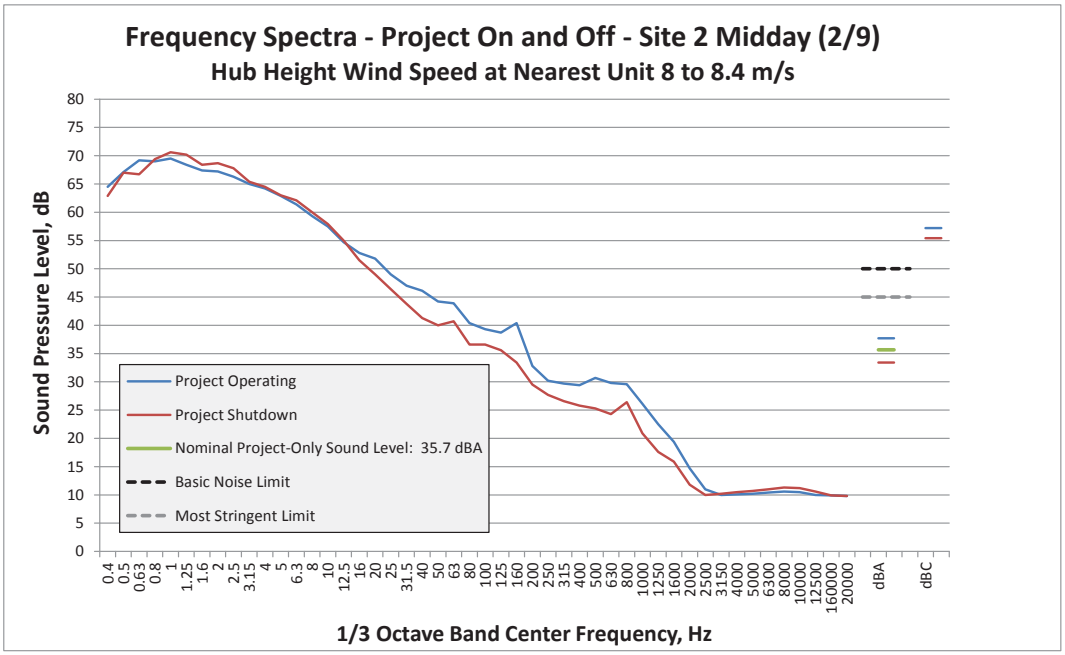


Figure 3.3.2.1

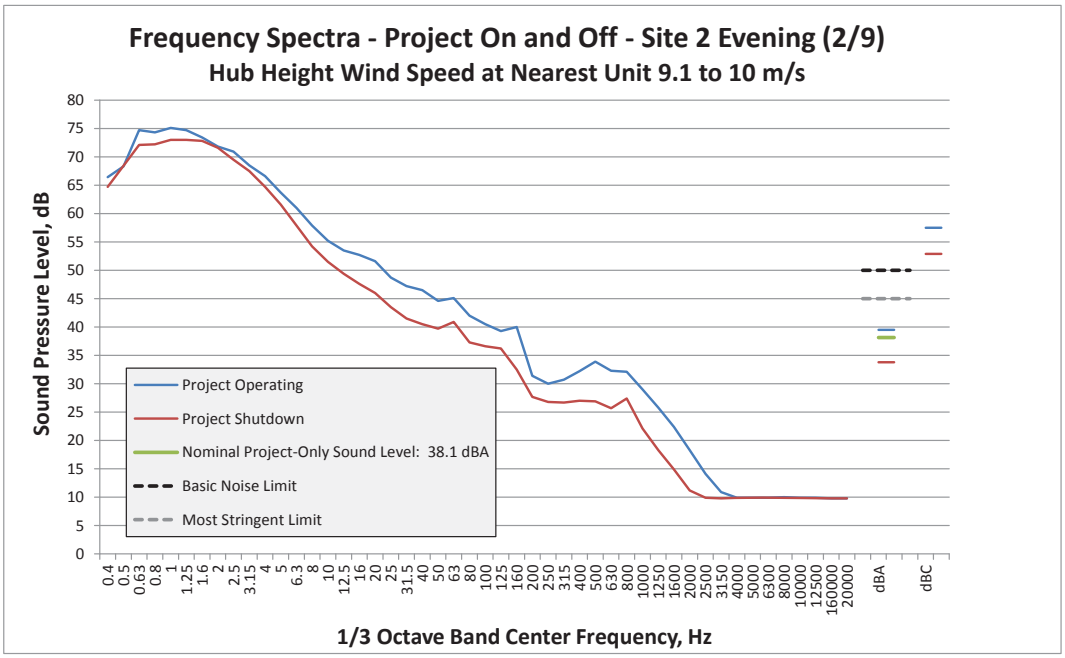


Figure 3.3.2.2

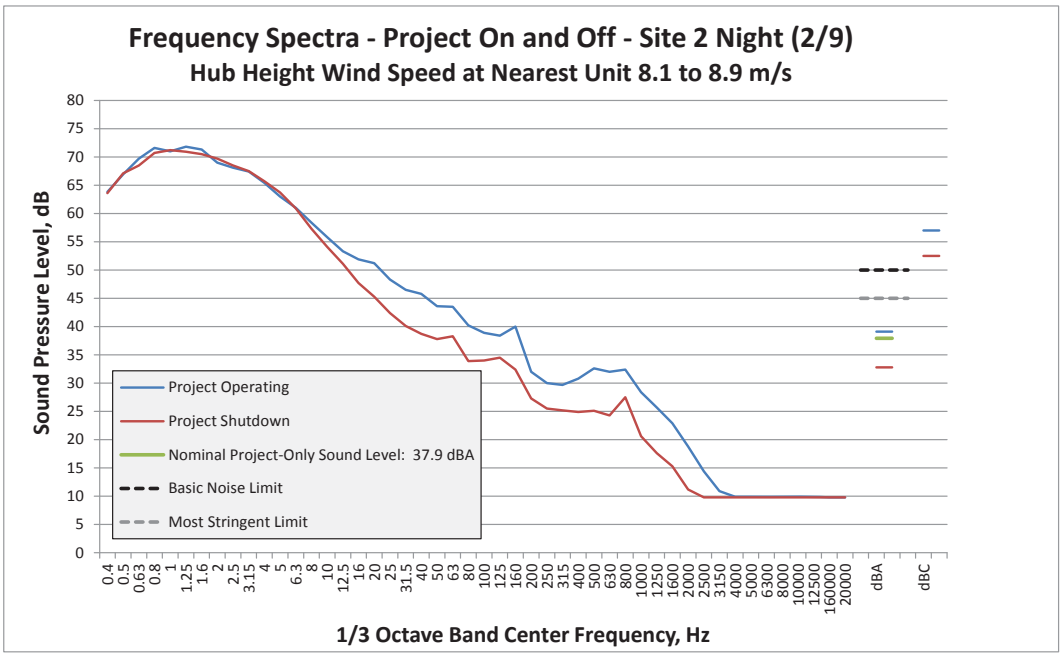


Figure 3.3.2.3

These measurements show that the calculated project-only levels are well below both the 45 and 50 dBA noise limits. There are no prominent tones in the project-on spectra above.

3.3.3 *Site 3*

The manned samples taken at Site 3 both with the project on and off are summarized in the table below.

Table 3.3.3.1 *Summary of Site 3 On-Off Measurements*

Sample Time and Ave. 80 m Wind Speed	Measure	A-weighted Sound Level, dBA		Nominal Project-Only Sound Level, dBA	C-weighted Sound Level, dBC	
		Project On	Project Off		Project On	Project Off
Midday 1:20 p.m. 8.9 m/s	Leq	43.1	42.1		65.3	65.8
	L10	44.5	43.7		68.2	69.2
	L50	42.9	38.6		62.7	62.6
	L90	41.4	36.1	**39.9**	60.2	58.2
Evening 6:00 p.m. 9.5 m/s	Leq	50.1	38.8		65.3	65.2
	L10	46.3	40.5		68.3	68.5
	L50	43.4	38.0		61.3	60.7
	L90	41.6	36.0	**40.2**	58.6	54.9
Night 11:30 p.m. 8.0 m/s	Leq	43.2	38.1		64.4	60.6
	L10	44.6	39.6		67.6	63.9
	L50	42.9	36.2		60.8	56.8
	L90	41.5	34.1	**40.6**	57.5	53.6

The frequency spectra of the L90 measurements taken during each time of day are plotted below.

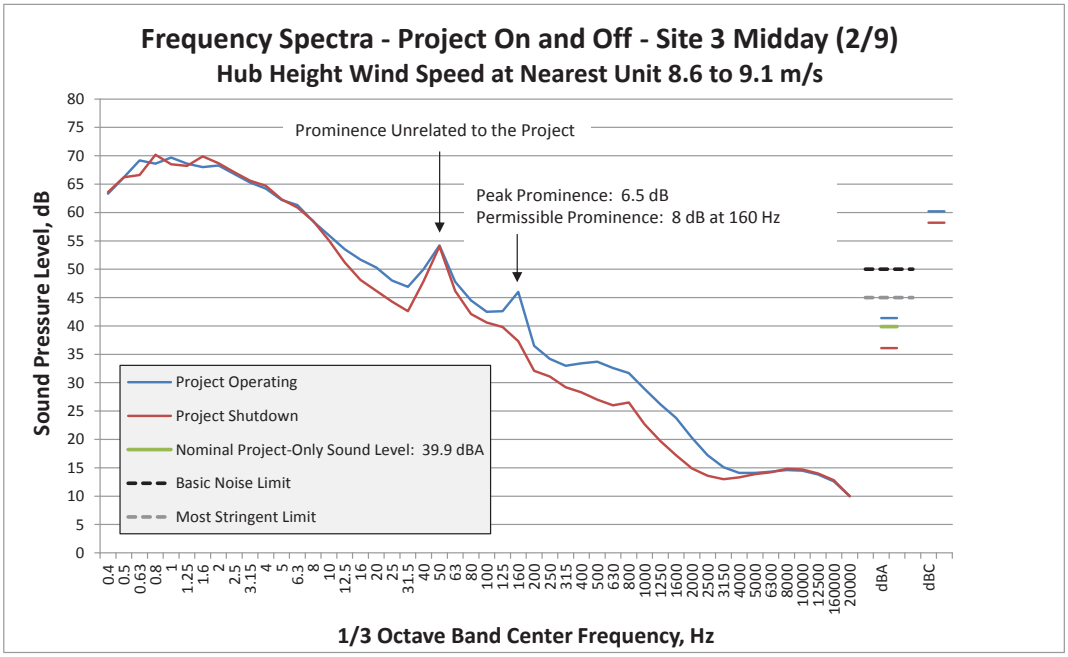


Figure 3.3.3.1

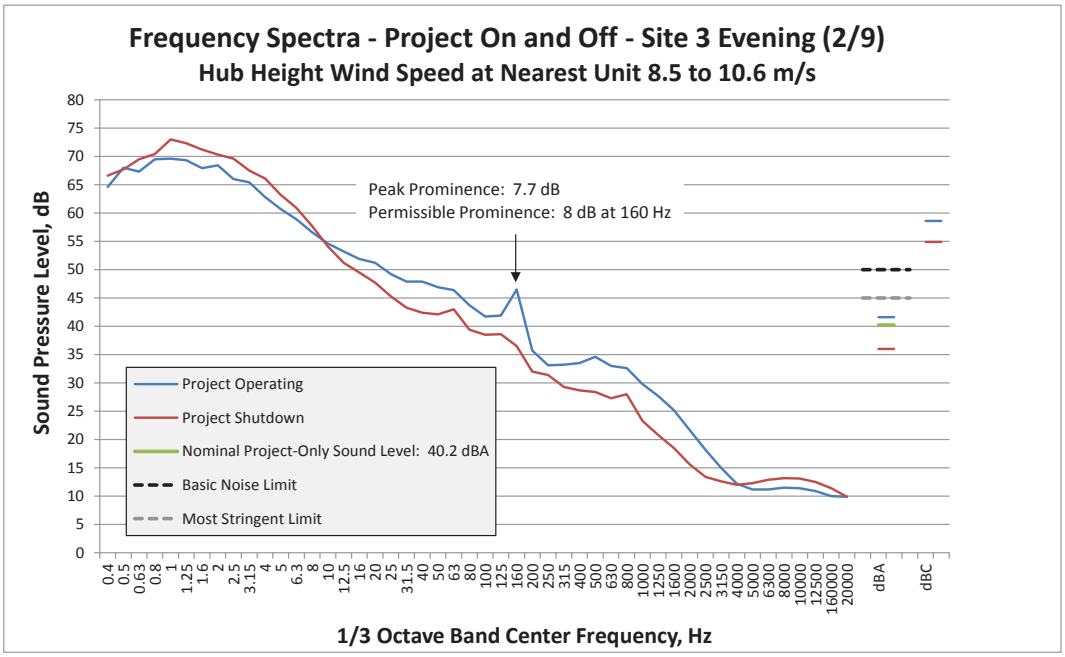


Figure 3.3.3.2

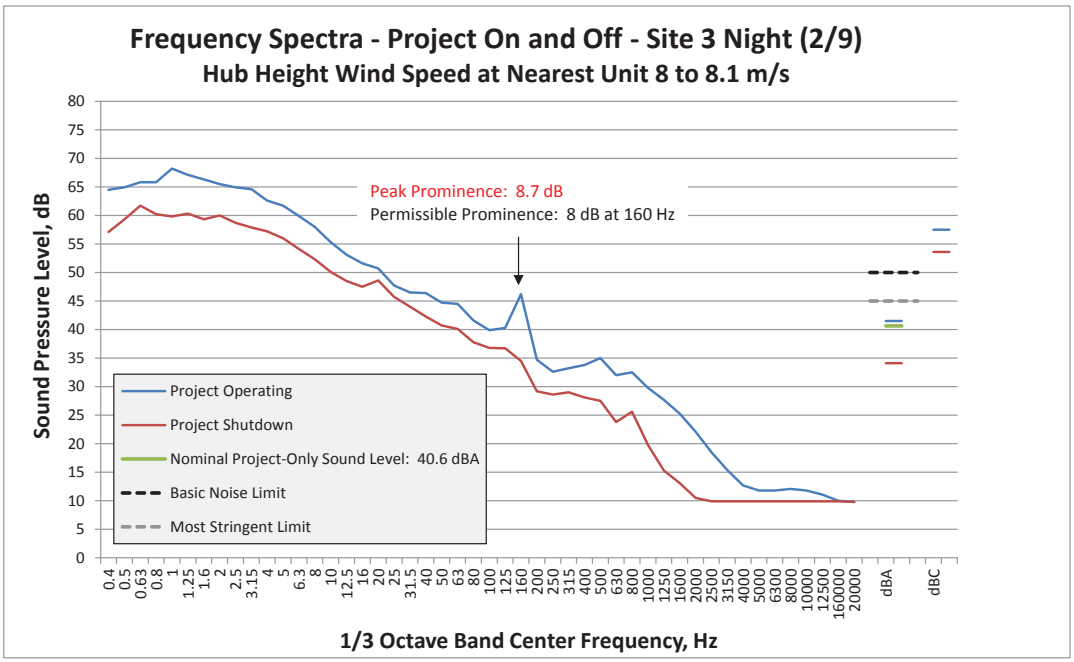


Figure 3.3.3.3

Table 3.3.3.1 shows that the overall project-only sound levels ranged between 39.9 and 40.6 dBA and were therefore below both the 45 and 50 dBA limits. At this location a noise peak at 160 Hz was observed in all three measurements. This sound appears to be associated with a mechanical source inside the nacelle. Although pronounced in all measurements, it was only found to exceed the EPA definition of prominent discrete tone, referred to in the town JDA, in the evening sample. In this instance, the more stringent 45 dBA noise limit would apply and is met despite the tone.

3.3.4 *Site 4*

The manned samples taken at Site 4 both with the project on and off are summarized in the table below.

Table 3.3.4.1 *Summary of Site 4 On-Off Measurements*

Sample Time and Ave. 80 m Wind Speed	Measure	A-weighted Sound Level, dBA		Nominal Project-Only Sound Level, dBA	C-weighted Sound Level, dBC	
		Project On	Project Off		Project On	Project Off
Midday 12:40 p.m. 8.3 m/s	Leq	47.4	47.3		65.5	65.5
	L10	50.8	51.5		68.5	69.8
	L50	45.2	43.7		62.0	61.7
	L90	41.0	38.3	**37.7**	57.9	55.1
Evening 5:20 p.m. 11.8 m/s	Leq	51.1	49.1		68.5	64.8
	L10	54.6	52.4		71.8	68.3
	L50	49.3	46.9		66.5	62.2
	L90	44.2	43.1	**37.7**	61.2	57.1
Night 9:40 p.m. 8.8 m/s	Leq	45.8	41.6		59.2	54.1
	L10	49.7	44.5		61.0	57.7
	L50	42.2	33.3		57.7	50.7
	L90	38.6	30.7	**37.8**	55.4	47.1

The frequency spectra of the L90 measurements taken during each time of day are plotted below.

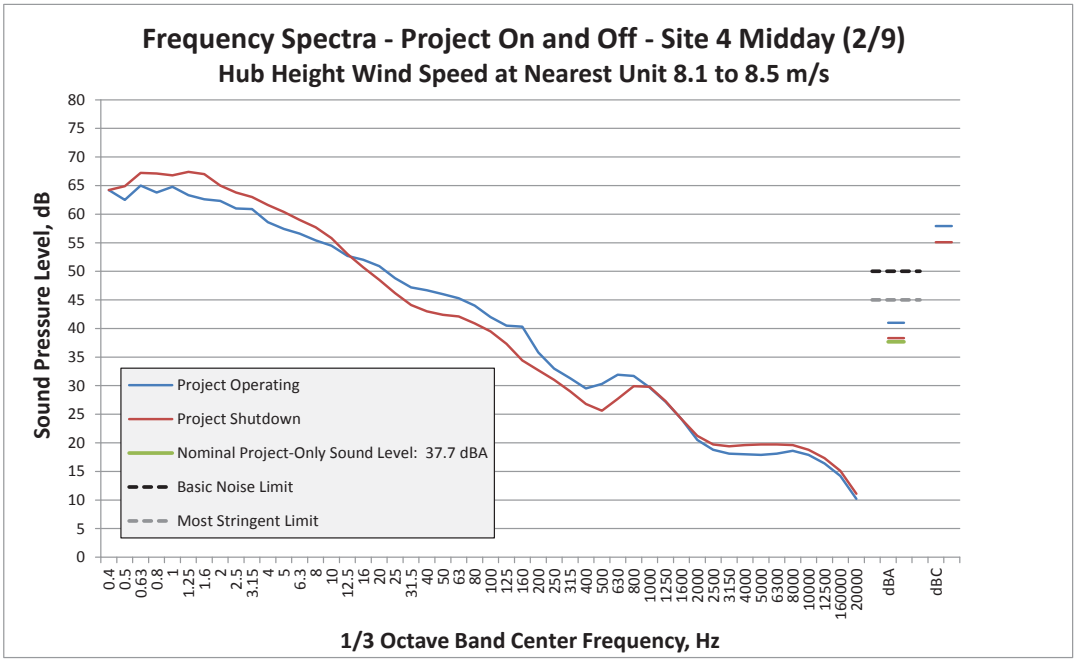


Figure 3.3.4.1

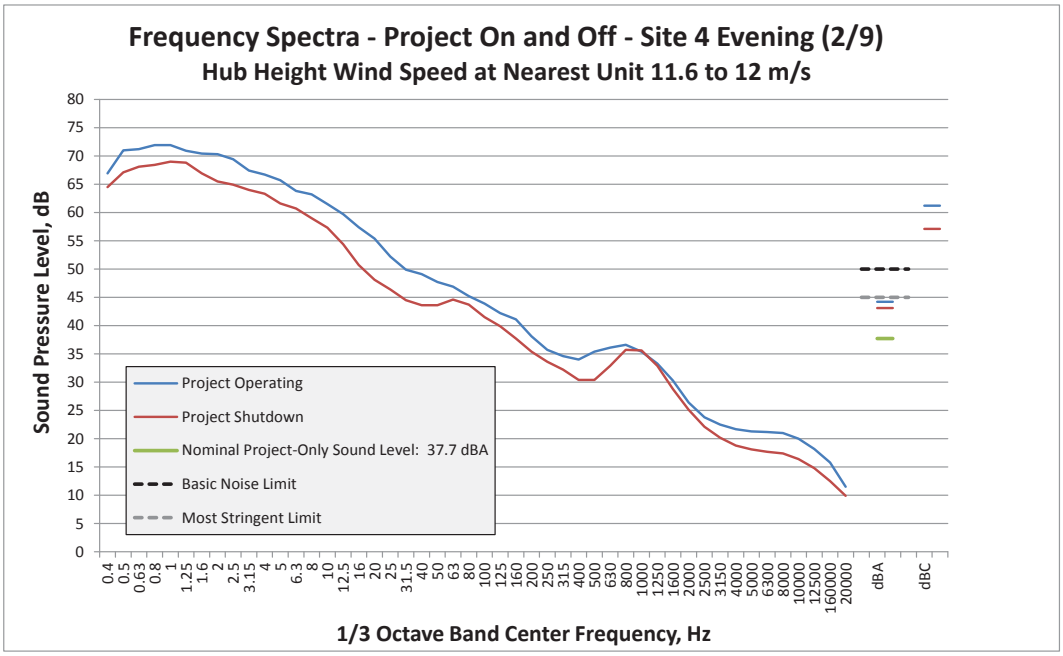


Figure 3.3.4.2

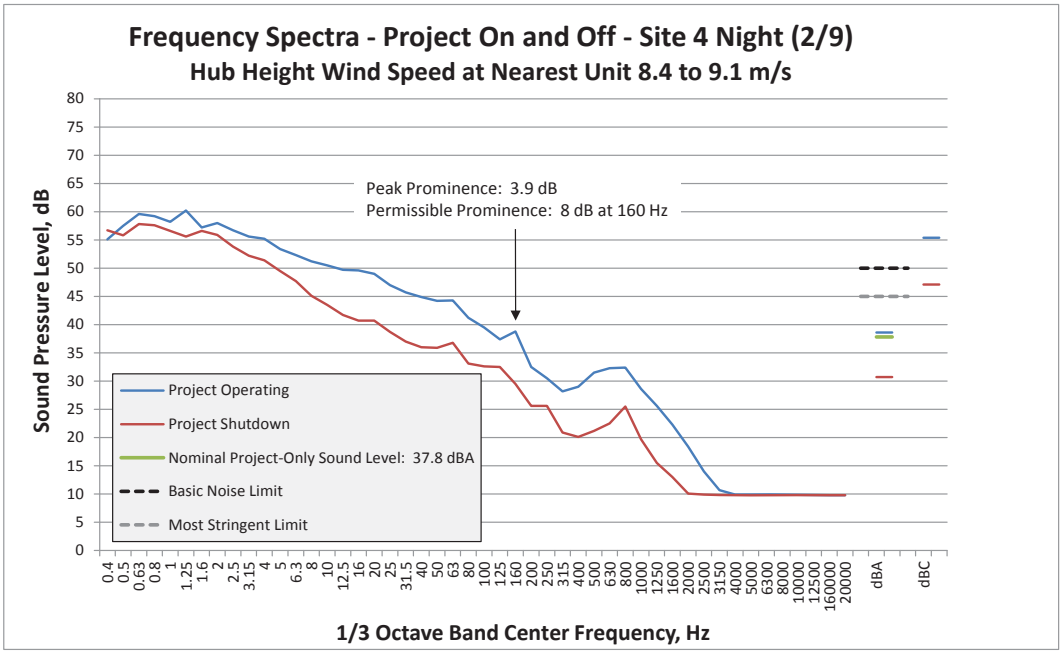


Figure 3.3.4.3

These measurements show that the calculated project-only levels, in all three cases about 37.3 dBA, are well below both the 45 and 50 dBA noise limits. There are no prominent tones in the project-on spectra above.

3.4 LONG-TERM RESULTS - BACKGROUND SOUND LEVELS

The short-term measurements described above have several drawbacks that prevent them from yielding a definitive result with respect to the State and local noise requirements. For example, in Section 3.3 spot samples are reported for four different times of day over three different days as required by the town's Joint Development Agreement, but these measurements only provide the *total* sound level, which encompasses not only the noise emissions of the project but also the noise from everything else as well. Thus, such an approach tends to overstate the sound level of project. This difficulty was overcome to a certain extent with the on-off measurements carried out as prescribed in the latest State sound assessment procedures. Measurements were taken at three different times of day with the project both on and off so an adjustment could be made for background contamination. However, the generation and propagation of wind turbine noise is highly variable with time due to factors such as the vertical wind and temperature gradients, turbulence and the general weather conditions, making it difficult to fully capture the long-term sound emissions of the project with a few spot samples. In addition, the four sampling points used for the short-term measurements were essentially an artifact of the pre-construction background survey and, while they represent locations with a relatively high exposure to project noise, they are not actually at any non-participating residences.

Consequently, because of these shortcomings, an extensive long-term monitoring program was designed into the test protocol as a supplement to State and local procedures to:

- Measure over a sufficiently long period that a wide variety of wind and weather conditions would be captured
- Collect data at or near a large sampling of the nearest non-participating residences
- Develop a time history of the background sound level that would likely have existed within the project area over the entire survey period thereby allowing the project-only sound level to be deduced at the on-site monitoring stations

This section describes how this estimated background level was determined.

The technique used to reasonably determine the background sound level throughout the long-term survey period was to set up monitoring positions at four diametrically opposite locations roughly 1.5 to 2.5 miles from the edge of the project area in the four cardinal directions: Positions NB, EB, WB and SB, as illustrated in Graphic A. In an effort to capture the natural, wind-induced background sound level, all of these positions were in fairly remote settings away from any major sources of man-made noise.

The L90(10 min) levels recorded at these positions are plotted below.

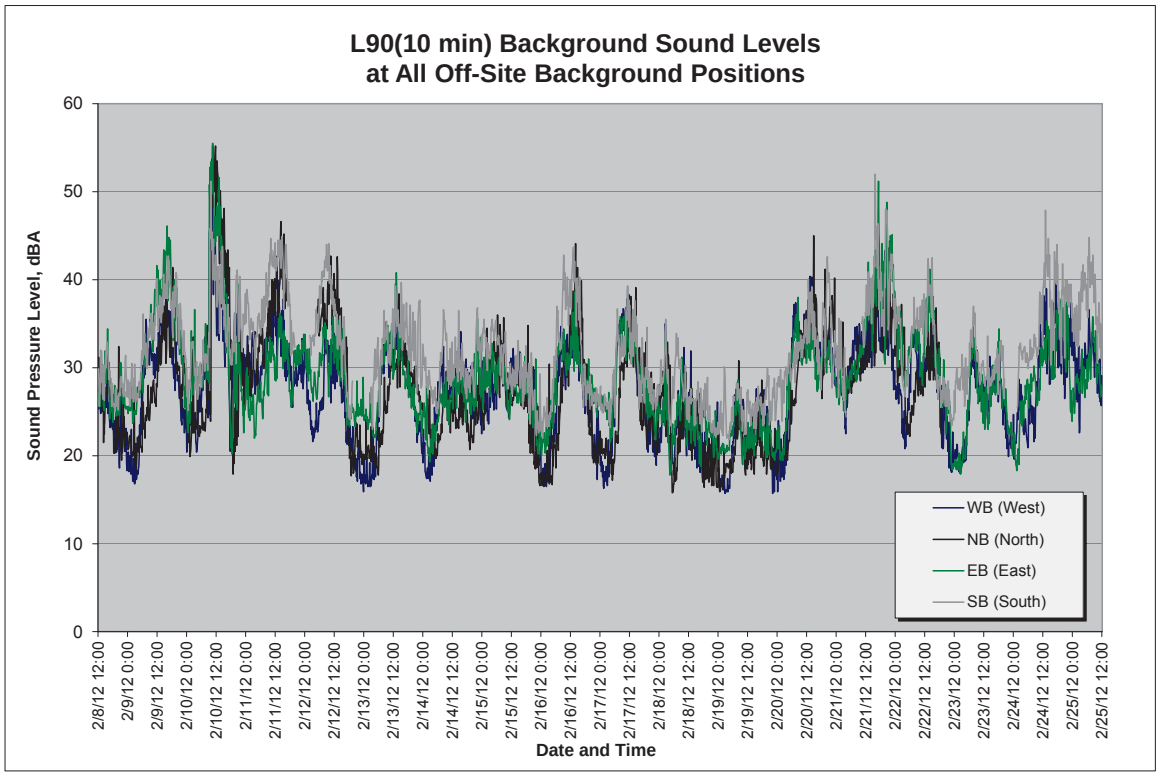


Figure 3.4.1

This plot shows that the background sound level is highly variable over a large dynamic range from essentially total silence at 17 dBA to levels that exceed the project noise limit of 50 dBA. Despite being separated from each other by many miles, the levels at each location generally follow the same temporal trends although there are times when they diverge by significant amounts; consequently, it is only possible establish an approximate background level by averaging all four locations. This nominal design level, the average of all four measurements, is plotted below along with the standard deviation.

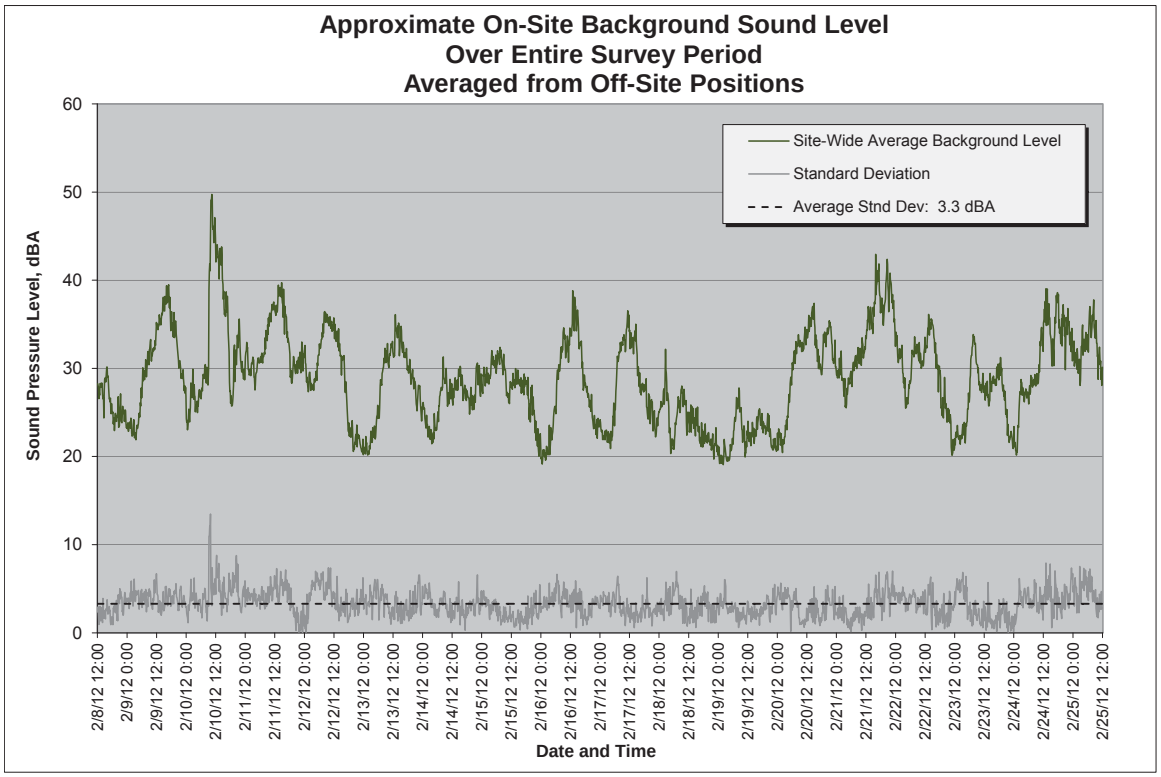


Figure 3.4.2

Although this average background is not an exact quantification of the site-wide background level because of the natural variance between the four off-site positions, it is considered a reasonable, or best, estimate of what the sound level at any given time during the survey would have existed between these four monitoring points at the on-site positions. The average standard deviation is 3.3 dBA; meaning that this design level is generally accurate to within +/- 3 dBA. The only real inconsistency occurred during the violent storm front that passed over the site on the morning of Feb. 10 where the sound levels at the off-site monitoring stations, which are all many miles apart, varied by more than 10 dBA.

3.5 LONG-TERM RESULTS – ON-SITE POSITIONS

Two graphics are presented below for each of the 11 on-site measurement positions.

The first shows the total measured L90(10 min) sound level (containing both project and background noise) as a function of time over the 17 day survey period compared to the design background level and concurrent wind speed as measured by the hub height anemometers on the four closest units to each measurement position.

Project noise is *apparent* wherever the total sound level significantly exceeds the background level. It is important to note, however, that it is far from certain that every on-site measurement that is higher than the estimated background level is actually due to the project. This technique tends to yield highly conservative results and overestimate the project sound level because any sound level measured at an on-site receptor that is higher than the approximate background level is assumed to be attributable to the project. Consequently, unrelated but sustained noise from such things as nearby trees rustling in the wind, planes flying over, farm activity, etc. can be easily misconstrued as project noise. Thus the results from this approach must be considered the

maximum sound level that could *possibly* have been generated by the project, but any given noise peak cannot be conclusively attributed to the project.

The second graphic shows the apparent project-only sound level where the background sound level has been logarithmically subtracted in every instance where the total level is more than 3 dBA higher than the background level.

The design background level is valid at all of the on-site measurement positions except three (Positions 1, 2 and 11) that are close to Highway 33 and strongly affected by its noise.

3.5.1 Position 1 – N7902 E. Friesland Road

The total sound level measured at Position 1 is plotted in Figure 3.5.1.1 along with the design background level and average wind speed measured by the nacelle (80 m) anemometers on the four nearest units.

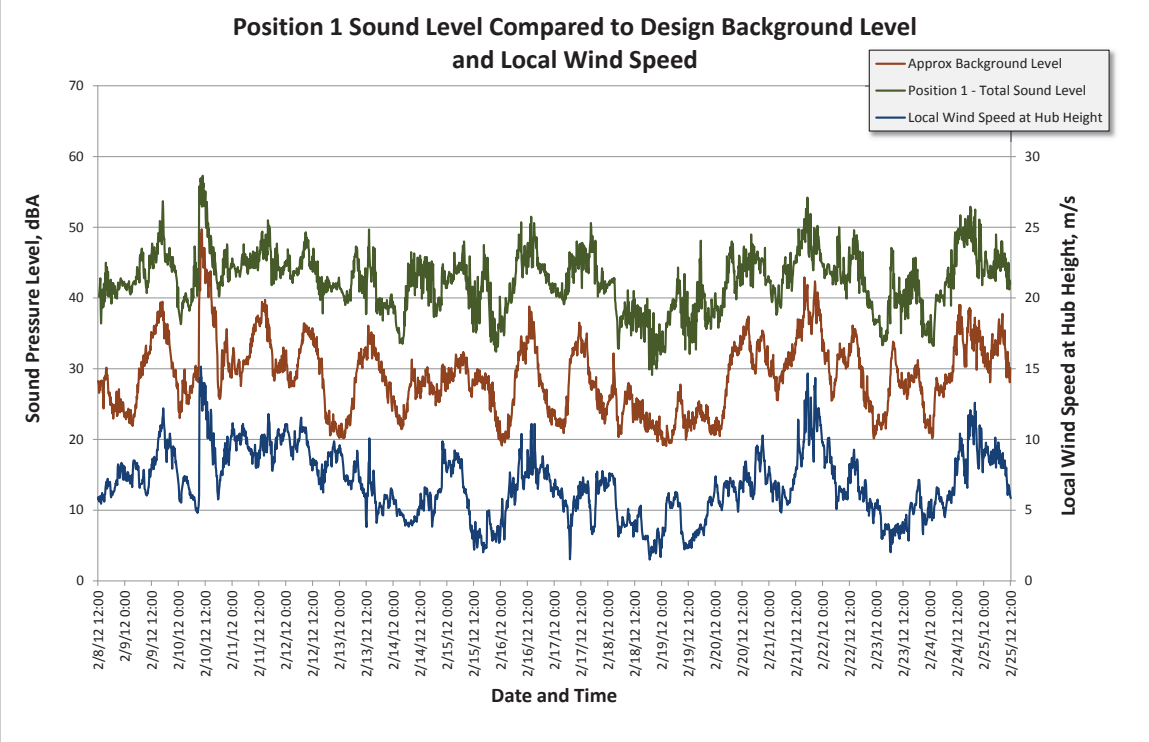


Figure 3.5.1.1

These results suggest that the sound level at this location was substantially and consistently higher than the background level; however, the design background level, measured by the four off-site monitors in quiet and relatively remote settings, is not a meaningful representation of the background level at this particular monitoring station, which is only 130 ft. from the centerline of Hwy 33. Traffic noise near this road is considerable in magnitude and nearly continuous in duration; consequently, the dominant component of the total sound level in the chart above (green trace) is most likely noise from numerous tractor trailer trucks and other vehicles passing closely by the monitor. In essence, the project-only sound level at this location cannot be deduced because the design background level is unsuitable for this location; i.e. the actual background level at this measurement point would almost certainly be substantially higher at any given moment than the design level shown in the plot.

Nevertheless, the ostensible, and probably grossly overestimated, project-only level has been calculated and is shown in Figure 3.5.1.2 relative to the concurrent wind speed.

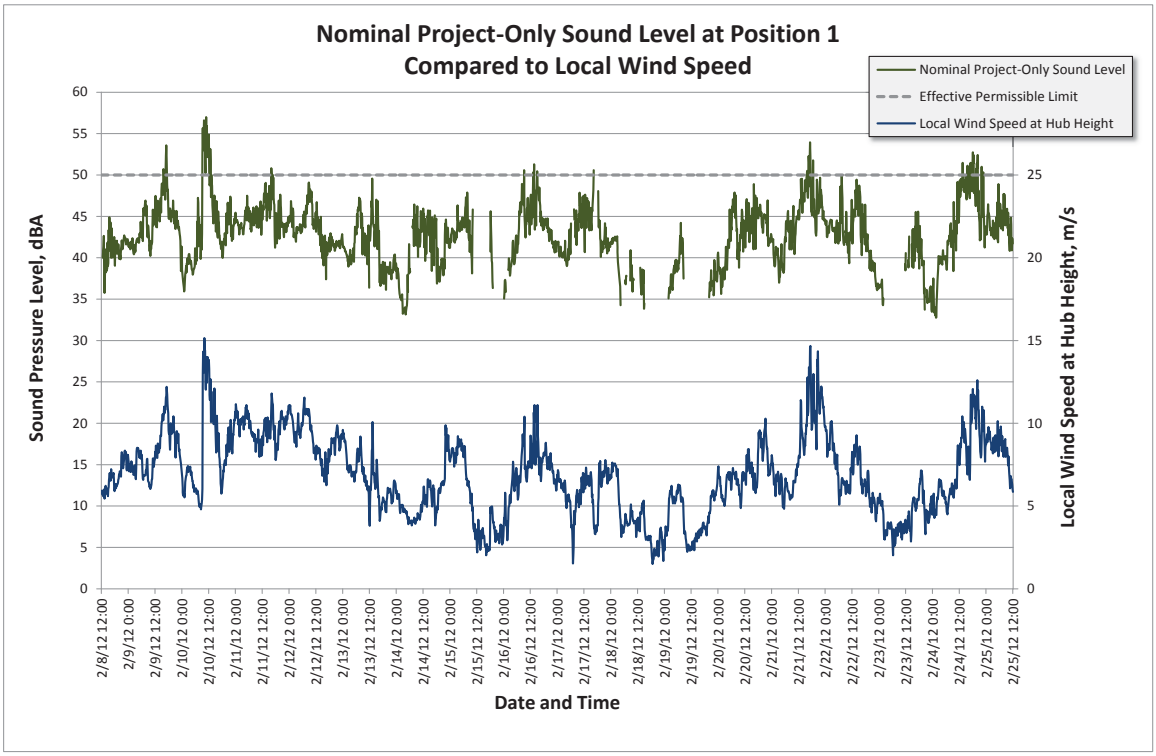


Figure 3.5.1.2

This derivation of the project-only sound level assumes that nearly all the sound measured at this location is due to the project and that traffic noise is inconsequential, which is obviously untrue. In spite of this, the results indicate that the project is in compliance with the basic 50 dBA sound level most of the time. More specifically, out of the 2420 measurements made at this position over the survey, 58 were higher than 50 dBA after adjusting for background noise. This means that the project level was ostensibly over the limit 2.4% of the time. As prescribed in the test protocol, if the project-only sound level is found to be below the applicable limit more than 95% of the time, the project is considered in compliance with the State and local noise standards. Consequently, despite the fact that the results plotted above almost certainly overstate the project sound level, compliance has still been achieved with the 50 dBA limit. The actual project level at this location is more likely to be in the 40 to 43 dBA range as measured during the on-off tests at Site 1 ½ mile north of Position 1 on E. Friesland Road (see Table 3.3.1.1).

3.5.2 **Position 2 – Near N7755 Krueger Road**

The long-term sound levels measured at Position 2 are shown in Figure 3.5.2.1.

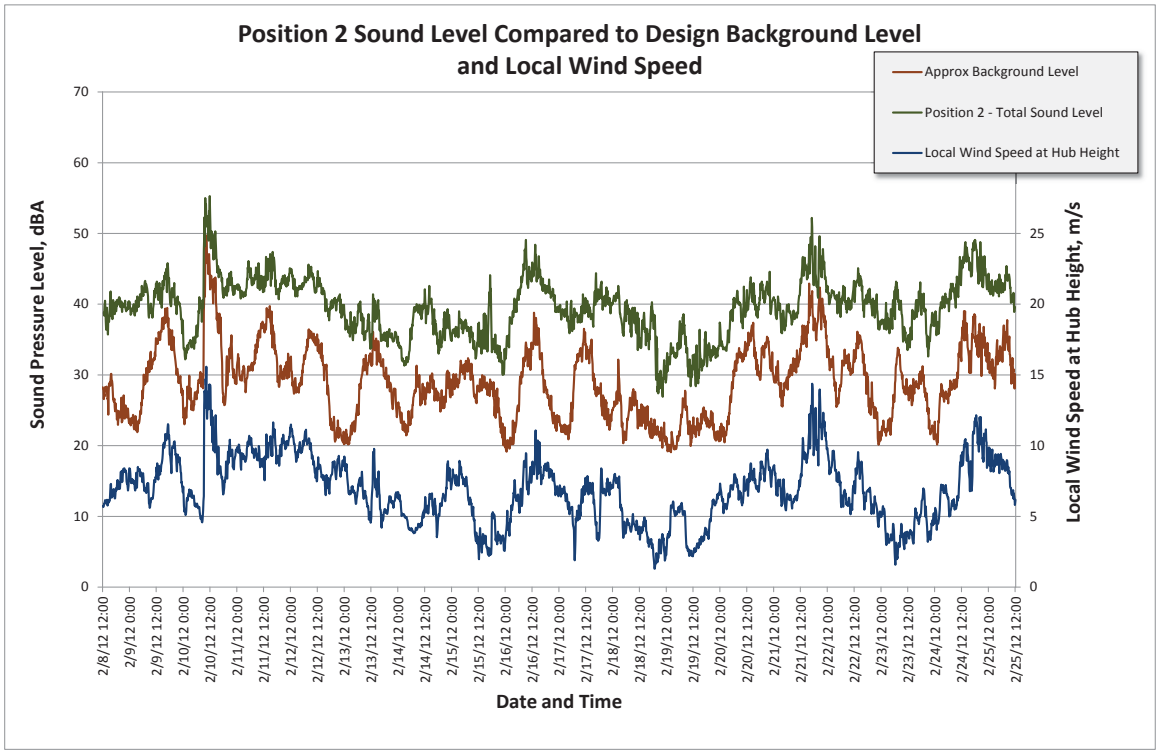


Figure 3.4.2.1

The results at this position are somewhat similar to those at Position 1 in the sense that the total sound level is substantially higher than the design background level nearly all the time, even during calm wind conditions when the project is idle. This indicates that traffic noise from Highway 33 was still very prominent at this location, which is 1230 ft. south of the highway, and that, again, the design background level, measured in remote settings, is not really appropriate for this particular monitoring station. In addition, this measurement position is considerably closer to Hwy 33 than the house it was intended to represent, which is 600 ft. further away to the south.

Despite all this, the calculated *apparent* project-only sound level is plotted in Figure 3.5.2.2.

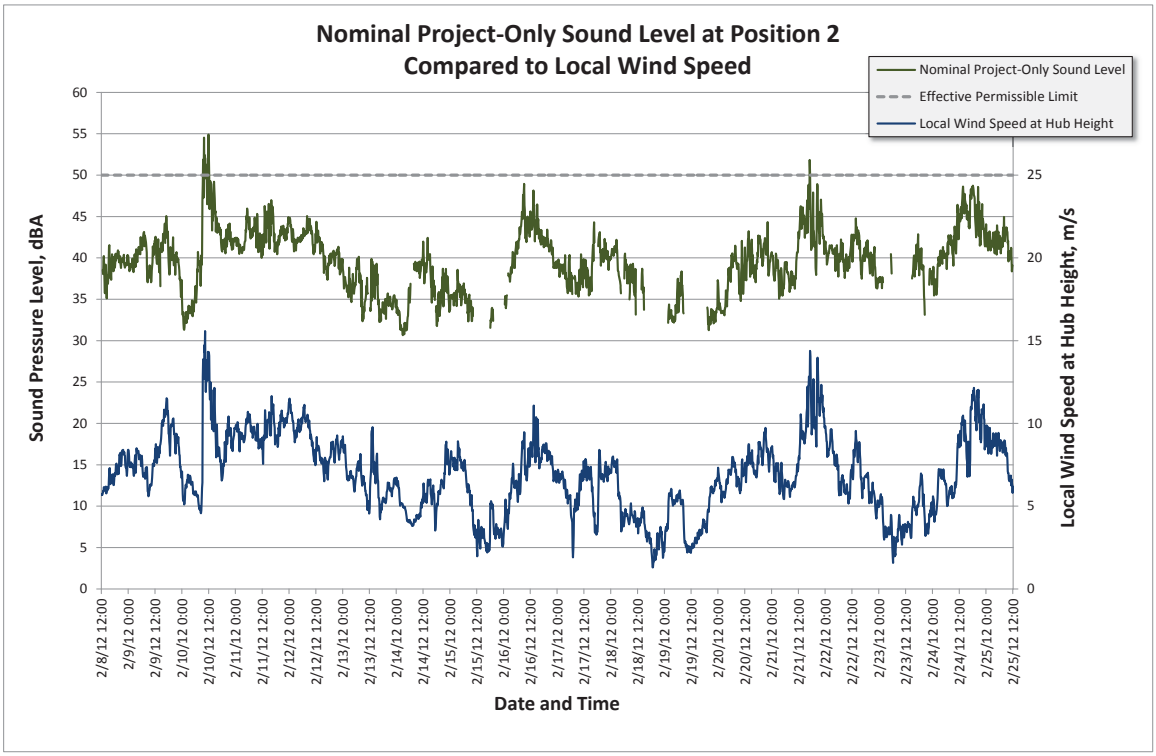


Figure 3.5.2.2

This plot shows that the ostensible project sound level (still more than likely containing substantial contamination from traffic noise) only exceeded the 50 dBA limit during two brief periods. Quantitatively, the apparent project sound level was above 50 dBA in 12 out of 2423 measurements, or 0.5% of the time. The actual project sound level at the residence 600 ft. further from Hwy 33 was almost certainly lower than shown in Figure 3.5.2.2.

3.5.3 **Position 3 – Near W1819 County Road E**

Sound levels vs. time for Position 3 are shown below in Figure 3.5.3.1.

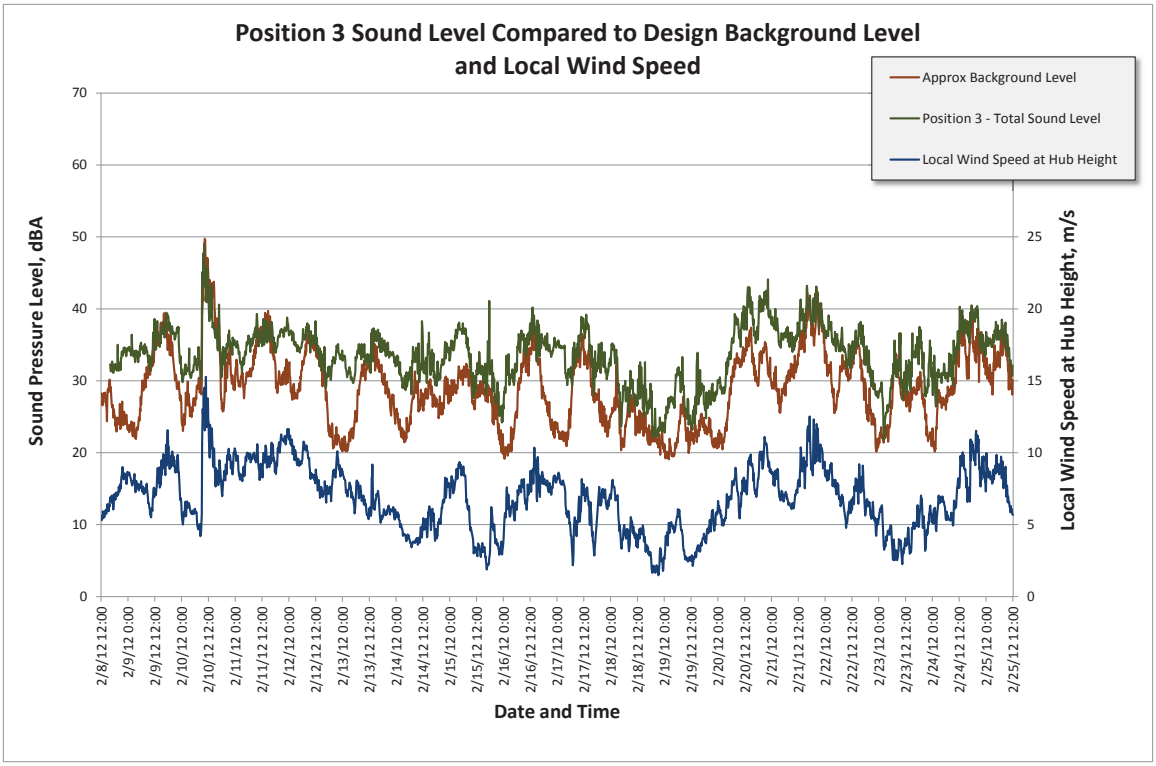


Figure 3.5.3.1

This result, for the first time, shows the total measured level at the test position relative to a truly comparable background sound level. Position 3 is far from the traffic noise of Hwy 33 in a setting similar to that of the background monitors. In this case, the sound level at Position 3 and the background level are similar in times of low wind, as they should be because project noise is absent at both locations. Both levels are also similar during periods of peak wind, which is also something to be expected, because the wind-induced environmental sound level increases indefinitely with wind speed whereas wind turbine sound emissions plateau at a maximum level fairly quickly allowing the background level to be dominant in high wind conditions.

The nominal project-only sound level, corrected for background, is shown in Figure 3.5.3.2.

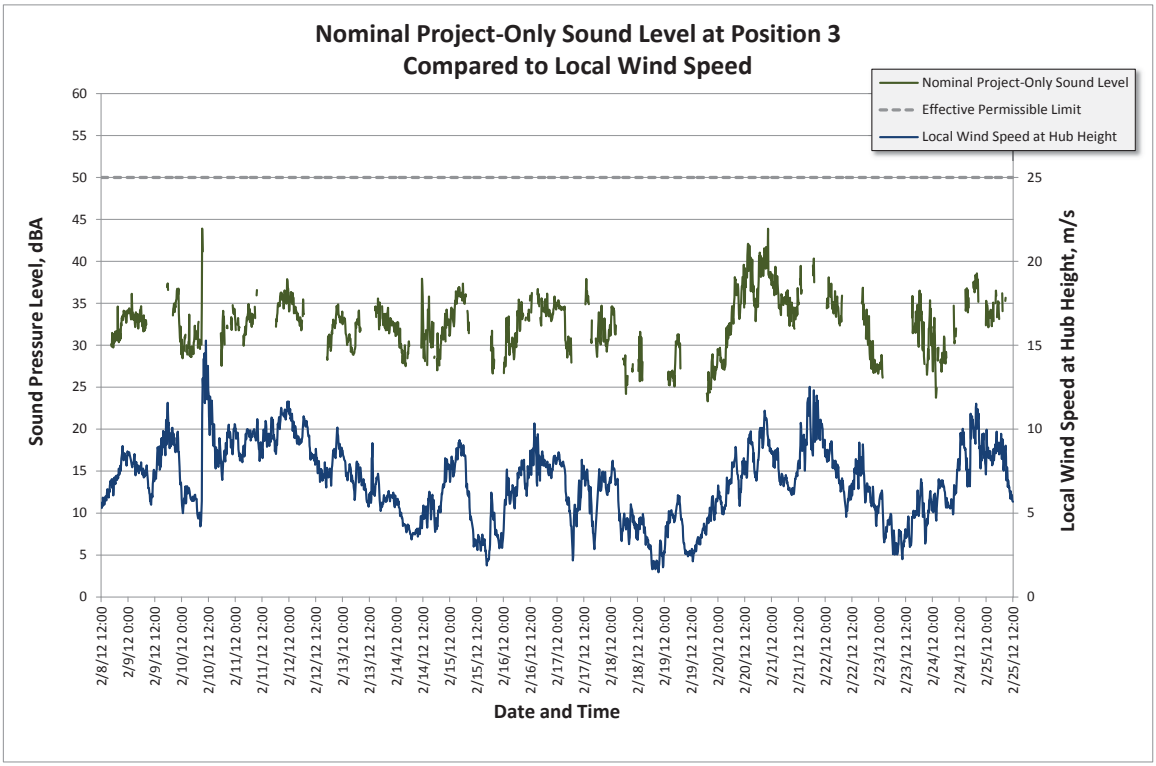


Figure 3.5.3.2

This plot, which is considered an accurate representation of the actual project-only sound level at this location, shows that the sound level ranges from about 30 to 42 dBA and is well below the 50 dBA limit at all times and, in fact, never exceeds the more stringent 45 dBA limit.

3.5.4 **Position 4 – W2182 Friesland Road**

The measurement results for Position 4 are shown below.

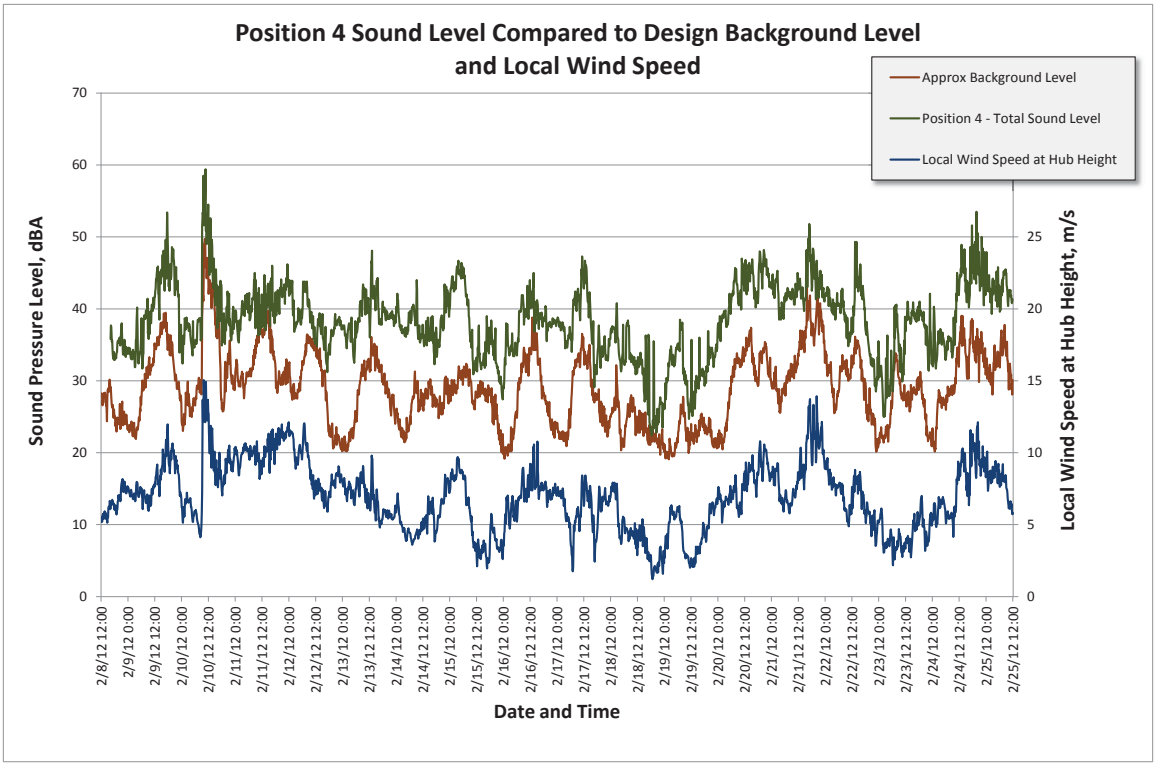


Figure 3.5.4.1

The adjusted, nominal project-only sound level is plotted in Figure 3.5.4.2.

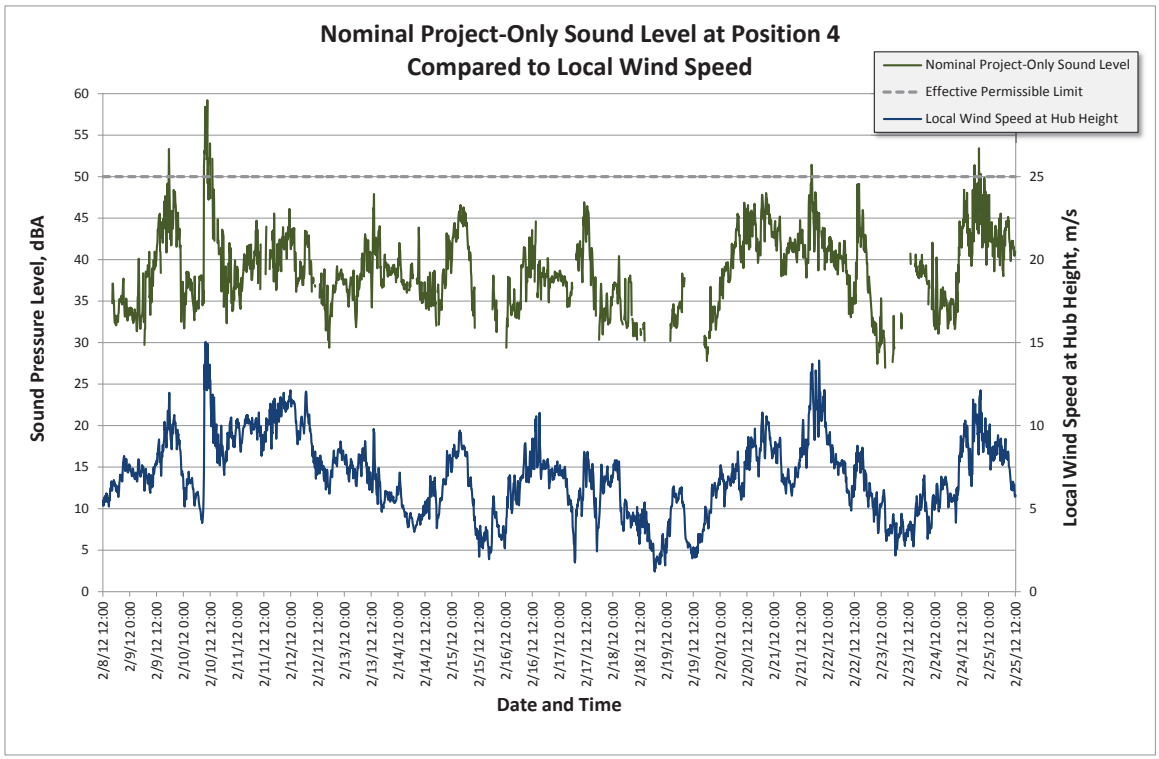


Figure 3.5.4.2

This latter plot indicates that the apparent project sound level is below the 50 dBA limit most of the time – exceeding it in only 21 of 2423 measurements, or 0.9% of the time. Consequently, the project is certainly in compliance with the basic limit of 50 dBA at this location.

The more stringent limit of 45 dBA is apparently exceeded 6.7% of the time, generally when the hub height wind speed is greater than about 10 m/s. However, the sound levels at this position were almost certainly elevated by local tree rustle noise during windy conditions (the monitor was attached to a tree in the front yard). Manned measurements on Feb. 9 at Site 2 in an open field not far from Position 4 show substantially lower levels (5 to 9 dBA lower) during the project shut down periods strongly suggesting that not all or even most of the sound measured at this location during windy periods was actually coming from the project. Because of this interference from contaminating background noise a valid result cannot be discerned for this location with respect to the 45 dBA noise limit.

3.5.5 **Position 5 – 9093 N County Road E**

The sound levels measured at Position 5 are plotted in Figure 3.5.5.1.

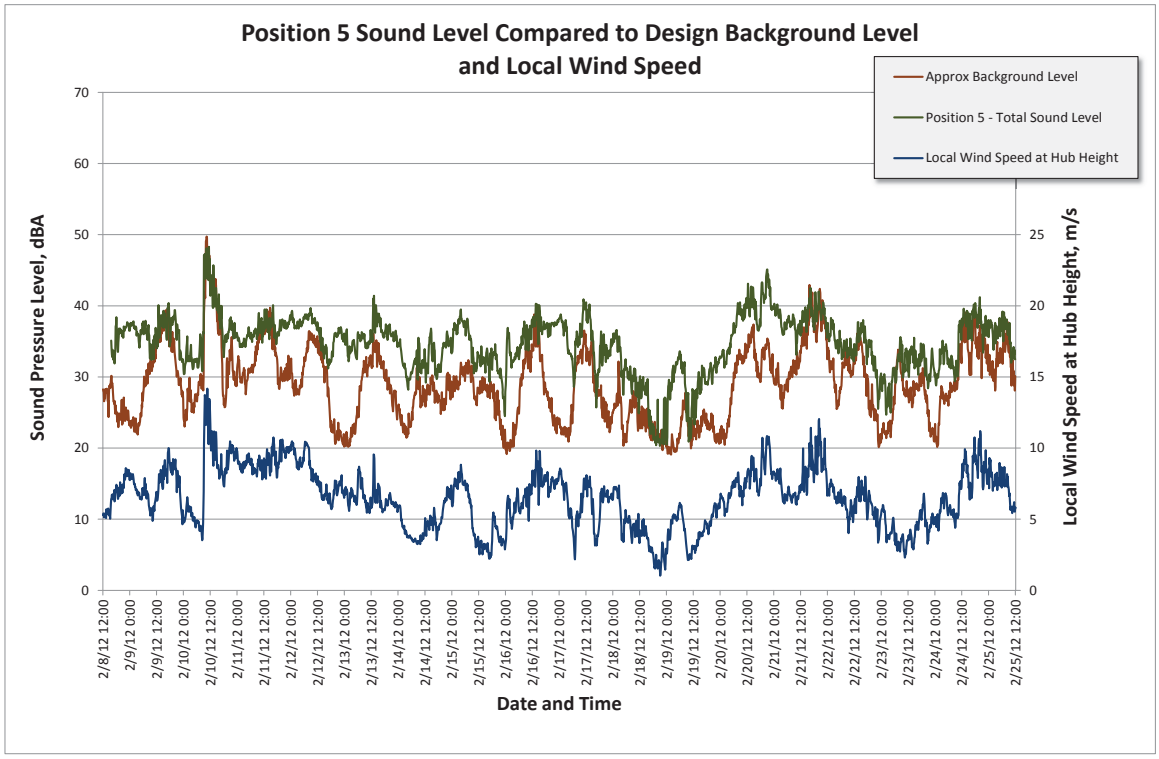


Figure 3.5.5.1

The nominal project-only sound level at this location is plotted below.

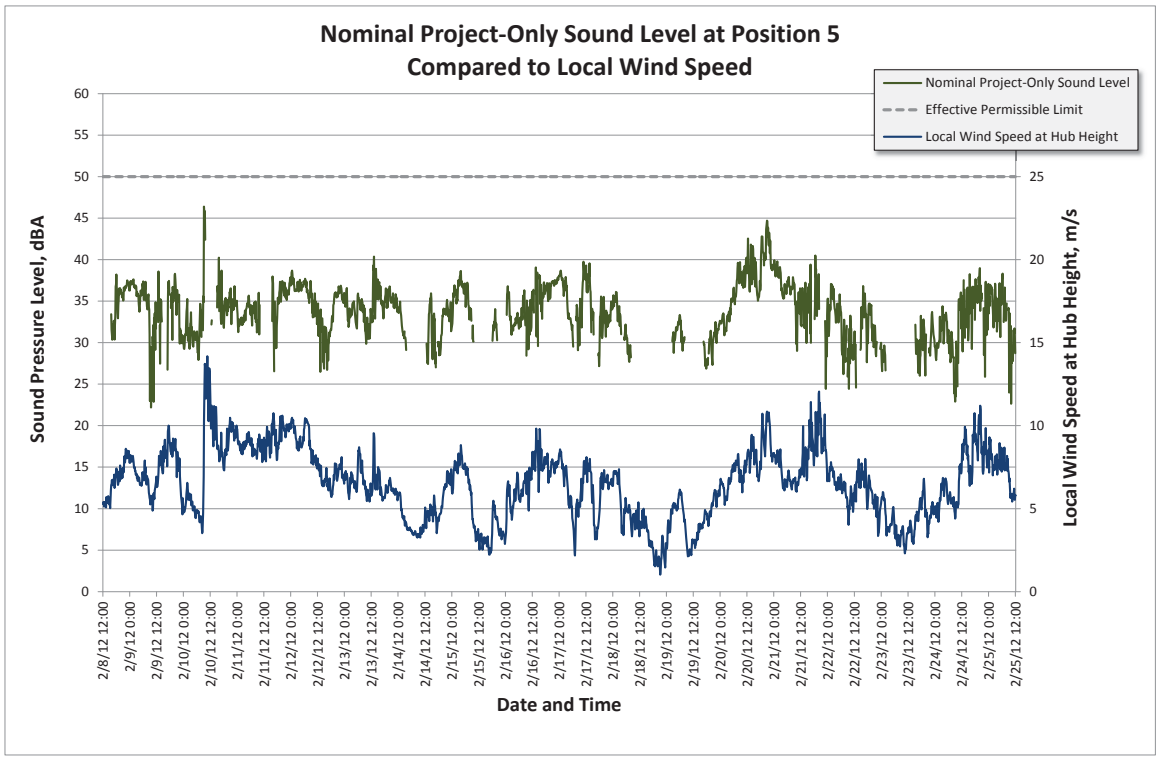


Figure 3.5.5.2

The results at this residence, which was at the minimum setback distance of 1250 ft. from the nearest turbine, indicate that the project is, without question, in compliance with the basic 50 dBA limit and nearly always in compliance with the 45 dBA limit that actually applies at this location because a complaint about noise has been received by the project. Three measurements out of 2430 were nominally above 45 dBA (0.1% of the time) but these levels were all observed during the sudden storm front that passed over the site on Feb. 9 when the background sound level had a variance of more than 10 dBA from one position to the next because of their geographical separation – meaning that the background value is unreliable at this particular time and that it is not a certainty that these levels just above 45 dBA were actually associated with the project. Nevertheless, if these three measurements are assumed to be project noise, the sound level is compliant with the applicable 45 dBA limit 99.9% of the time.

3.5.6 **Position 6 – W2741 County Road E**

The data collected at Position 6 is plotted in Figure 3.5.6.1 and the project-only levels are shown in Figure 3.5.6.2. A complaint about noise was also received at this location so the applicable limit is 45 dBA.

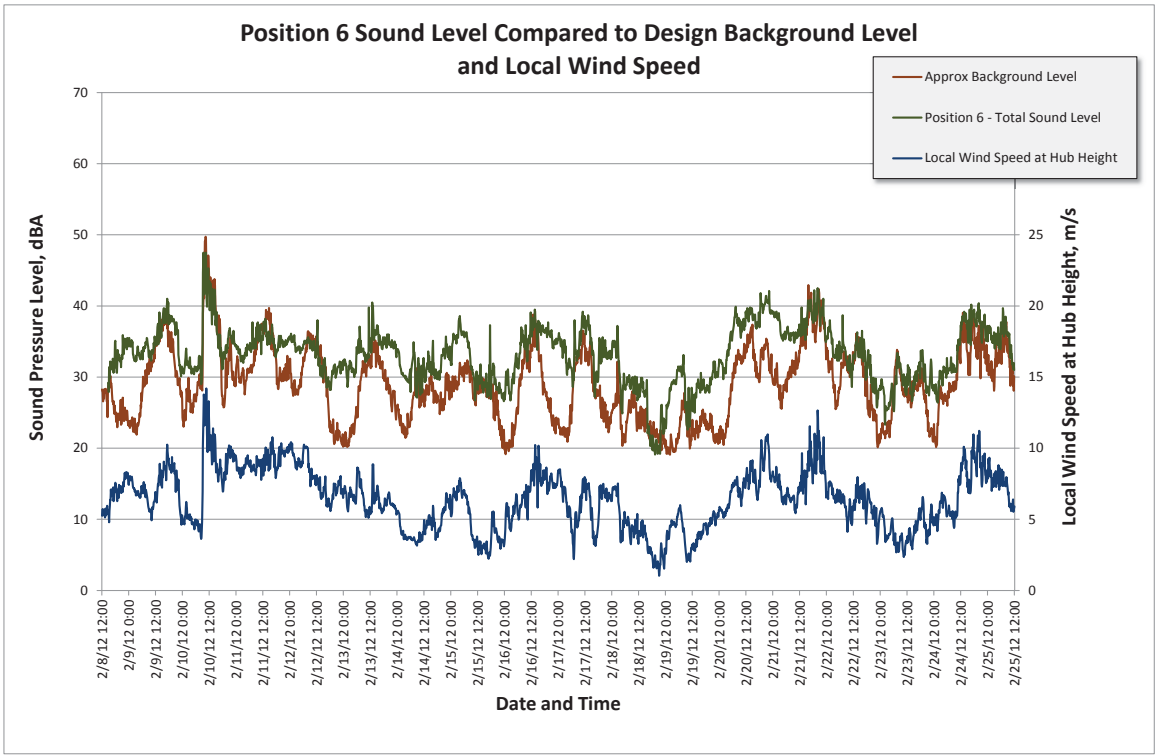


Figure 3.5.6.1

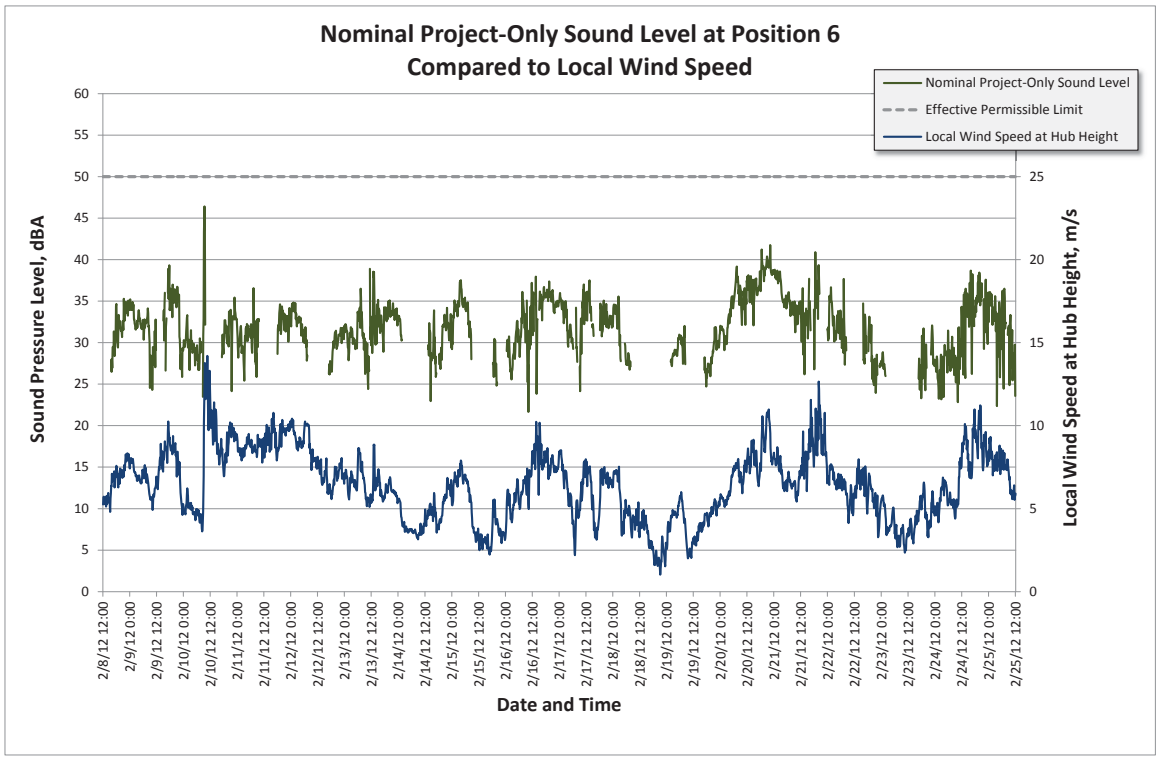


Figure 3.5.6.2

The result at this position is similar to the previous position in that the basic 50 dBA limit is certainly met at all times and the 45 dBA limit, which applies here, was only slightly exceeded once out of 2430 measurements. Consequently, the project sound level is considered in compliance with the State and local requirements.

In general, the project sound level is about 3 or 4 dBA lower than at nearby Position 5 although it is only about 100 ft. further from the nearest turbine. Since this small of a difference in distance would be inconsequential to the sound level, the actual difference appears to be associated with the wooded setting at Position 5 versus an open setting at the Position 6. In other words, tree rustle noise at Position 5 appears to have elevated the measured levels and the apparent project level suggesting that the results reported above for Position 5 are conservative.

3.5.7 **Position 7 – N8448 Larson Road**

The sound levels measured at Position 7 are plotted below.

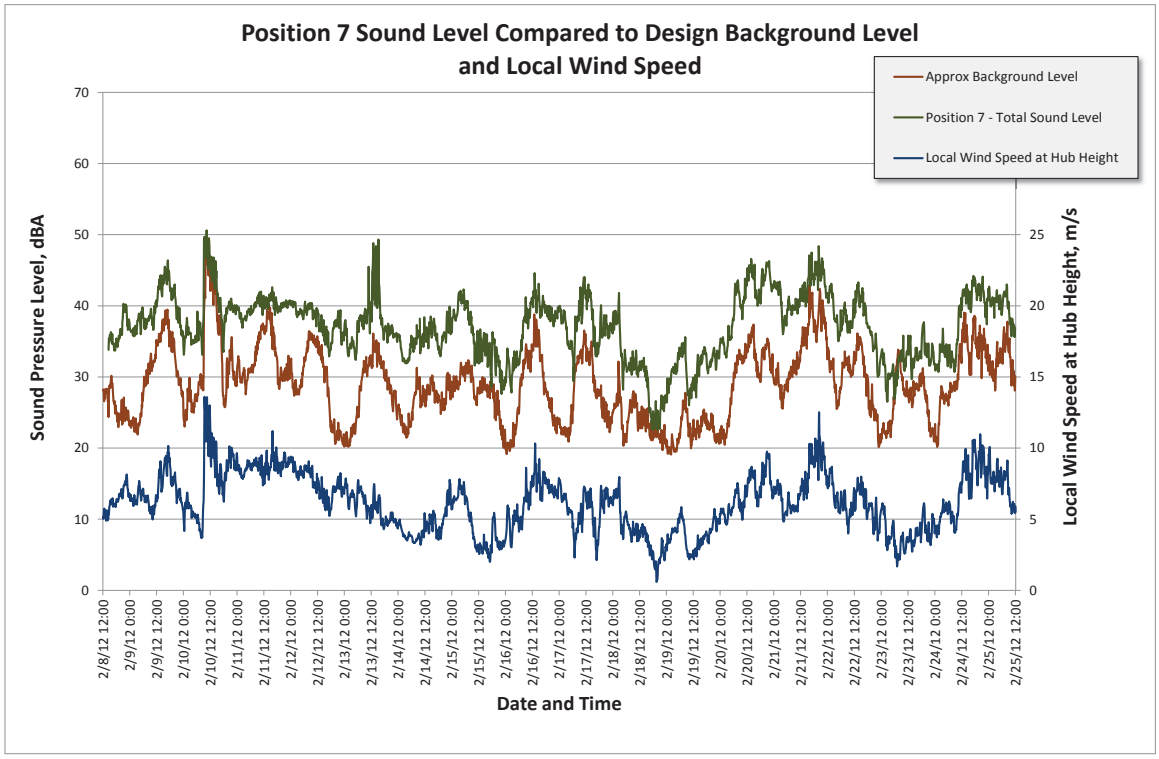


Figure 3.5.7.1

The nominal project-only sound levels are plotted below.

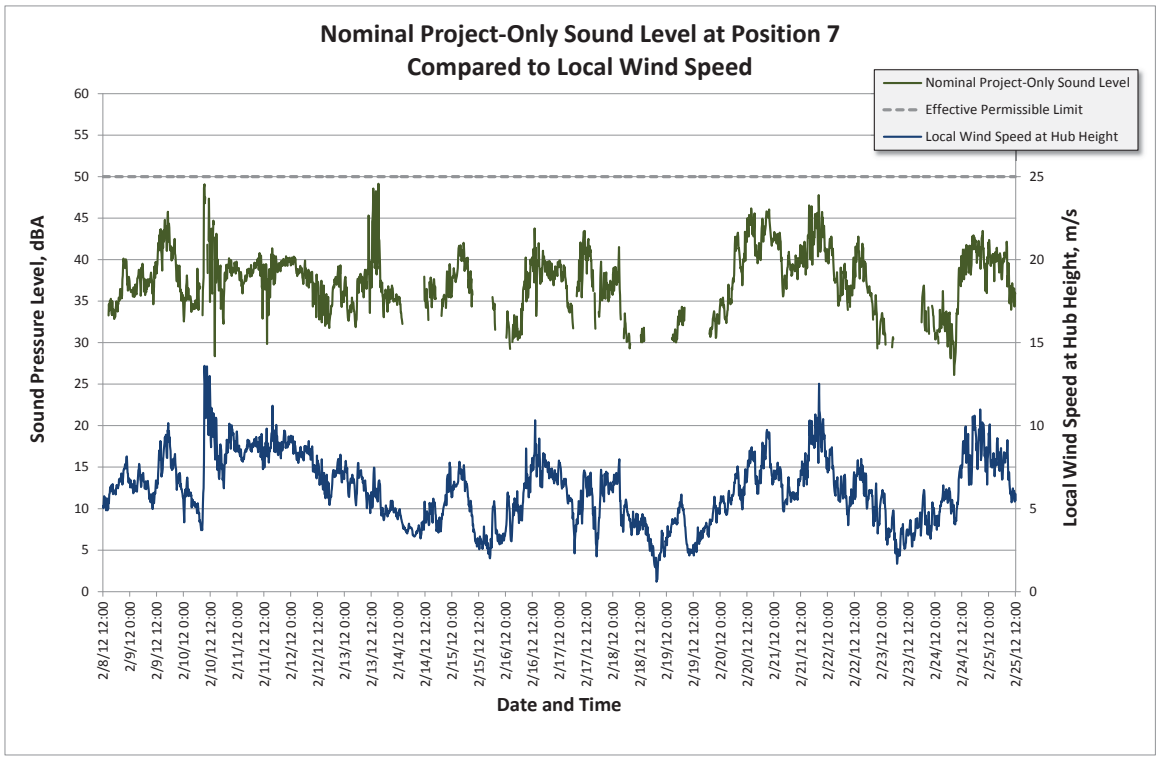


Figure 3.5.7.2

As Figure 3.5.7.2 shows the project sound level did not exceed 50 dBA at any time during the survey. 45 dBA is exceeded a small percentage (1.5%) of the time but is still compliant. The relatively high sound levels (above 45 dBA) around midday on 2/13 are somewhat suspect since there is no spike in the local wind speed at that time and they may well have been caused by farm activity rather than the project.

3.5.8 **Position 8 – Near 4115 Crown Road**

The sound levels measured at Position 8 are plotted below.

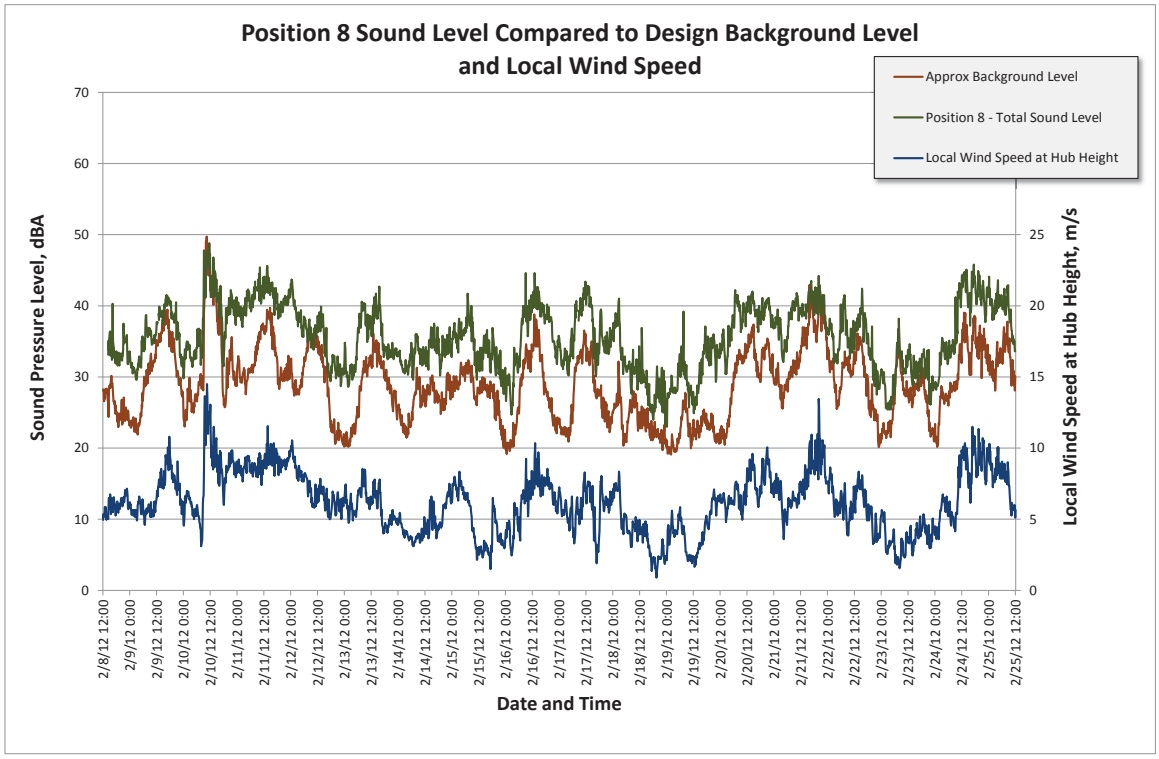


Figure 3.5.8.1

The project-only sound level, after correction for background noise, is plotted in Figure 3.5.8.2.

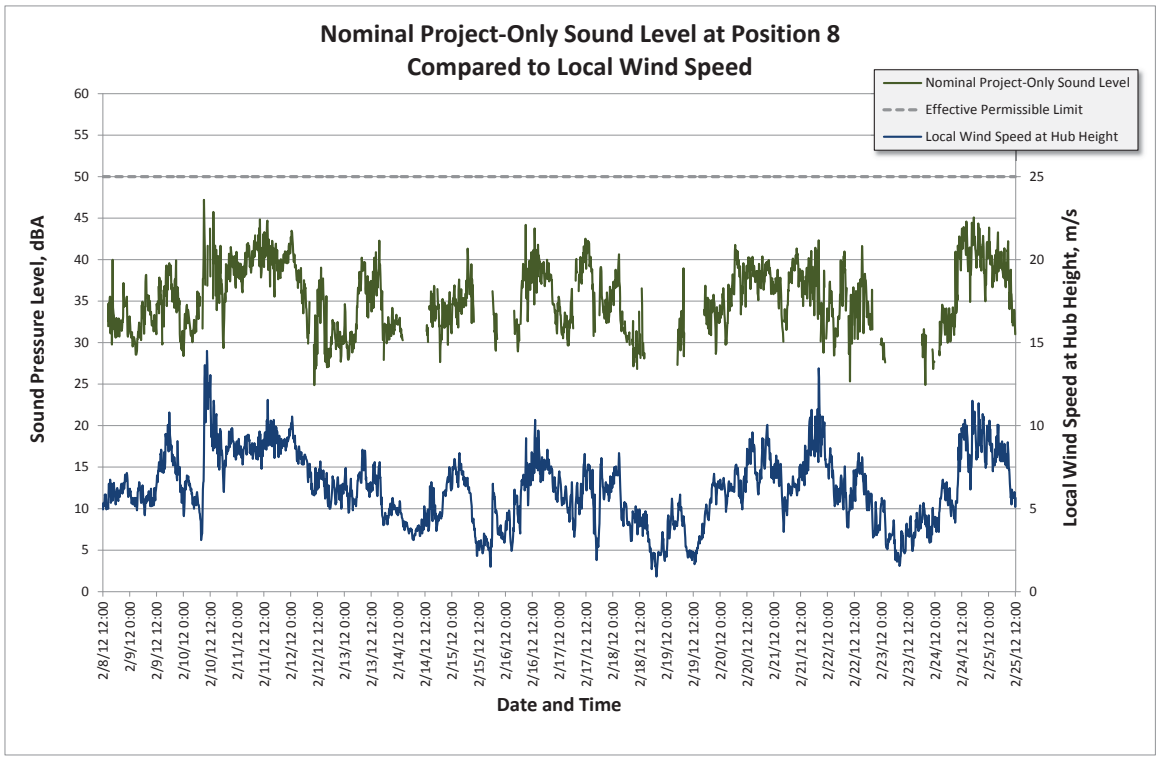


Figure 3.5.8.2

These results indicate that the project was in compliance with the 50 dBA limit at all times and only exceeded the more stringent 45 dBA limit in 3 out of 2411 measurements, or 0.1% of the time.

3.5.9 **Position 9 – Near N7665 Larson Road**

The sound levels measured at Position 9 are plotted below.

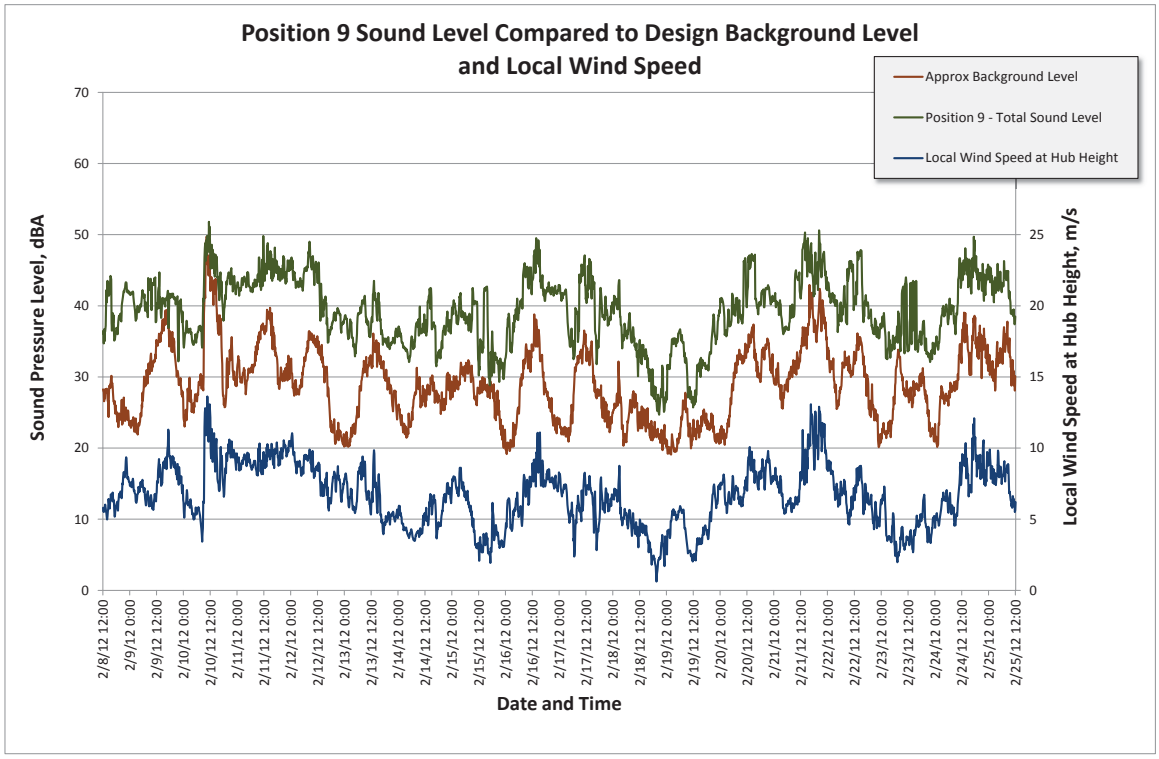


Figure 3.5.9.1

The apparent project-only sound level, after correction for background noise, is plotted in Figure 3.5.9.2. An adjustment of -1 dBA has also been applied to these results because the monitoring position was about 150 ft. closer to the nearest turbine than the minimum setback distance of 1250 ft.

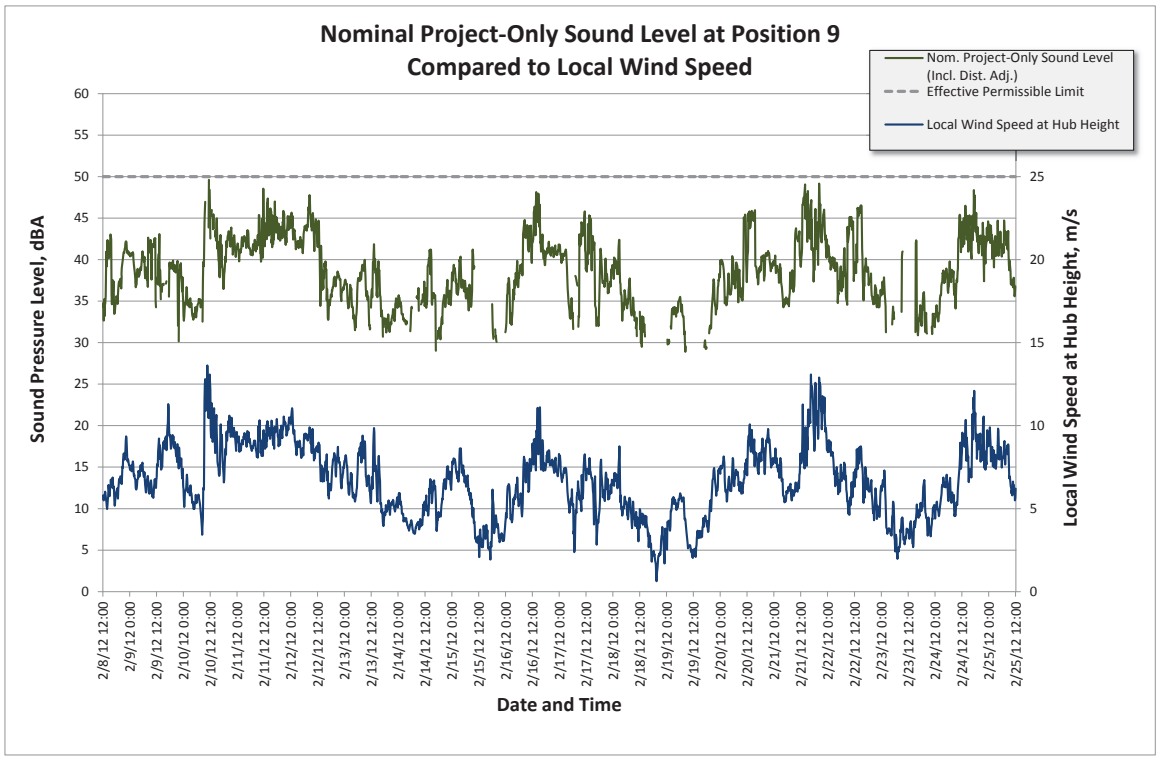


Figure 3.5.9.2

These results indicate that the project was in compliance with the 50 dBA limit at all times. The more stringent limit of 45 dBA was nominally exceeded 5.3% of the time (129 out of 2423) but it is suspected that local noise from some nearby trees may have adversely affected the results here.

3.5.10 **Position 10 – W2663 Vaughn Road**

The sound levels measured at Position 10 are plotted below.

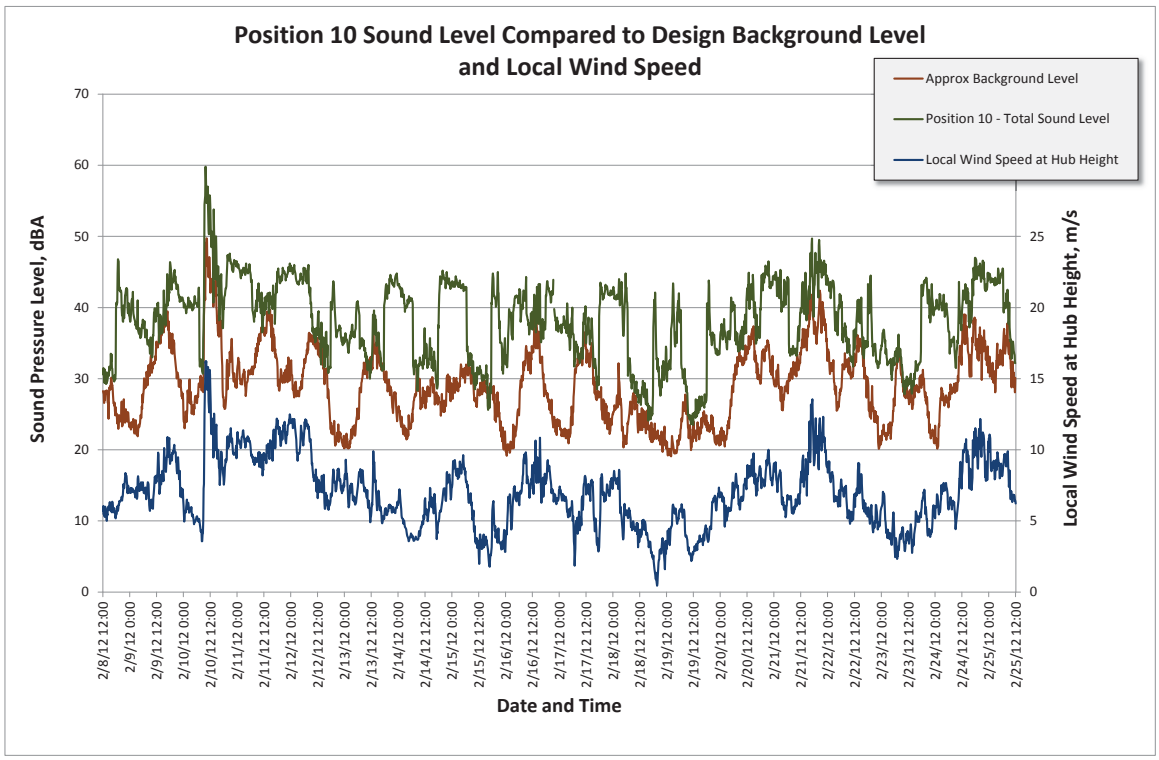


Figure 3.5.10.1

The sound level at Position 10 (green trace) exhibits signs of local contaminating noise in the sense that there are numerous occasions when the sound level suddenly rises or falls with no similar trend in the wind speed. For example, on the afternoon of Feb. 13 the sound level suddenly increases from 32 to 42 dBA, a very substantial increase, and remains relatively high until about 5 a.m. the following morning when the level suddenly returns to 32 dBA. Winds were generally light and diminishing throughout this period indicating that these sudden changes in sound level weren't associated with project noise or natural wind-induced sounds but rather were caused by some nearby man-made source. The same general phenomenon occurs the next day and on a number of other occasions.

Neglecting this odd behavior, the *apparent* project-only sound level, after correction for background noise, is plotted in Figure 3.5.10.2.

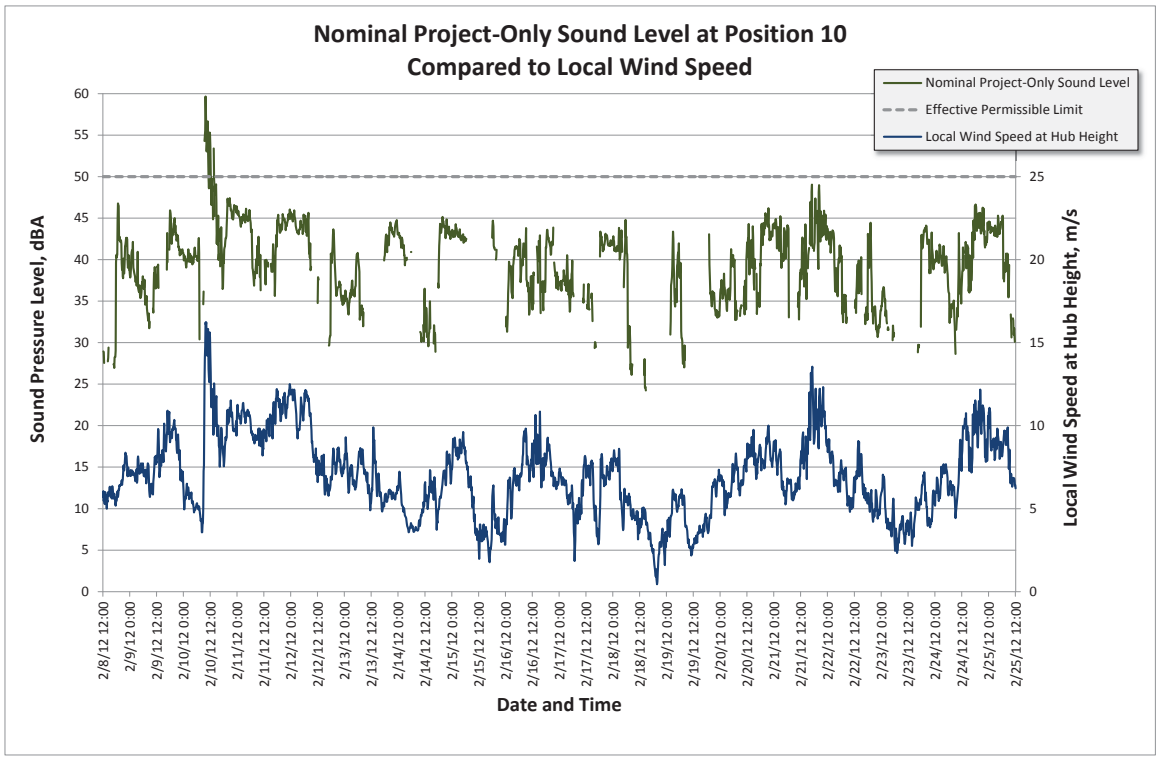


Figure 3.5.10.2

These results, despite the almost certain presence of contaminating local noise, indicate that the project was in compliance with the 50 dBA limit at least 99.3% of the time. The sound levels at this particular location were unusually high during the storm front on Feb. 10 for reasons that are unclear and are probably unrelated to the project.

The more stringent limit of 45 dBA was apparently exceeded 5.6% of the time (136 out of 2421 measurements) but the clear presence of contamination strongly suggests that this figure represents a gross overestimate of the project sound level. In general, a valid result for this location with respect to the 45 dBA limit cannot be determined from the available data.

3.5.11 **Position 11 – W638 E Friesland Road**

In contrast to the previous ten positions, which were at or near non-participating residences, Position 11 was at the nearest participating residence where a noise limit of 50 dBA (only) applies. Measurements were taken at this position over the last three days of the survey. The sound levels are plotted below.

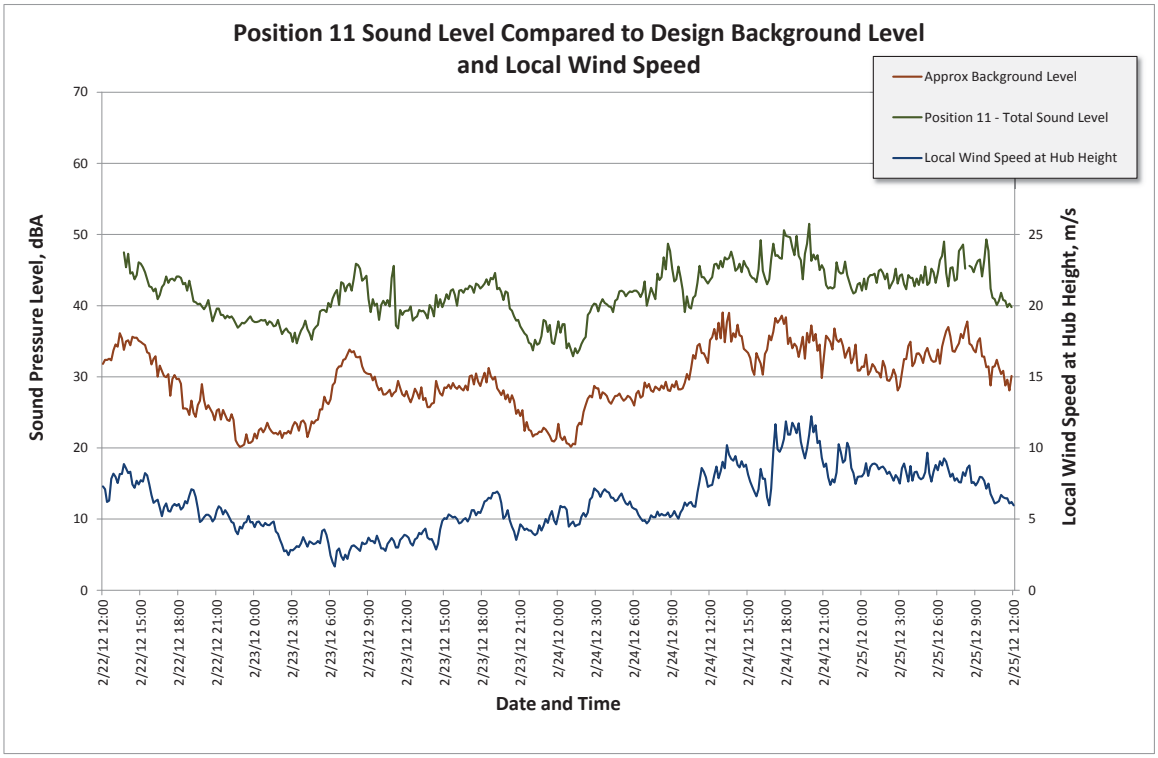


Figure 3.5.11.1

The nominal project-only sound level, after correction for background noise, is plotted in Figure 3.5.11.2.

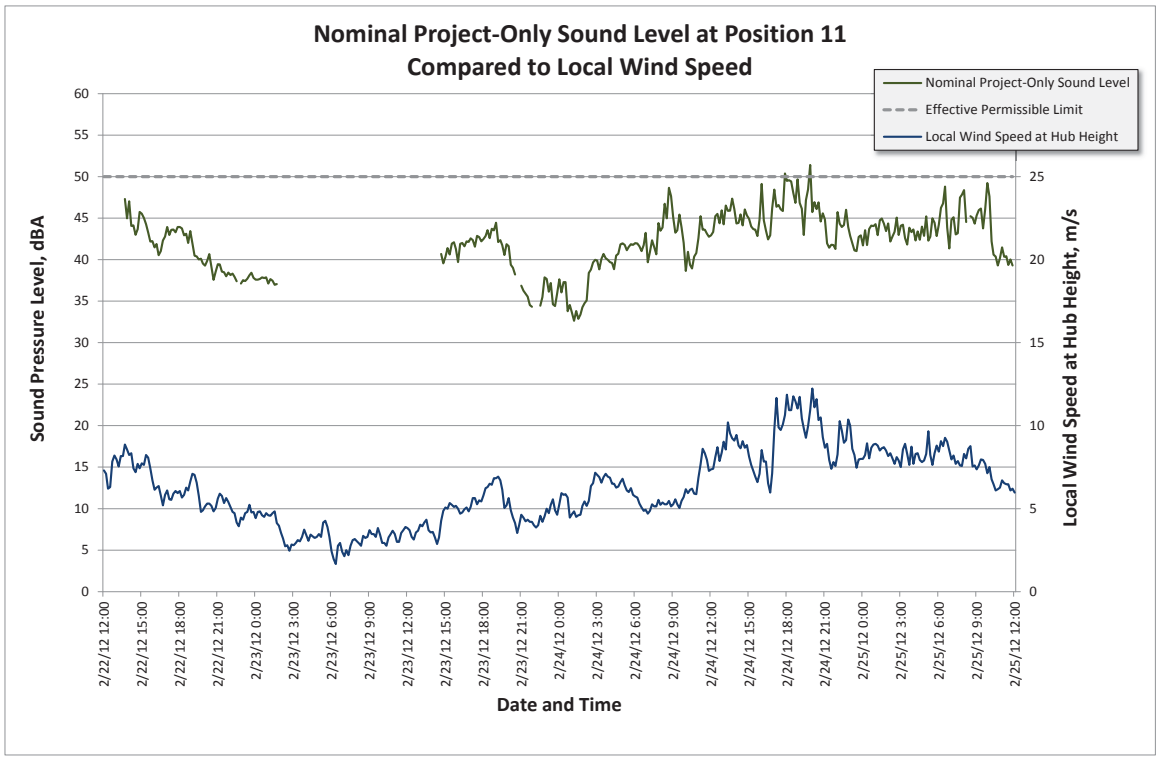


Figure 3.5.11.2

These results indicate that the project was in compliance with the 50 dBA limit at least 99.5% of the time; i.e. 2 measurements out of 421 were slightly over 50 dBA. It is not clear whether these levels were actually associated with the project, however, because this position, like Positions 1 and 2 discussed earlier, is fairly close to (1080 ft. south of) Highway 33. It is very likely that contaminating noise from traffic is elevating the results at this position. Nevertheless, it is clear that compliance is being achieved at this location, since the compliance rate is much greater than 95%.

4.0 SUMMARY AND CONCLUSIONS

An extensive field survey has been carried out to measure the sound levels produced by the Glacier Hill Wind Park in order to evaluate compliance with noise limits contained in the project's Certificate of Public Convenience and Necessity (CPCN) and the Joint Development Agreement (JDA) with the Town of Scott. The sound emissions from the project are essentially limited to 50 dBA by both agreements. A lower limit of 45 dBA would apply if the sound emissions were tonal in character or in the event of a complaint. At the time of the survey two noise complaints had been received and sound level monitoring stations were placed at those residences to evaluate compliance with the 45 dBA limit.

In accordance with the test protocol approved in advance by the Wisconsin Public Service Commission, several different measurement approaches were taken in order to follow the test procedures mandated in the JDA and in the latest version of the State's noise assessment protocol for electrical generating facilities. Short-term measurements were made at four principal design points, Sites 1 – 4, that were selected during the pre-construction background sound survey as locations with exposures to project noise replicating the exposure of the nearest non-participating

residences. The essential results of these measurements relative to the applicable noise limits are briefly summarized in Table 4.0.1 and discussed in further detail below.

Table 4.0.1 *Summary of Measured Project-Only Sound Levels Relative to Applicable Noise Limits at Principal Design Points (Sites 1 through 4) Based on Revised PSC Test Protocol*

Measurement Location	Maximum Measured Project-Only Sound Levels, dBA	Tone Observed	Applicable CPCN and JDA Noise Limit	Compliance with Applicable Noise Limit
Site 1	40.5 - 42.6	No	50	Yes
Site 2	35.7 - 38.1	No	50	Yes
Site 3	39.9 - 40.6	Yes	45	Yes
Site 4	37.7 - 37.8	No	50	Yes

These short-term sampling procedures were supplemented with a long-term monitoring program designed to capture a wide variety of wind and weather conditions at a large sampling of the nearest non-participating residences, including the two complaint locations.

Local Joint Development Agreement

The first measurement approach dictated by the JDA was to measure the total sound level (both background and project sound) with the project operating at Sites 1 – 4 at four times of day (morning, midday, evening and nighttime) over three different days. These results, expressed in terms of the L90 sound level, are summarized in the following table. Measurements were taken during three different wind conditions on 2/8, 2/9 and 3/1.

Table 4.0.2 *Total Measured Sound Levels (L90, dBA) per JDA Test Procedure (Includes both Project and Background Noise)*

Site	Time of Day	Moderate Winds (2/8)	High Winds (2/9)	Light Winds (3/1)	Tone Observed
1	Morning	38.6	41.5	40.9	No
	Midday	36.9	45.7	32.9	No
	Evening	38.6	43.2	31.5	No
	Night	43.2	43.3	36.3	No
2	Morning	33.3	36.6	35.2	No
	Midday	31.1	37.7	26.4	No
	Evening	33.3	39.5	27.4	No
	Night	36.6	39.1	30.3	No
3	Morning	35.6	38.3	33.5	No
	Midday	32.3	41.4	30.3	No
	Evening	39.1	41.6	26.3	No
	Night	38.9	41.5*	24.3	*Tone observed at 160 Hz (2/9)
4	Morning	35	39	37.7	No
	Midday	38.1	41	33.3	No
	Evening	39.1	44.2	34.8	No
	Night	35.8	38.6	24.4	No

In general, these results indicate full compliance with the Town of Scott Joint Development Agreement limit of 50 dBA even without making any adjustment for background noise. In the single instance where a tone was observed the total sound level was well below (41.5 dBA) the more stringent 45 dBA limit that would apply under those circumstances.

State Public Service Commission Test Protocol

The second approach, deriving from the updated PSC test procedure, was to take measurements at Sites 1 – 4 at three different times of day measuring first the operational sound level and then, a short time later, the background level with all units within about a mile of each measurement positions temporarily shut down. The results for each site are summarized in the following tables.

Table 4.0.3 *Summary of Site 1 On-Off Measurements*

Sample Time and Ave. 80 m Wind Speed	Measure	A-weighted Sound Level, dBA		Nominal Project-Only Sound Level, dBA	C-weighted Sound Level, dBC	
		Project On	Project Off		Project On	Project Off
Midday 2:30 p.m. 9 m/s	Leq	49.7	49.2		66.5	66.4
	L10	52.2	52.7		69.1	70.8
	L50	48.5	47.3		64.1	62.7
	L90	45.7	42.8	**42.6**	61.5	57.9
Evening 7:20 p.m. 8.9 m/s	Leq	44.5	42.0		62.7	61.5
	L10	45.8	45.0		64.3	63.4
	L50	44.3	41.8		62.2	58.9
	L90	43.2	39.8	**40.5**	60.6	56.6
Night 11:30 p.m. 7.7 m/s	Leq	44.6	40.5		61.5	56.7
	L10	45.8	42.3		62.9	58.5
	L50	44.3	40.1		60.9	56.2
	L90	43.3	38.2	**41.7**	59.1	54.4

Table 4.0.4 *Summary of Site 2 On-Off Measurements*

Sample Time and Ave. 80 m Wind Speed	Measure	A-weighted Sound Level, dBA		Nominal Project-Only Sound Level, dBA	C-weighted Sound Level, dBC	
		Project On	Project Off		Project On	Project Off
Midday 1:50 p.m. 8.2 m/s	Leq	45.3	44.7		63.8	63.9
	L10	42.1	39.9		66.8	67.5
	L50	39.1	35.5		61.2	60.9
	L90	37.7	33.4	**35.7**	57.2	55.4
Evening 6:40 p.m. 9.6 m/s	Leq	42.4	38.6		65.3	62.8
	L10	42.8	37.7		68.1	66.4
	L50	40.7	35.5		61.4	58.3
	L90	39.5	33.8	**38.1**	57.5	52.9
Night 11:30 p.m. 7.7 m/s	Leq	40.5	35.0		64.7	62.6
	L10	41.7	36.8		68.2	66.0
	L50	40.3	34.5		61.4	58.8
	L90	39.1	32.8	**37.9**	57.0	52.5

Table 4.0.5 *Summary of Site 3 On-Off Measurements*

Sample Time and Ave. 80 m Wind Speed	Measure	A-weighted Sound Level, dBA		Nominal Project-Only Sound Level, dBA	C-weighted Sound Level, dBC	
		Project On	Project Off		Project On	Project Off
Midday 1:20 p.m. 8.9 m/s	Leq	43.1	42.1		65.3	65.8
	L10	44.5	43.7		68.2	69.2
	L50	42.9	38.6		62.7	62.6
	L90	41.4	36.1	**39.9**	60.2	58.2
Evening 6:00 p.m. 9.5 m/s	Leq	50.1	38.8		65.3	65.2
	L10	46.3	40.5		68.3	68.5
	L50	43.4	38.0		61.3	60.7
	L90	41.6	36.0	**40.2**	58.6	54.9
Night 11:30 p.m. 8.0 m/s	Leq	43.2	38.1		64.4	60.6
	L10	44.6	39.6		67.6	63.9
	L50	42.9	36.2		60.8	56.8
	L90	41.5	34.1	**40.6**	57.5	53.6

Table 4.0.6 *Summary of Site 4 On-Off Measurements*

Sample Time and Ave. 80 m Wind Speed	Measure	A-weighted Sound Level, dBA		Nominal Project-Only Sound Level, dBA	C-weighted Sound Level, dBC	
		Project On	Project Off		Project On	Project Off
Midday 12:40 p.m. 8.3 m/s	Leq	47.4	47.3		65.5	65.5
	L10	50.8	51.5		68.5	69.8
	L50	45.2	43.7		62.0	61.7
	L90	41.0	38.3	**37.7**	57.9	55.1
Evening 5:20 p.m. 11.8 m/s	Leq	51.1	49.1		68.5	64.8
	L10	54.6	52.4		71.8	68.3
	L50	49.3	46.9		66.5	62.2
	L90	44.2	43.1	**37.7**	61.2	57.1
Night 9:40 p.m. 8.8 m/s	Leq	45.8	41.6		59.2	54.1
	L10	49.7	44.5		61.0	57.7
	L50	42.2	33.3		57.7	50.7
	L90	38.6	30.7	**37.8**	55.4	47.1

These results indicate that the L90 sound level, the best indicator of project sound exclusive of contamination from both audible noise events and microphone self-noise, was well below 50 dBA at all positions after correction for background noise. At Site 3 a mild tone was detected during the nighttime measurement (only) but, as mentioned above, the overall sound level was well below the more stringent 45 dBA limit that would apply.

Long-term Measurements

As a supplement to these two short-term measurement approaches, long-term monitors were set-up at or near 10 non-participating residences with maximum proximity/exposure to project noise

and at the nearest participating residence. A total of over 2400 10 minute samples were taken on a continuous day and night basis over a 17 day period at each of the monitoring stations. The survey was carried out from February 8 to February 25, 2012 during wintertime conditions. A number of high wind periods, wind directions and atmospheric conditions were captured during the survey. Essentially all of the turbines were in normal operation throughout the survey.

Four positions were set-up off the site in the four cardinal directions to develop a time history of the approximate background level that was likely occurring on the site (in the area surrounded by these monitors) at any given time during the survey. This approximate background level was then subtracted from the total levels measured at the on-site locations to derive the *apparent* project-only sound level. It is very important to note that this technique tends to yield highly conservative results and overestimate the project sound level because any sound level measured at an on-site receptor that is 3 dBA higher than the approximate background level is assumed to be attributable to the project. Consequently, unrelated but sustained noise from such things as nearby trees rustling in the wind, planes flying over, farm activity, etc. can be easily misconstrued as project noise. Thus the results from this approach must be considered the maximum sound level that could *possibly* have been generated by the project, but any given noise peak cannot be conclusively attributed to the project.

The specific results for the 11 on-site receptor locations are tabulated below. The measured performance relative to the fundamental limit of 50 dBA is expressed in terms of the percentage of the time the *apparent* project sound level was below that limit. In accordance with the test protocol, a value of 95% or greater is considered compliant. The compliance rate with the more stringent limit of 45 dBA, which applies in cases where a noise complaint has been lodged, is also given for reference wherever a reasonably credible result could be obtained. As discussed above, any significant source of local background noise can easily skew the results or make it impossible to quantify the project-only sound level because the signal (project) to noise (background) ratio is too low. In general, the closer the threshold level gets to the normal background level the harder it is to clearly detect the project. Consequently, a reliable or meaningful result could not be obtained with respect to the relatively low 45 dBA criterion in all cases.

Table 1.1.7 *Summary of Long-Term Results at On-Site Receptor Positions*

Measurement Position	Apparent Compliance Rate with Basic Limit of 50 dBA	Apparent Compliance Rate with Secondary Limit of 45 dBA	Comments	Overall Compliance with Applicable Limit
1	**>97.6%**	Project sound level undetectable	Local sound levels dominated by traffic noise	Yes
2	**>99.5%**	Project sound level undetectable	Local sound levels dominated by traffic noise	Yes
3	**100%**	100%		Yes
4	**99.1%**	Project sound level not clearly discernible	Local sound levels dominated by tree rustle	Yes
5	100%	**99.9%**	Complaint received but in compliance with 45 dBA limit	Yes
6	100%	**100%**	Complaint received but in compliance with 45 dBA limit	Yes
7	**100%**	98.5%		Yes
8	**100%**	99.9%		Yes
9	**100%**	94.7%	Result possibly elevated due to local tree rustle noise	Yes
10	**99.3%**	Project sound level not clearly discernible	Local sound levels often dominated by unidentified man-made noise	Yes
11	**>99.5%**	n/a Participating Residence	Local sound levels dominated by traffic noise	Yes

Since the apparent project sound level, probably including at least some background interference, was found to be lower than the 50 dBA limit more than 95% of the time in all cases it can be concluded that the project is in compliance with the basic State and local noise requirements. In the two instances where noise complaints were known to have been received prior to the survey, at Positions 5 and 6, the measured levels were, conservatively, found to be compliant with the more stringent 45 dBA sound level.

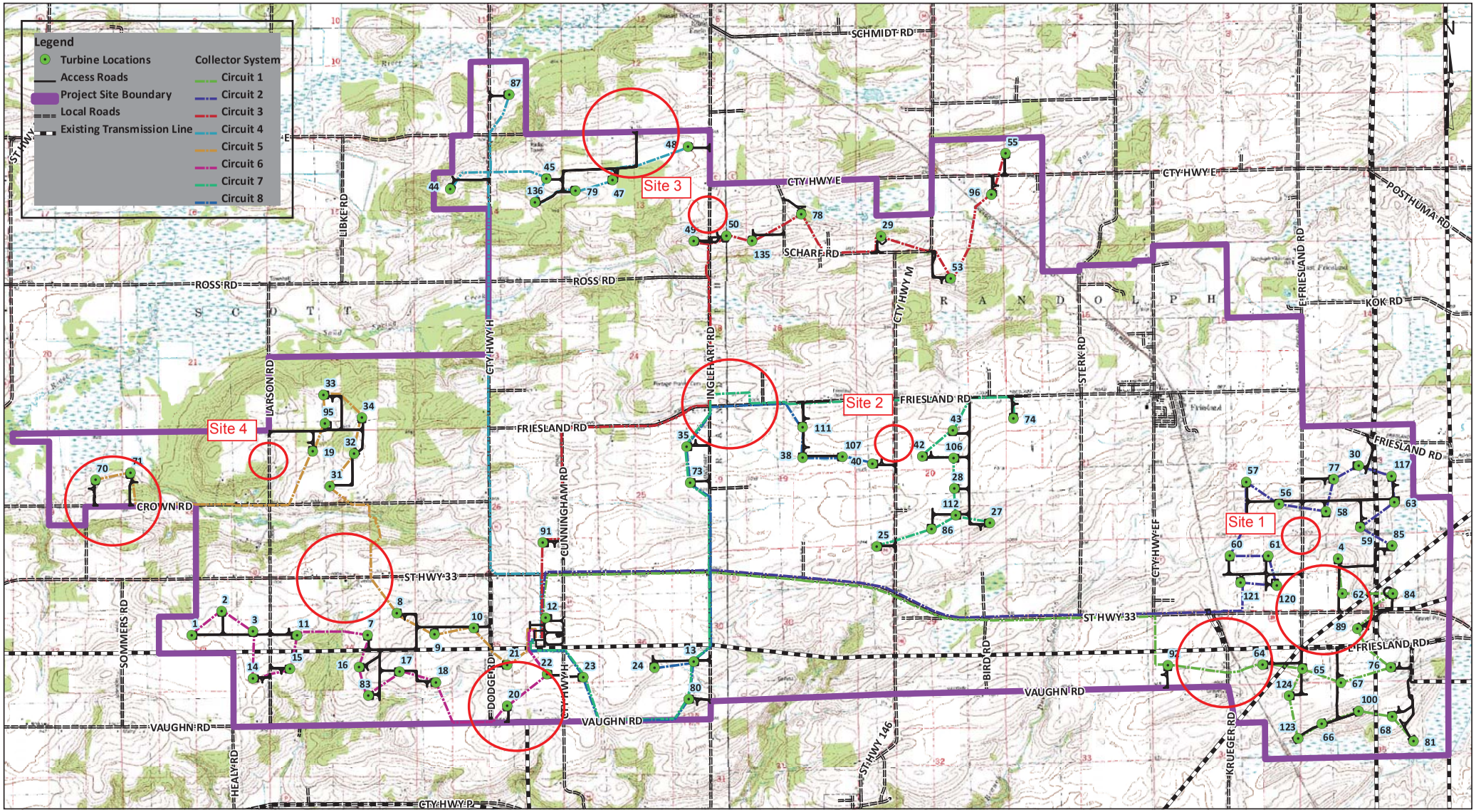
In general, then, the project was found to be in compliance with both the CPCN and JDA noise requirements using three separate test methodologies.

END OF REPORT TEXT

REFERENCES

[1] Hessler, G. F., Hessler, D.M., Brandstaett, P., Bay, K, "Experimental study to determine wind-induced noise and windscreen attenuation effects on microphone response for environmental wind turbine and other applications", *Noise Control Engineering Journal*, J.56, July-August 2008.

[2] Bowdler, D., Leventhall, G. editors, *Wind Turbine Noise*, Chapter 7 "Measuring and Analyzing Wind Turbine Noise", Multi-Science Publishing Co. Ltd, Essex, UK, 2012.

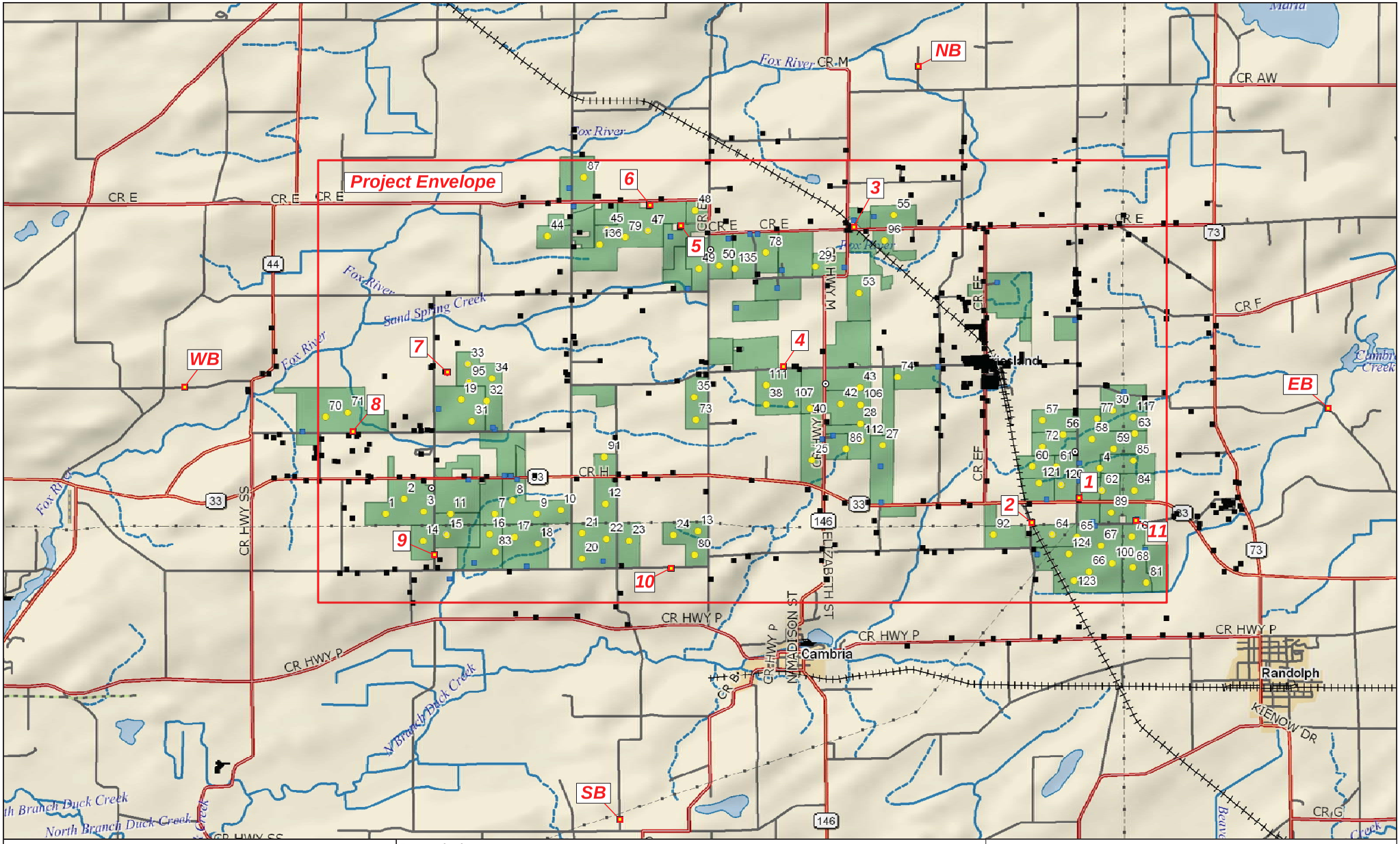


Data Sources may include WDNR, Columbia County Land Information Department, We Energies, NRCStantec, and Kapur.

Site Facility Locations
Glacier Hills Wind Park
We Energies
Columbia County, Wisconsin

Proposed On-Site Sound Measurement Locations
Sites 1 to 4 Correspond to Pre-Construction Measurement Points

Issue Date: 01/11/2012



Project: **Glacier Hills**	*Description:* **Graphic A**
Prepared for: **We Energies**	**Sound Monitoring Positions**
Date: □pri□□□2□12	*Drawing #:* □□-□e□-P-1-1

Legend:

- Monitor□Location
- □esidence
- Participatin□Propert□

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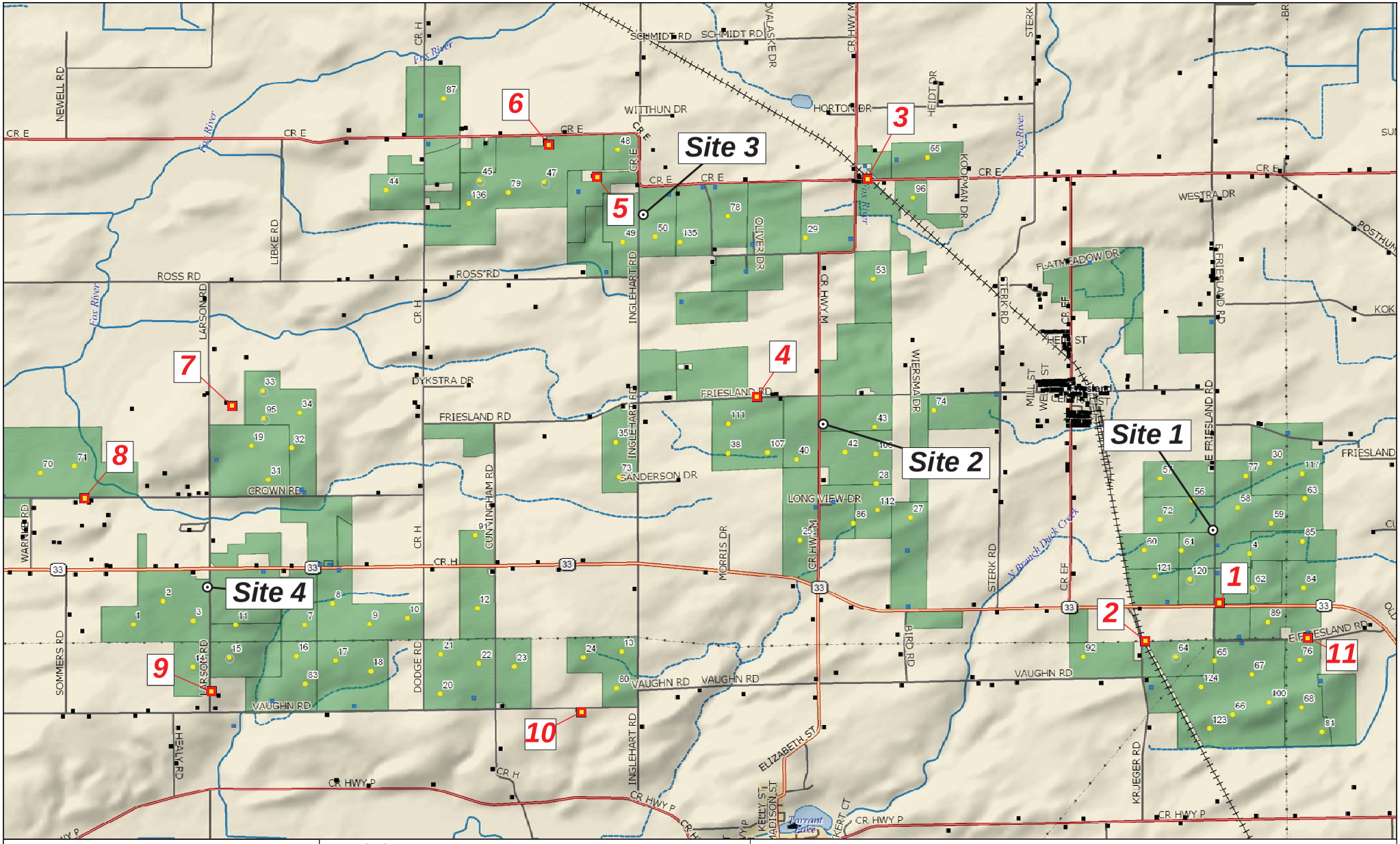

Project: **Glacier Hills**	*Description:* **Graphic B**	*Legend:* Monitor Location; Manual Measurement Location; Residence; Turbine Location; Participating Property
Prepared for: **We Energies**	**On-Site Sound Monitoring Positions**	
Date: April 2, 2012	*Drawing #:* 12-046-P-1-1	

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□□C□□□C□L MEMORANDUM

Title:	**Operational Sound Level Survey Test Protocol**
Project:	**Glacier Hills Wind Park**
Location:	**Columbia County, WI**
Prepared For:	**We Energies**
Prepared By:	**David M. Hessler, P.E.**
Revision:	**A**
Issue Date:	**February 2, 2012**
Reference No:	**TM-011312-A**
Attachments:	**State and Local Noise Restrictions** **Proposed Sound Measurement Locations**

1.0 Introduction

This protocol summarizes the field test procedures to be used in evaluating the sound emissions from the Glacier Hills Wind Park (GHWP) relative to applicable State and local noise limits once the project is fully operational. The procedure is two-pronged in the sense that short-term manual measurements will be taken in accordance with the latest version of the "Measurement Protocol for Sound and Vibration Assessment of Proposed and Existing Electric Power Plants" (Wisconsin Public Service Commission, May 2010) and long-term automated measurements will be taken by continuously recording monitors over a period of two weeks in order to capture project noise under a variety of wind and weather conditions.

It is important to note that the noise limits expressed in the CPCN and town agreement apply exclusively to sound levels produced by the project and do not include any background noise from unrelated sources, such as cars passing by, trees rustling in the wind, planes flying over, etc. Consequently, the aim of the survey is to quantify the project-only sound level, which will generally involve subtracting the likely concurrent background sound level from the total measured level at measurement locations within the project area.

In general, it is also important to note that many customary techniques that have long been successfully used to test, say, a conventional fossil fueled power plant either cannot be applied to wind turbine projects or must be modified in recognition of the fact that the sound emissions from the project are wholly dependent on, rather than independent of, the wind, weather and general atmospheric conditions. For instance, the usual approach of taking sound measurements during quiet, low wind conditions to avoid contamination from wind-induced background sounds cannot be employed because the project is likely to

be idle during such circumstances. Almost by definition one is required to measure during windy condition so a number of special measurement techniques are needed that are applicable only to the unique circumstances of wind turbine projects.

The general concept of the long-term test is to measure continuously over a two week period with automated monitors at a number of key test points both on and off the site to record sound levels during a range of wind and atmospheric conditions. The off-site measurements will be used to estimate the background level during any given measurement interval so the on-site measurements can be corrected. It is essential in wind turbine surveys to use the background level recorded at the same time as the operational sound measurement so that all the weather parameters - such as wind speed, wind direction, wind gradient, thermal gradient, turbulence, cloud cover, precipitation, etc. – are the same and directly comparable. Both wind turbine and background sound levels are highly variable with time and the specific atmospheric conditions occurring at that instant; consequently, it is not practical to generalize about the background sound level based solely on wind speed and correct a measurement of operational sound with a background level measured at some other time.

2.0 Permissible Sound Levels

Sound emissions from the project are limited by the Certificate of Public Convenience and Necessity (CPCN) Order (Sections 10 and 11) and by the terms of an agreement with the Town of Scott (Section 13). The full text of both documents relating to noise is appended to this protocol. Both documents are fundamentally the same in intent and limit project noise to **50 dBA** at adjacent residences or other potentially sensitive receptors.

A provision in the CPCN lowers the permissible nighttime (10 p.m. to 6 a.m.) sound level to 45 dBA during the warmer months of the year (April 1 to September 30) if any complaints about nighttime noise are received.

The agreement with the town also lowers the permissible sound level to 45 dBA if the project produces a prominent pure tone per the definition in Section 3.2.26 of EPA Report 550/9-76-003, which evaluates tones in terms of the prominence of a single 1/3 octave band above the average level of the two adjacent bands. More specifically, a prominent pure tone would be said to exist if the band containing the tone is higher than the average of the adjacent bands by the following frequency dependent amounts:

15 dB for frequencies lower than or equal to 125 Hz
8 dB for frequencies between 160 and 400 Hz, inclusive
5 dB for frequencies equal to or above 500 Hz

The local agreement generally follows the WPSC test protocol by specifying that the measurements shall be taken as 10 minute L90 samples at 4 different times of the day (early morning, mid-day, early evening and night) for three days (including weekdays and weekends and while the project is operating).

3.0 Instrumentation and Set up

3.1 Short-term Measurements

The manned short-term measurements will be taken using an ANSI Type 1 precision 1/3 octave band analyzer to measure not only the overall sound level but also the frequency spectrum in 1/3 octaves in order to evaluate the potential presence of pure tones. 10 minute samples will be taken at the 4 sites used

during the pre-construction sound surveys carried out in June of 2008 and July of 2009 (Identified as Sites 1 – 4 on the accompanying site plan). In accordance with Section V of the PSC Protocol, three sets of measurements will be made at these locations during calm conditions when the nearest turbines are essentially idle and again during wind conditions "just above the cut-in speed for the wind turbines". A reasonable effort will be made to obtain both the on and off samples during the same times of day.

When there is sufficient wind for the project to operate, measurements, possibly overlapping some of those just described, will also be taken during the early morning, midday, early evening and nighttime hours over three not necessarily consecutive days as described in Section 13a of the local Joint Development Agreement. Both A-weighted and C-weighted Leq, L10, L50 and L90 levels will be recorded during all of these manned measurements. The instrument shall be field calibrated at the beginning and end of each measurement period.

Along with the time and weather conditions, observations will also be recorded and reported regarding the audibility of the project and background sounds. The average A and C-weighted background sound levels measured concurrently by the long-term, off-site monitors (discussed below) will be used to make any appropriate corrections to the on-site measurements in order to derive the project-only sound level at each position.

3.2 Long-term Measurements

The instruments used shall be Type 2 or better per ANSI S1.4-1983 (R2006) *American National Standard for Sound Level Meters* and shall be capable of integrating and storing the A-weighted L90 statistical sound level in 10 minute increments over a 14 day survey period. The instruments shall be field calibrated at the beginning of the survey and checked at the end of the survey for possible drift. Any variance from the original pre-survey reading shall be recorded and noted in the survey report. All instruments shall be synchronized to local time or control room SCADA system time, if significantly different.

The meters shall be protected from the elements inside weather-proof cases and the microphones shall be fitted with hydrophobically treated windscreens with a minimum diameter of 7" (ACO Pacific WS7-80T, or similar). Standard 3" windscreens are unacceptable.

Each meter shall be mounted on a post or tripod such that, where possible, the microphone is located at 3 ft. above local grade. This is to minimize the wind speed incident on the microphone. Wind speed diminishes rapidly close to surface, theoretically going to zero at the ground or boundary layer. Care should be taken that the instrument is positioned no closer than about 20 ft. from any large reflective surface or building to avoid reflections.

The selected measurement position should be representative of the sound environment experienced at and around nearby houses and away from any sources of local contaminating noise, such as HVAC systems, farm equipment, on-going human activity, etc.

In addition to the sound measurement equipment a temporary weather station shall be set up at at least one measurement position to record in 10 minute increments the wind speed at 3 ft. above ground level (microphone height), wind direction and rainfall during the survey. This selected location(s) shall be at measurement stations that are fairly open and exposed to the wind.

Arrangements shall be made to obtain, once the survey is completed, the wind speed and direction data (in 10 minute increments) from all on-site met towers for the survey period. In addition, a time history of the operating parameters of the project as a whole and each turbine shall be recorded by the SCADA system and made available after the survey for correlation to the measured sound levels.

4.0 On-Site Measurement Locations

Monitors will be set up at Sites 1 through 4 to supplement the intermittent manned measurements at those locations. In addition, approximately 6 to 7 additional locations will be established at or near residences with maximum exposure and proximity to project turbines. Proposed locations are illustrated on the attached graphic. The specific locations for all of the monitors will need to be verified in the field pending the suitability of the locations and landowner permission. The positions will be selected to sufficiently cover the entire project area and capture points at or near non-participating residences where maximum project sound levels can be expected to occur.

The data measured at each location shall be evaluated and corrected for spurious noise events, which typically manifest themselves as short-duration noise spikes that are not evident at any other location. Any such isolated spikes that are not accompanied by a simultaneous spike in wind speed (as measured by the on-site met tower(s)) shall be disregarded. Any measurements obtained during periods of liquid precipitation, if any, shall be neglected.

5.0 Off-Site Measurement Locations and Background Noise Correction

In addition to the on-site measurement locations, 4 background monitor stations shall be established at off-site locations generally North, South, East and West of the project area that are at least 1.5 miles from the nearest turbine but no more than 2.5 miles. The selected locations shall be similar in setting and general circumstances to typical on-site positions, the objective being to record the "proxy" background sound level that would have probably existed at the on-site locations at any given time during the survey.

The L90 levels measured at these four off-site positions shall be plotted together to evaluate their consistency over the survey. Based on the homogeneous nature of the site area and its surroundings it is anticipated that the sound levels will be similar in the sense that they intertwine with one another and no one position is consistently higher or lower than the others. If that turns out to be the case the arithmetic average of all four shall be used as the design background level for the survey after any spurious noise spikes (i.e. apparently local noise events occurring at only one position), are discarded. If the off-site levels are substantially dissimilar, a design background level shall be derived from the available results in a manner deemed reasonable and appropriate by the test engineer and the rationale shall be clearly explained in the test report.

The design background level obtained from the off-site monitors shall be used to derive the project-only sound level at the on-site test locations through logarithmic subtraction of like quantities; for example, the L90 background level for a particular 10 minute time period shall be subtracted from the L90 level measured at each on-site position during that same time period. The general formula for this subtraction is as follows:

$$Lp_{Project} = 10 \log [10^{(Lp_{Total}/10)} - 10^{(Lp_{Background}/10)}], \text{ dBA} \quad (1)$$

Where,

$Lp_{Project}$ = the sound pressure level associated exclusively with the project, dBA
Lp_{Total} = the total measured sound level at an on-site receptor positions, dBA
$Lp_{Background}$ = the design background level derived from the off-site monitor data, dBA

This correction process is only relevant to samples recorded while the turbines were actually in operation and not necessarily to all samples; consequently, the data must be sifted to ignore all periods of calm winds. This can be accomplished by dealing only with data sets collected above the effective cut-in wind speed for the turbine model in question (bearing in mind whether that wind speed is measured at 10 m or hub height) or, more preferably, by comparing the measured data to a time history of project electrical output obtained from the SCADA, or project control system. For this latter option it is best to compare the operational output of the 2 or 3 units closest to each on-site measurement position rather than the total project output because this not only accurately defines the on and off times at each monitoring station but also may reveal that certain units were temporarily down for maintenance or due to some unexpected malfunction. The goal of the survey will be to measure during normal operating conditions with all or nearly all units functioning.

Because the proxy background level is, for practical reasons, an inexact estimation of the site-wide background level, there will usually be instances when the background level exceeds the total measured level at certain on-site positions. Under this circumstance, and when the background level is below but within 3 dB of the total level, the project-only sound level shall be considered indeterminate. The subtraction using Eqn. (1) above shall only be performed when the background level is between 3 and 10 dB below the total measured level. When this difference is greater than 10 dB the background level is inconsequential and no correction is needed.

6.0 Correction for Wind-induced Distortion

One of the principal errors in measuring wind turbine noise is false signal noise from wind blowing through the windscreen and over the microphone tip, which is manifested in the form of artificially elevated sound levels in the lower frequency bands. Some degree of distortion is essentially inevitable in any measurement taken above ground level when the wind is blowing, even when using an extra-large windscreen as required for this survey.

The correction factors for a limited number of common windscreens have been developed through wind tunnel testing carried out by Hessler and Brandstätt in 2008[1] in which conventional ½" microphones fitted with an array of windscreens were subjected to known wind velocities in a massively silenced wind tunnel. The measured sound levels during each test were essentially a direct measure of the false-signal noise. Thus for a specific windscreen it is possible to estimate for any reasonable wind speed the overall A-weighted sound level of the distortion and then subtract it from the total measured level to reverse the error.

An example is shown in Figure 6.0.1 where the overall A-weighted level of self-noise is calculated as a function of wind speed and subtracted from the as-measured sound level. The plot is a three day detail of a wind turbine survey where oversized 175 mm (7") diameter treated windscreens (ACO Model WS7-80T) were used. This particular windscreen was found to be the best performer, in terms of minimizing wind-induced self-noise, in the wind tunnel study.

[1] Hessler, G. F., Hessler, D. M., Brandstätt, P., Bay, K., "Experimental study to determine wind-induced noise and windscreen attenuation effects on microphone response for environmental wind turbine and other applications", *Noise Control Engineering Journal*, J.56, July-August 2008.

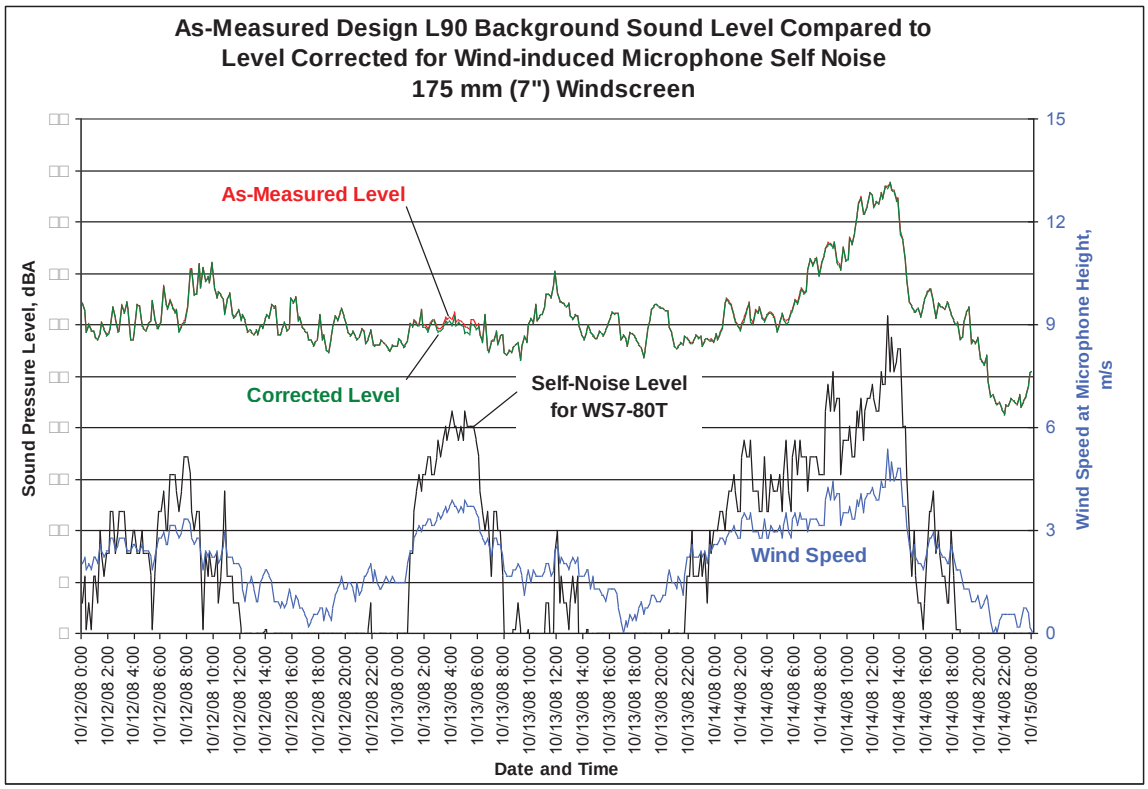

Figure 6.0.1

This plot shows the very typical result, at least where extra-large windscreens are used, that the correction is small and can almost be neglected when it comes to A-weighted sound levels.

The overall level of self-generated noise for the WS7-80T windscreen recommended for this survey can be calculated, per Ref. 1, from the general expression:

$$L_{p,self} = 28.692 \ln(v) - 17.447, \text{ dB} \quad \text{for } v>1.5 \text{ m/s} \quad (2)$$

Where v is the average wind speed measured at microphone height in m/s. This value shall be taken from the 3 ft. anemometer on the temporary weather station set up at one or more exposed positions on site.

7.0 Compliance Determination

Once the on-site short and long-term L90(10 min) sound levels have been corrected for spurious noise events, rain, background noise and microphone distortion the results shall be compared to the State and local noise limits for overall and tonal noise emissions. Spurious data points showing apparent noise excursions well above the mean are common in long-term surveys and it is often difficult or impossible to definitively ascribe these levels to the project. For example, a tractor many have been idling near a monitor station on a windy day creating the false impression that project noise was elevated at that location during that period. In order to reasonably allow for this possibility the project shall be considered in compliance with the regulatory limits if the corrected project-only level determined from the long-term survey is equal to or below the stated limits at least 95% of the time. No such uncertainty

surrounds the short-term manned measurements and project compliance can be determined directly from the results. Tonal noise will be evaluated exclusively from the manned, short-term samples where the 1/3 octave band frequency spectrum is measured.

8.0 Reporting

A report shall be prepared summarizing the survey set up and methodology, data analysis and results. Any deviations from the protocol shall be explained along with the rationale for the alternate approach or interpretation. The report shall state whether the project was found to be in or out of the compliance with the applicable regulatory noise limits.

reasonably comply with any new provisions resulting from the upcoming proceeding to the extent practicable.

10. WEPCO shall operate the project in a manner that meets noise limits of 50 dBA during daytime hours, and, upon complaint by an affected resident, shall be permanently reduced to 45 dBA during nighttime hours for areas related to the complaint. Nighttime hours are defined to include those hours between 10:00 p.m. to 6:00 a.m. daily, from April 1 through September 30. The requirement to meet the seasonally reduced nighttime noise limit shall be triggered by the receipt by WEPCO of any complaint regarding nighttime noise levels. Methods available for WEPCO to comply with both the daytime and nighttime noise limits shall include, but are not limited to, operational curtailment of the turbine or turbines contributing to the exceedance of the noise limits. WEPCO is relieved from meeting the nighttime noise limit if the affected resident agrees to a financial settlement. Compliance with noise limits shall be measured or otherwise evaluated at the outside wall of the non-participating residence. WEPCO shall provide notification to potentially affected residents of the provisions of this Final Decision relating to noise limits prior to initial operation of the project.

11. WEPCO shall evaluate compliance with the noise limits included in this Final Decision as part of its post-construction noise study. The post-construction noise study shall be conducted as described in the most current version of the PSC Noise Measurement Protocol. WEPCO shall file a copy of the post-construction noise study report with the Commission.

12. WEPCO shall construct its project using a minimum setback from non-participating residences of 1,250 feet.

The Parties agree that should the PSCW establish any requirements with respect to setbacks that apply to the Project that would be more protective of the Town or its residents or more restrictive upon Owner than those referred to in this Section, then such requirements shall be deemed incorporated into this Agreement and they shall become part of Owner's performance obligations under this Agreement; provided however, compliance shall be established and interpreted by the PSCW as granted under Wisconsin law..

13. **Noise.** Owner shall comply with the following noise standards:

a. The noise design limit for the Project shall not exceed 50 dBA as measured as the cumulative Wind Turbine average dBA at the location of the nearest Non-Participating residence from the relevant Wind Turbine(s), or a school, hospital, church or public library existing on the date of the execution of this Agreement. The average dBA shall be measured by the LA90 metric, using the logarithmic average, over 10 minute intervals measured four times a day (early morning, mid-day, early evening and night) for three days. Noise measurements shall be taken during conditions that fairly represent the operation of the Project (e.g. enough wind that the Wind Turbines are rotating, Wind Turbines are not locked, there is an absence of noisy farm equipment in the adjacent fields during the measurement period, measurements are taken during different times during the same day and during both weekdays and weekends, etc.).

b. The parties acknowledge that the Project's construction will be the source of intermittent noise. Owner shall require all contractors to incorporate reasonable noise reduction measures in order to mitigate the amount of noise generated during the construction phase.

c. In the event audible noise due to wind turbine operations contains a steady prominent pure tone as defined in Section 3.2.26 of EPA Report 550/9-76-003, such as a whine, screech, or hum, the standards for audible noise set forth in Subparagraph (a) of this subsection shall be reduced by five (5) dBA with respect to the prominent pure tone.

The Parties agree that should the PSCW establish any requirements with respect to Noise levels within the Project that would be more protective of the Town or its residents or more restrictive upon Owner than those referred to in this Section, then such requirements shall be deemed incorporated into this Agreement and they shall become part of Owner's performance obligations under this Agreement; provided however, compliance shall be established and interpreted by the PSCW as granted under Wisconsin law.

14. **Signal Interference.** If the Wind Turbines create interference with radio, cell phone or television signals, Owner, at Owner's sole expense, shall promptly but in no event in greater than seven (7) days) send representatives to verify landowner signal complaints and in no greater than fourteen (14) days implement appropriate remedial measures (antenna adjustment, installation of repeater antennas or, if necessary, satellite dishes) to restore landowners' radio or television signals and mitigate interference caused by the Wind Turbines. In addition, Owner shall comply with all applicable state and Federal standards.

MEASUREMENT PROTOCOL FOR SOUND AND VIBRATION ASSESSMENT OF PROPOSED AND EXISTING WIND ELECTRIC GENERATION PLANTS

May, 2010

Note: Consult with Commission staff prior to conducting any sound and vibration measurements.

I. Objectives

The primary objectives of this protocol include:

1. To measure and characterize the existing sound and vibration environment in the area of the proposed development.
2. To predict the incremental increase in sound and vibration levels that would occur as a result of operation of the proposed development.
3. To verify that the predicted incremental increase in sound and vibration levels is reasonable by taking post-construction sound level measurements.
4. To verify compliance with applicable sound and vibration level limitations by taking post-construction sound level measurements.

II. PSC Staff Contacts

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III. Introduction

The potential sound and vibration impact associated with the operation of wind electric generation developments is often a primary concern for citizens living in the areas of the developments. This is especially true of projects located near homes, residential neighborhoods, schools, and hospitals. Determining the likely sound and vibration impacts is a highly technical undertaking and requires a serious effort in order to collect reliable and meaningful data for both the public and decision-makers.

This protocol is based, in part, on criteria published in the Standard Guide for Selection of Environmental Noise Measurements and Criteria.[i] The purpose of this protocol is to establish a consistent and scientifically sound procedure for estimating existing sound and vibration levels in a project area.

The layout of the proposed development and the features of the surrounding environment will influence the design of the sound and vibration study. Site layout and the existence of significant local sound and vibration sources and sensitive receptors must be taken into consideration when designing a sound and vibration study. It may be necessary to hire a qualified consultant to conduct the sound and vibration study.

Note: Consult with Commission staff prior to conducting any sound and vibration measurements.

These guidelines are meant to be general in nature and may need to be modified to accommodate unique site characteristics. Consult with Commission staff assigned to the project for guidance on study design before you begin the sound and vibration study. During consultation, good quality maps and diagrams of the site will be necessary. Maps and diagrams should show the site layout on an aerial photogragh base and identify important landscape features as well as significant local sound and vibration sources and sensitive receptors.

IV. Measurement of the Existing Sound and Vibration Environment

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

A. Sites With No Existing Generation

1. At a minimum, sound level measurements should be taken at three locations or measurement points (MPs). Because each site is unique, more than three MPs may be necessary. **Consult with Commission staff regarding the quantity and location of the MPs.**

   MPs selected in consultation with Commission staff will generally be selected to provide information on the range of noise environments in a wind project area. Some examples of areas commonly selected for measurements include: areas with residences, areas with industrial noises, quiet areas, and public areas.

   All MPs should be located so that no significant obstruction (building etc.) blocks sound and vibration from existing wind facilities.

2. Duration of measurements should be a minimum of ten continuous minutes for each criterion (See item 4 below) at each location. Measurements should be taken during each of the following four periods:
   a. Morning (6 - 8 a.m.)
   b. Midday (12 noon – 2 p.m.)
   c. Evening (6 - 8 p.m.)
   d. Night (10 p.m. – 12 midnight)

The use of unattended continuous sound level measurement devices is encouraged. If these measurements are collected, qualitative sound recordings of the ambient noise environment should be collected for the duration of the measurements.

Sound level measurements must be made on a weekday of a non-holiday week.

3. For each MP and for each measurement period, provide each of the following measurement criteria:
    a. At a minimum, unweighted octave-band analysis (16,[ii] 31.5, 63, 125, 250, 500, 1K, 2K, 4K, & 8K Hz), one-third octave band analysis is encouraged
    b. L_{ave}, L_{10}, L_{50}, and L_{90}, in dBA
    c. L_{ave}, L_{10}, L_{50}, and L_{90}, in dBC
    d. A narrative description of sounds audible during each measurement

4. Identify all major sources of sound and vibration (i.e. highways, factories etc.) and where they are located in relation to MPs.

5. Provide a map on an aerial photo base clearly showing:
    a. the layout of the site
    b. the location of MPs
    c. the distance between MPs and the nearest proposed wind turbine generators
    d. the location of significant local sound and vibration sources
    e. the distance between all MPs and significant local sound and vibration sources
    f. the location of all sensitive receptors (schools, day-care centers, hospitals, and residences or residential neighborhoods) within the project area
    g. the distance to all major infrastructure (major roads, transmission lines, gas pipelines) in project area

B. Sites With Existing Wind Electric Generation Facilities

1. Two complete sets of sound level measurements must be taken under two wind conditions:
    a. Under calm conditions without the existing wind turbine rotors rotating. These measurements shall be taken with the entire wind generating development off line.
    b. Under wind conditions just above the cut-in speed for the wind turbines with as many of the wind turbines in the development operating as possible.

2. At a minimum, sound level measurements should be taken at three MPs. Because each site is unique, more than three MPs may be necessary. **Consult with Commission staff regarding the quantity and location of the MPs.**

MPs selected in consultation with Commission staff will generally be selected to provide information on the range of noise environments in a wind project area. Some examples of areas commonly selected for measurements include: areas with residences, areas with industrial noises, quiet areas, and public areas.

All MPs should be located so that no significant obstruction (building etc.) blocks sound and vibration from existing wind facilities.

3. Duration of measurements should be a minimum of ten continuous minutes for each criterion (see section IV.B.4 below) at each location. Measurements should be taken during each of the following four periods:
    a. Morning (6 - 8 a.m.)
    b. Midday (12 noon – 2 p.m.)
    c. Evening (6 - 8 p.m.)
    d. Night (10 p.m. – 12 midnight)

    The use of unattended continuous sound level measurement devices is encouraged. If these measurements are collected, qualitative sound recordings of the ambient noise environment should be collected for the duration of the measurements.

    Sound level measurements must be taken on a weekday of a non-holiday week.

4. For each MP and for each measurement period, provide each of the following measurement criteria:
    a. At a minimum, unweighted octave-band analysis (16,[ii] 31.5, 63, 125, 250, 500, 1K, 2K, 4K, & 8K Hz), one-third octave band analysis is encouraged
    b. L_{ave}, L_{10}, L_{50}, and L_{90}, in dBA
    c. L_{ave}, L_{10}, L_{50}, and L_{90}, in dBC
    d. A narrative description of sounds audible during each measurement

5. Identify all major sources of sound and vibration (e.g. highways, factories etc.) and where they are located in relation to each MP.

6. Provide a map or diagram clearly showing:
    a. the layout of the site
    b. the location of MPs
    c. the distance between MPs and the nearest existing wind turbine generators
    d. the location of significant local sound and vibration sources
    e. the distance between all MPs and significant local sound and vibration sources
    f. the location of all sensitive receptors (schools, day-care centers, hospitals, and residences or residential neighborhoods) within the project area
    g. the distance to all major infrastructure (major roads, transmission lines, gas pipelines) in project area

C. Sound Level Estimates for Proposed Wind Turbine(s)

In order to estimate the sound and vibration impact of the proposed wind development on the existing environment, an estimate of the sound and vibration produced by the proposed turbine(s) must be provided.

1. Provide the manufacturer's sound level characteristics for the proposed turbine model operating at full capacity. Include an **unweighted** octave band (16,[ii] 31.5, 63, 125, 250, 500, 1K, 2K, 4K, & 8K Hz) analysis for the unit at full capacity.

2. Provide a contour map of the expected sound levels from the wind energy development, in 5dBA increments, extending out to the 30 dBA contour.

3. Determine the impact of the new sound and vibration source on the existing environment. For each MP used in the ambient study:
    a. Report expected changes to existing sound levels for L_{ave}, L_{10}, L_{50}, and L_{90}, in dBA.
    b. Report expected changes to existing sound levels for L_{ave}, L_{10}, L_{50}, and L_{90}, in dBC.

    At least one MP should be located at the nearest sensitive receptors, as required by sections IV.A.1 and IV.B.2.

4. Clearly report all assumptions made in arriving at the estimates of impact and any conclusions reached regarding the potential effects on people living in the project area.

V. Post-Construction Measurements

1. Within twelve months of the date when the project is fully operational, and within two weeks of the anniversary date of the pre-construction ambient noise measurements, repeat the existing sound and vibration environment measurements taken before project approval.

2. Post-construction sound level measurements should be taken under two wind conditions:
    a. Under calm conditions without the wind turbine rotors rotating. These measurements shall be taken with the entire wind generating development off line.
    b. Under wind conditions just above the cut-in speed for the wind turbines with as many of the wind turbines in the development operating as possible.

3. Notes regarding post-construction sound level measurements for wind project developments:
    a. Measurements taken as required under section V.2.b may be taken prior to measurements taken under section V.2.a.
    b. Because of the variability of wind speeds, post-construction measurements may be taken outside of the measurement periods listed in section IV.B.3. However, measurements taken under section V.2.a, above, must be taken during the same time of day as the corresponding measurements taken under section V.2.b.
    c. For each MP at which pre-construction noise measurements were taken, a minimum of three sets of measurements shall be taken under sections V.2.a and 2.b. The three sets of measurements should correspond to at least two different times of day. Any or all of the measurements may be taken outside of the measurement periods listed in section IV.B.3.
    d. Measurements taken to fulfill the requirements of items sections V.2.a and 2.b must be taken within as few consecutive days as practicable.
    e. Measurements taken under sections V.2.a and 2.b must include a measurement of the 16 Hz octave band, as described in section IV.B.4.a.

4. The post-construction sound level measurement analysis must include an evaluation of whether the wind development meets any and all state and local sound level requirements.

5. File a copy of the post-construction noise measurement report with the Public Service Commission including pre- and post-construction measurement data and using the same report format as used for the pre-construction sound and vibration study reports.

Revision History

Revisions of May 26, 2010:

- Adapted the November 17, 2008, version of the PSC Noise Protocol to apply specifically to wind energy developments.

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[i] Standard Guide for Selection of Environmental Noise Measurements and Criteria (Designation E 1686-96). July 1996. American Society for Testing and Measurements.

[ii] PSC staff acknowledges that few sound level meters are capable of measurement of the 16 Hz center frequency octave band. However, because noise complaints from the public most likely involve low frequency noise associated with proposed plants, we encourage applicants to pursue the collection of this important ambient noise data.

If obtaining the 16 Hz data is beyond the capabilities of the sound level measurement apparatus, contact PSC staff prior to collection of any field ambient measurement data.

Hessler Associates, Inc.
Consultants in Engineering Acoustics

3862 [illegible]
[illegible]
[illegible] 20169 [illegible]
[illegible]: [illegible]03[illegible]53[illegible]1602
[illegible]: [illegible]03[illegible]53[illegible]1522
[illegible]: [illegible]

APPENDIX C

Total Measured Sound Level Spectra
LA90(10 min) Samples

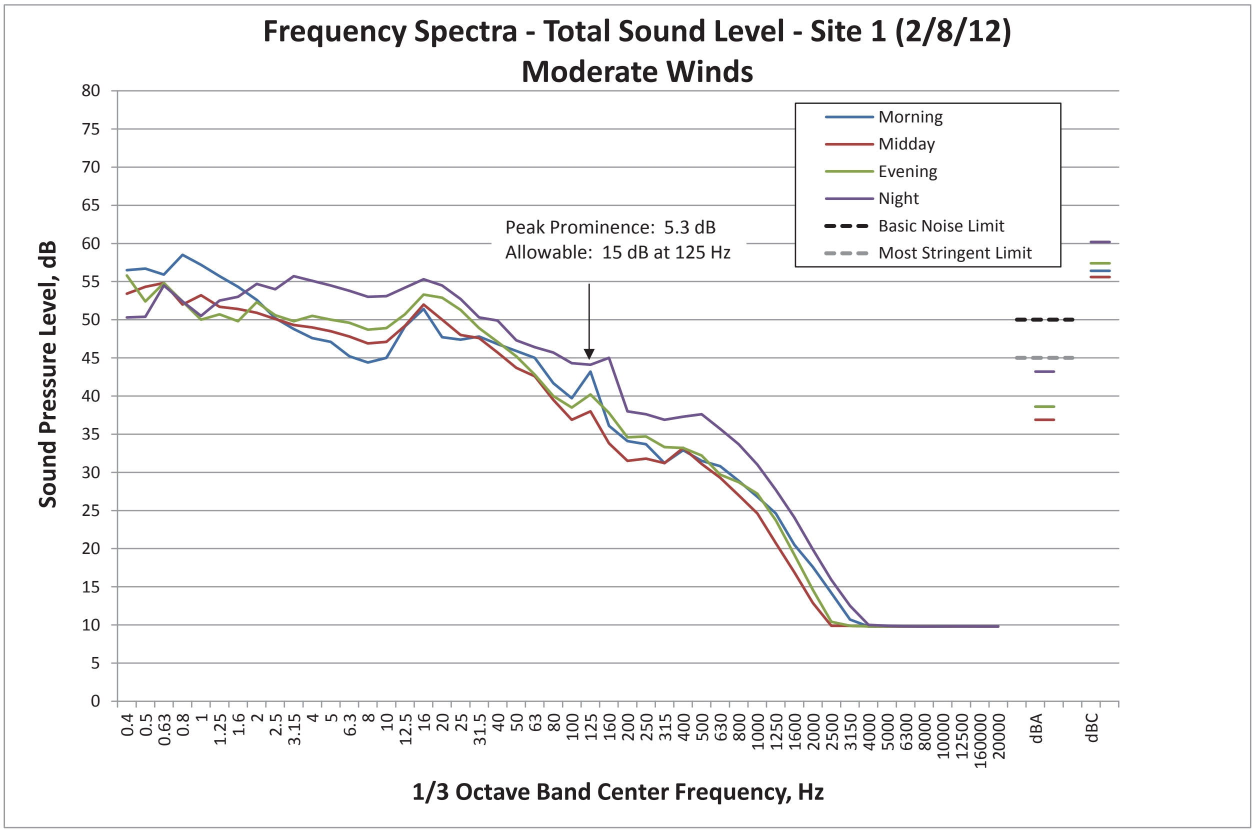

Figure C1

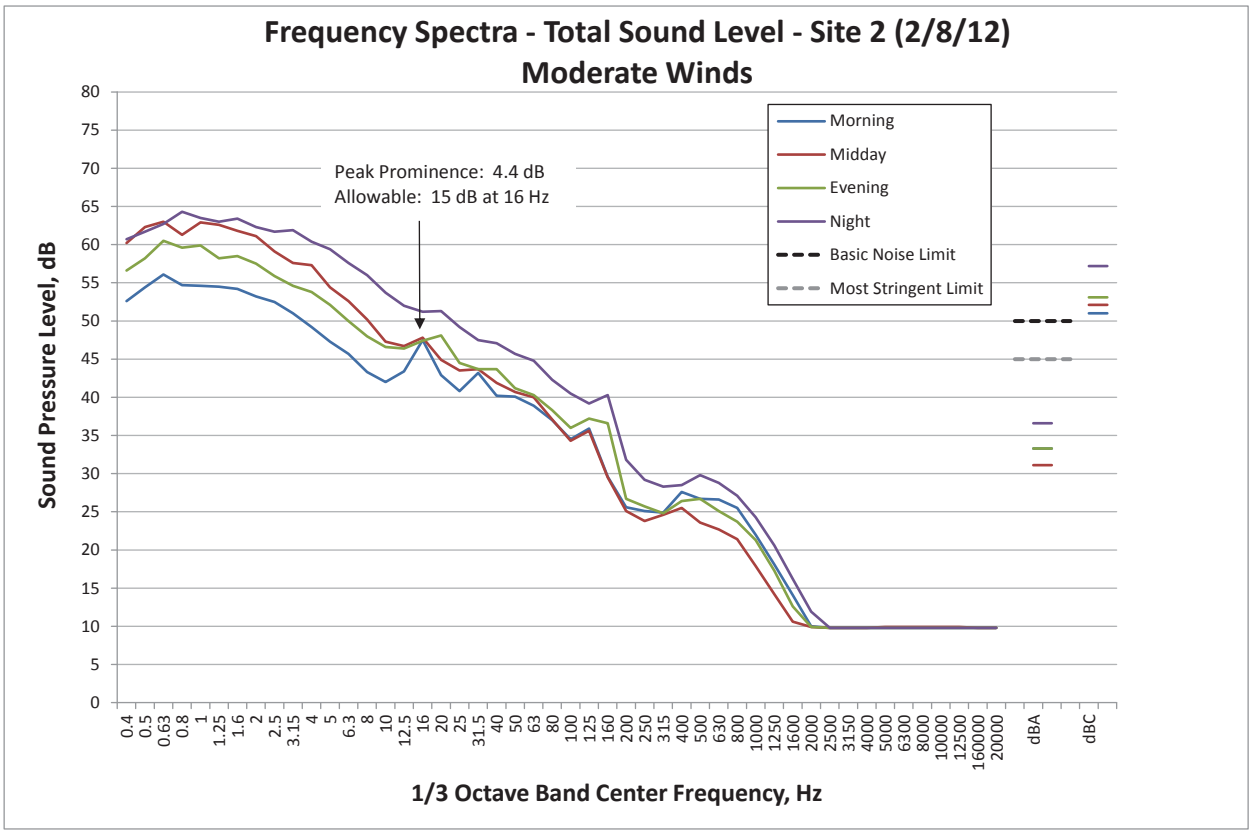
Frequency Spectra - Total Sound Level - Site 2 (2/8/12)
Moderate Winds
Peak Prominence: 4.4 dB
Allowable: 15 dB at 16 Hz
Morning
Midday
Evening
Night
Basic Noise Limit
Most Stringent Limit
Sound Pressure Level, dB
1/3 Octave Band Center Frequency, Hz
dBA
dBC

Figure C2

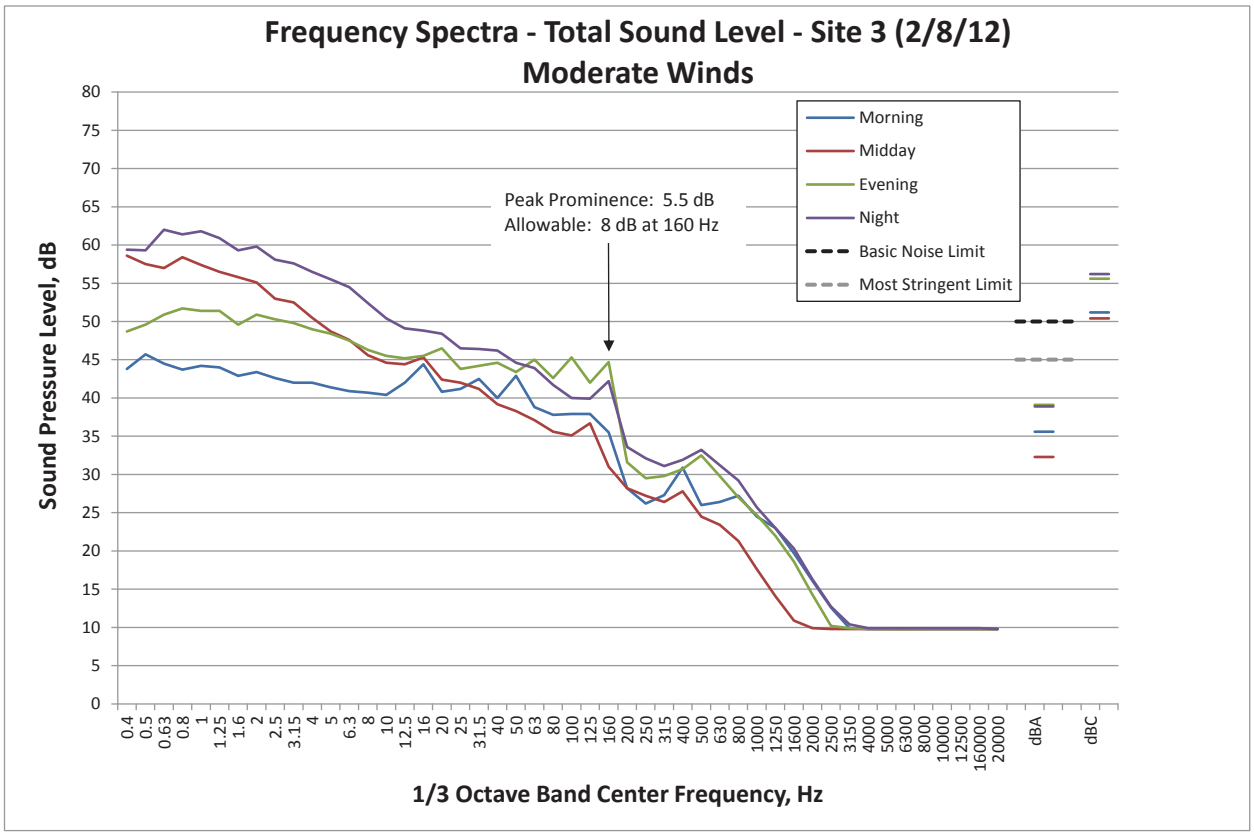
Frequency Spectra - Total Sound Level - Site 3 (2/8/12)
Moderate Winds
Sound Pressure Level, dB
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
Peak Prominence: 5.5 dB
Allowable: 8 dB at 160 Hz
Morning
Midday
Evening
Night
Basic Noise Limit
Most Stringent Limit
0.4
0.5
0.63
0.8
1
1.25
1.6
2
2.5
3.15
4
5
6.3
8
10
12.5
16
20
25
31.5
40
50
63
80
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
10000
12500
160000
20000
dBA
dBC
1/3 Octave Band Center Frequency, Hz

Figure C3

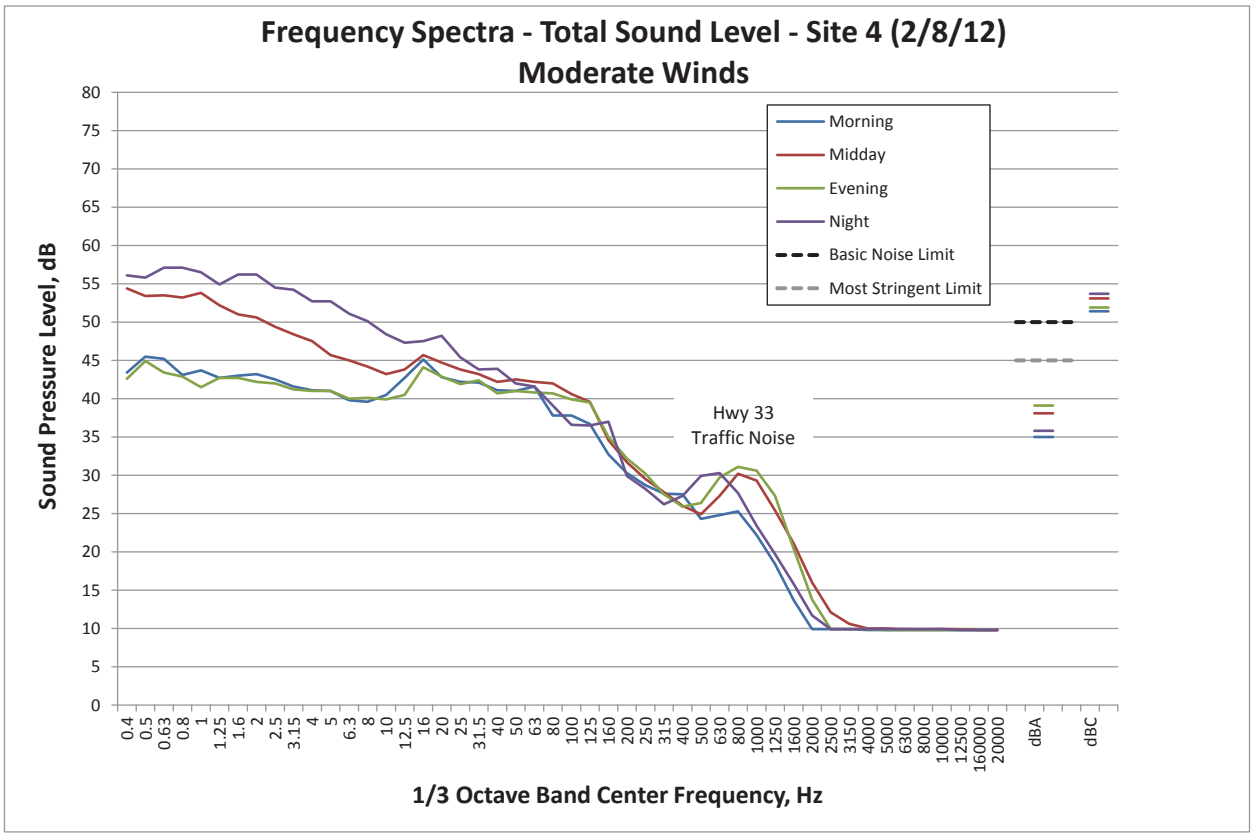
Frequency Spectra - Total Sound Level - Site 4 (2/8/12)
Moderate Winds
Morning
Midday
Evening
Night
Basic Noise Limit
Most Stringent Limit
Hwy 33
Traffic Noise
Sound Pressure Level, dB
1/3 Octave Band Center Frequency, Hz
dBA
dBC

Figure C4

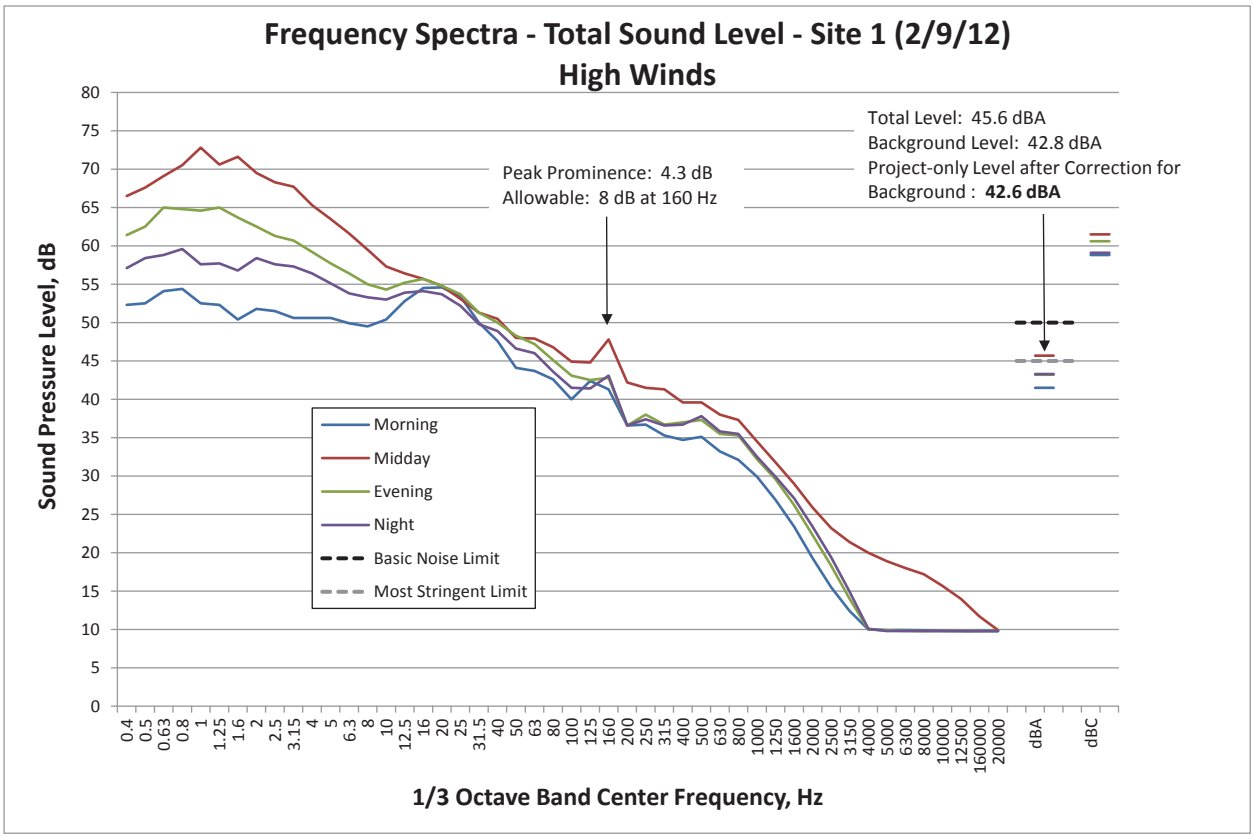
Frequency Spectra - Total Sound Level - Site 1 (2/9/12)
High Winds
Total Level: 45.6 dBA
Background Level: 42.8 dBA
Project-only Level after Correction for
Background : 42.6 dBA
Peak Prominence: 4.3 dB
Allowable: 8 dB at 160 Hz
Morning
Midday
Evening
Night
Basic Noise Limit
Most Stringent Limit
Sound Pressure Level, dB
1/3 Octave Band Center Frequency, Hz
dBA
dBC

Figure C5

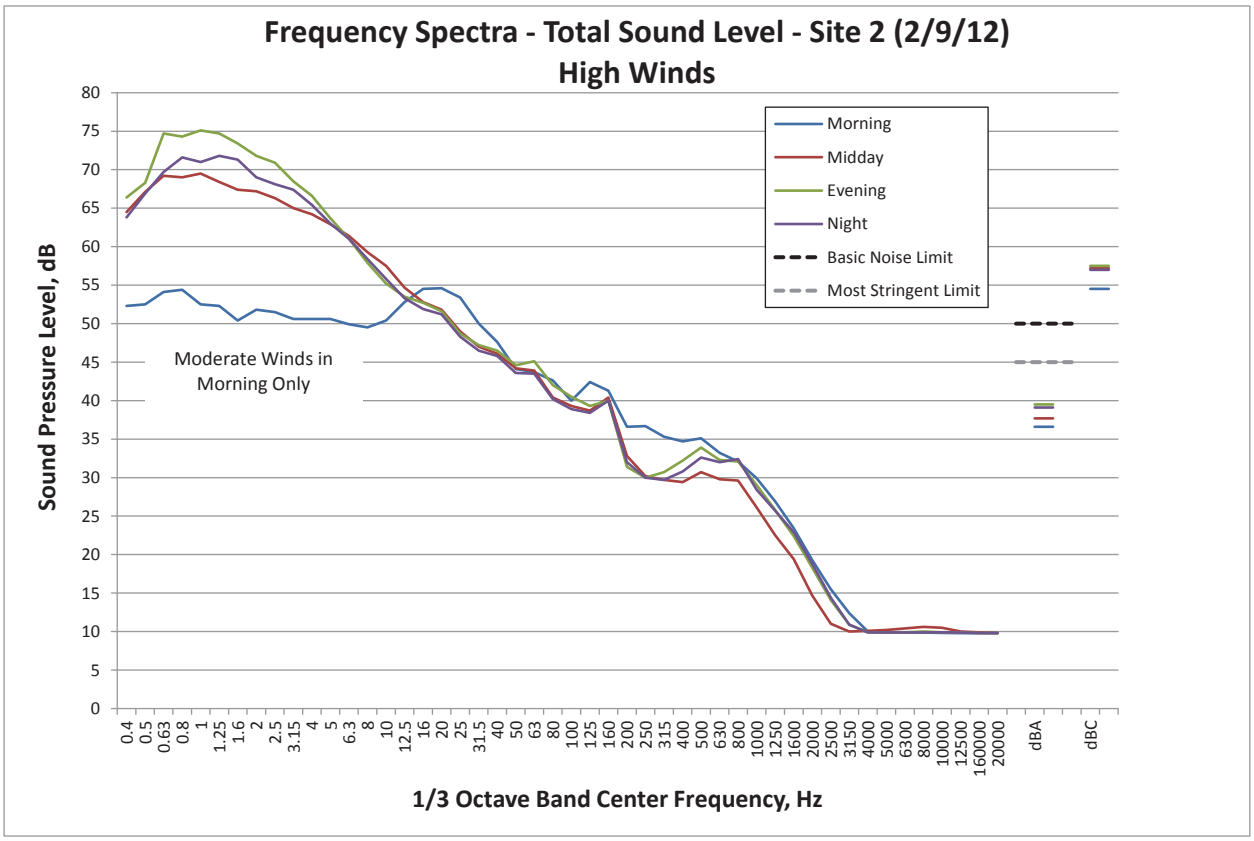
Frequency Spectra - Total Sound Level - Site 2 (2/9/12)
High Winds
Sound Pressure Level, dB
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
Morning
Midday
Evening
Night
Basic Noise Limit
Most Stringent Limit
Moderate Winds in Morning Only
0.4
0.5
0.63
0.8
1
1.25
1.6
2
2.5
3.15
4
5
6.3
8
10
12.5
16
20
25
31.5
40
50
63
80
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
10000
12500
160000
20000
dBA
dBC
1/3 Octave Band Center Frequency, Hz

Figure C6

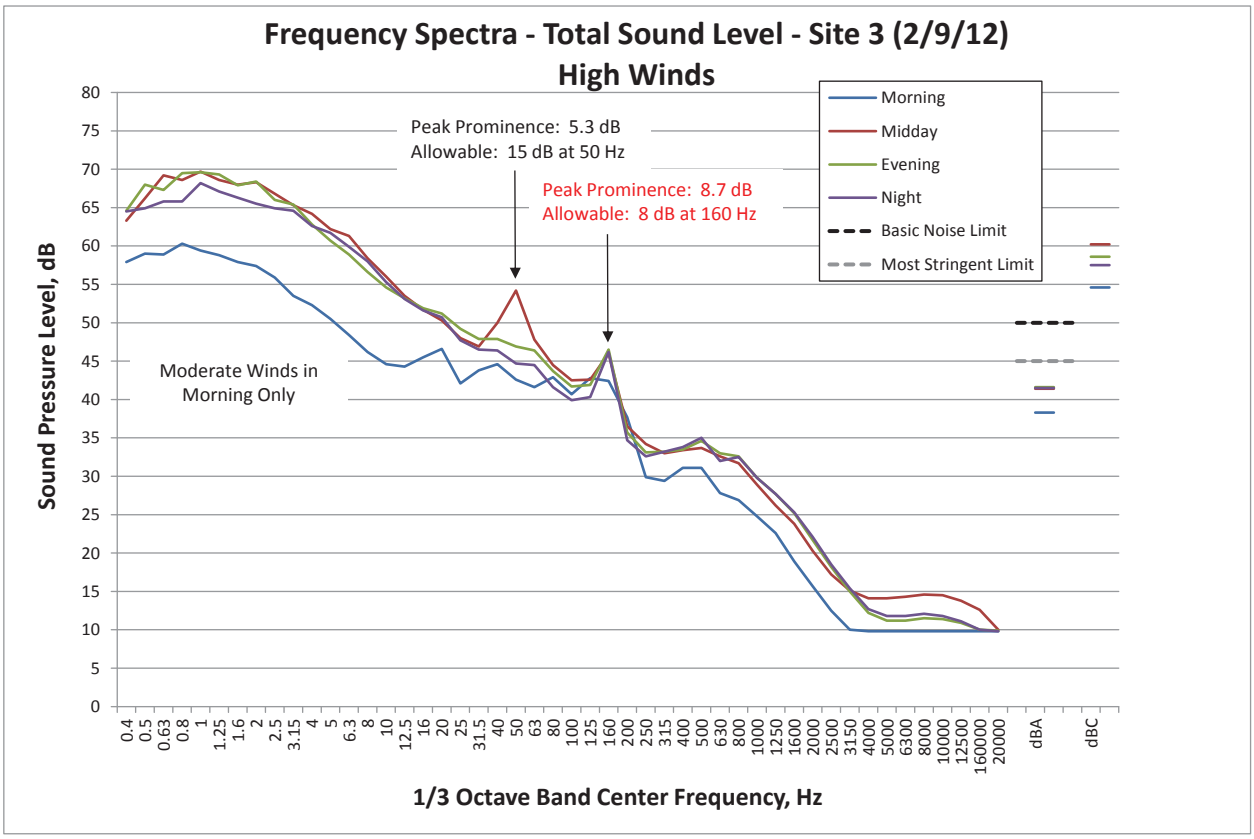
Frequency Spectra - Total Sound Level - Site 3 (2/9/12)
High Winds
Peak Prominence: 5.3 dB
Allowable: 15 dB at 50 Hz
Peak Prominence: 8.7 dB
Allowable: 8 dB at 160 Hz
Moderate Winds in Morning Only
Morning
Midday
Evening
Night
Basic Noise Limit
Most Stringent Limit
Sound Pressure Level, dB
1/3 Octave Band Center Frequency, Hz
dBA
dBC

Figure C7

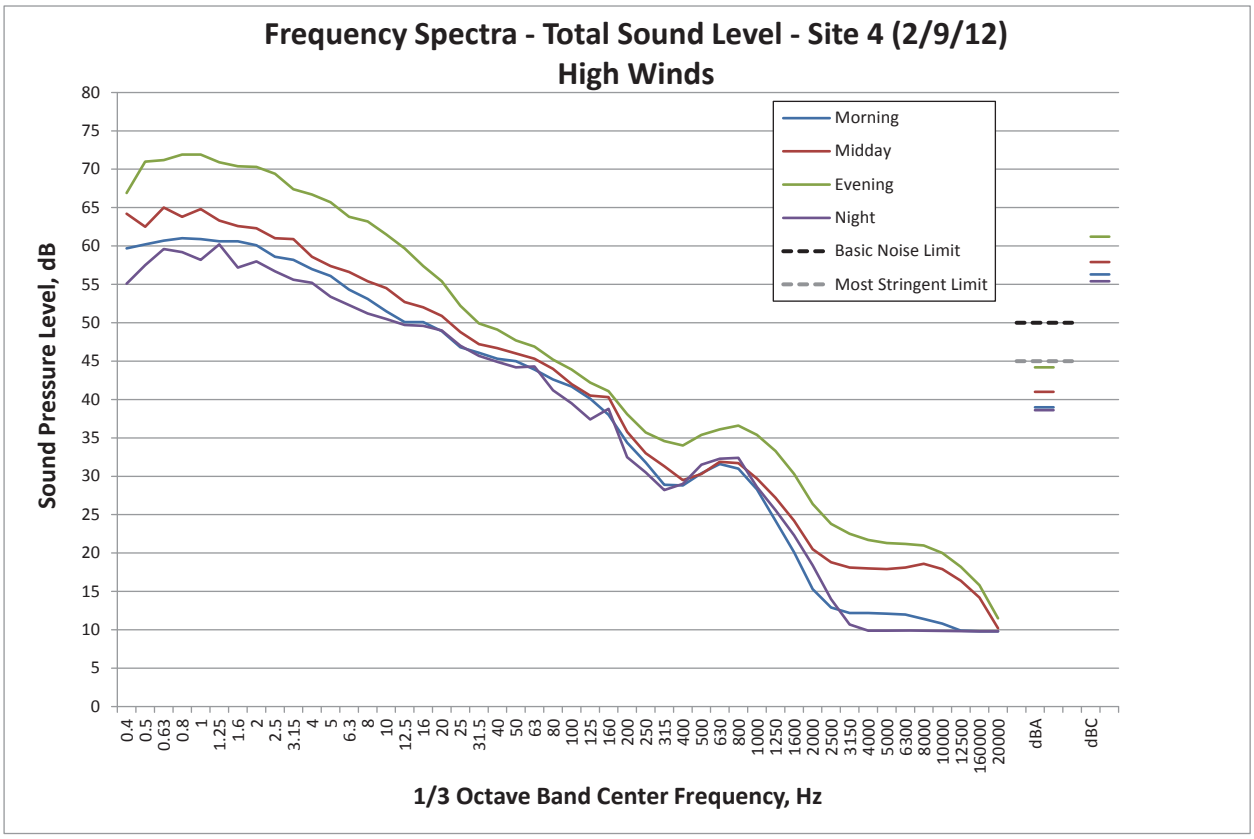
Frequency Spectra - Total Sound Level - Site 4 (2/9/12)
High Winds
Morning
Midday
Evening
Night
Basic Noise Limit
Most Stringent Limit
Sound Pressure Level, dB
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0.4
0.5
0.63
0.8
1
1.25
1.6
2
2.5
3.15
4
5
6.3
8
10
12.5
16
20
25
31.5
40
50
63
80
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
10000
12500
160000
20000
dBA
dBC
1/3 Octave Band Center Frequency, Hz

Figure C8

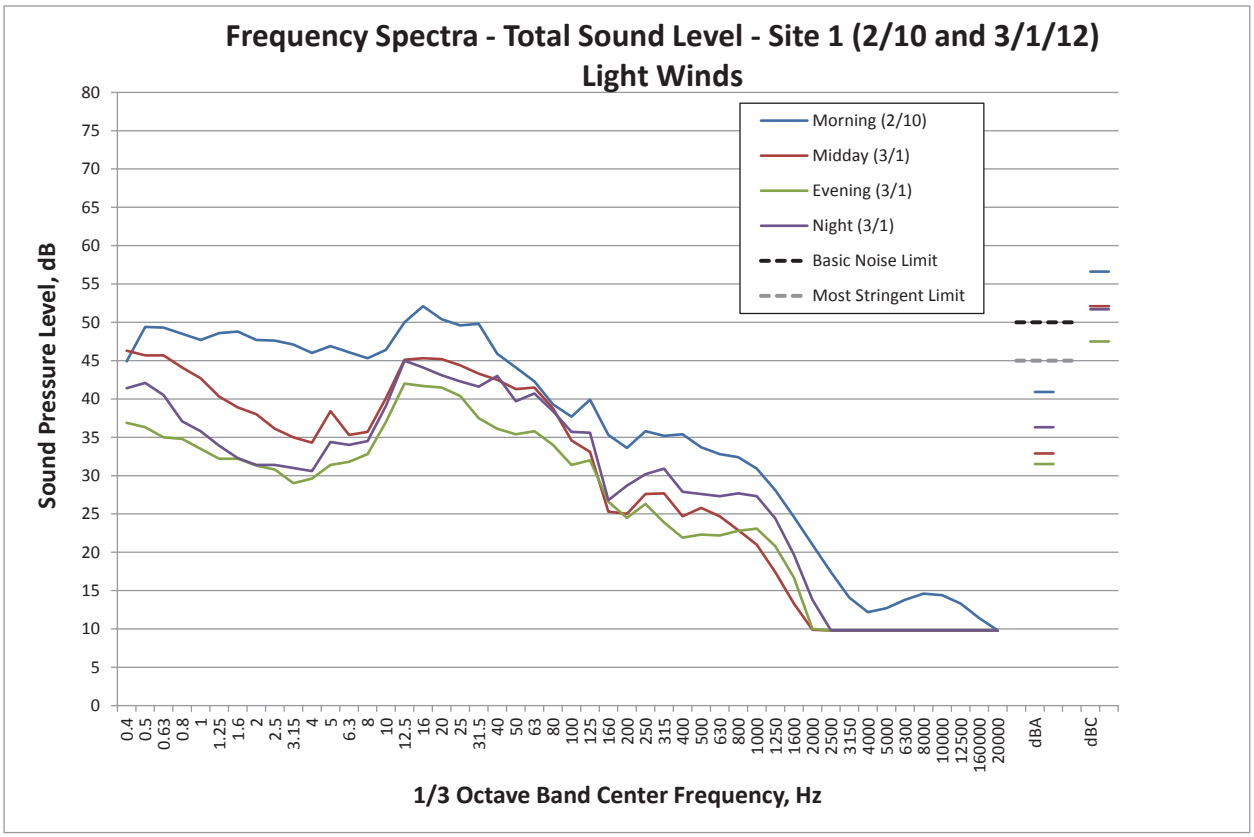
Frequency Spectra - Total Sound Level - Site 1 (2/10 and 3/1/12)
Light Winds
Sound Pressure Level, dB
1/3 Octave Band Center Frequency, Hz
Morning (2/10)
Midday (3/1)
Evening (3/1)
Night (3/1)
Basic Noise Limit
Most Stringent Limit
dBA
dBC

Figure C9

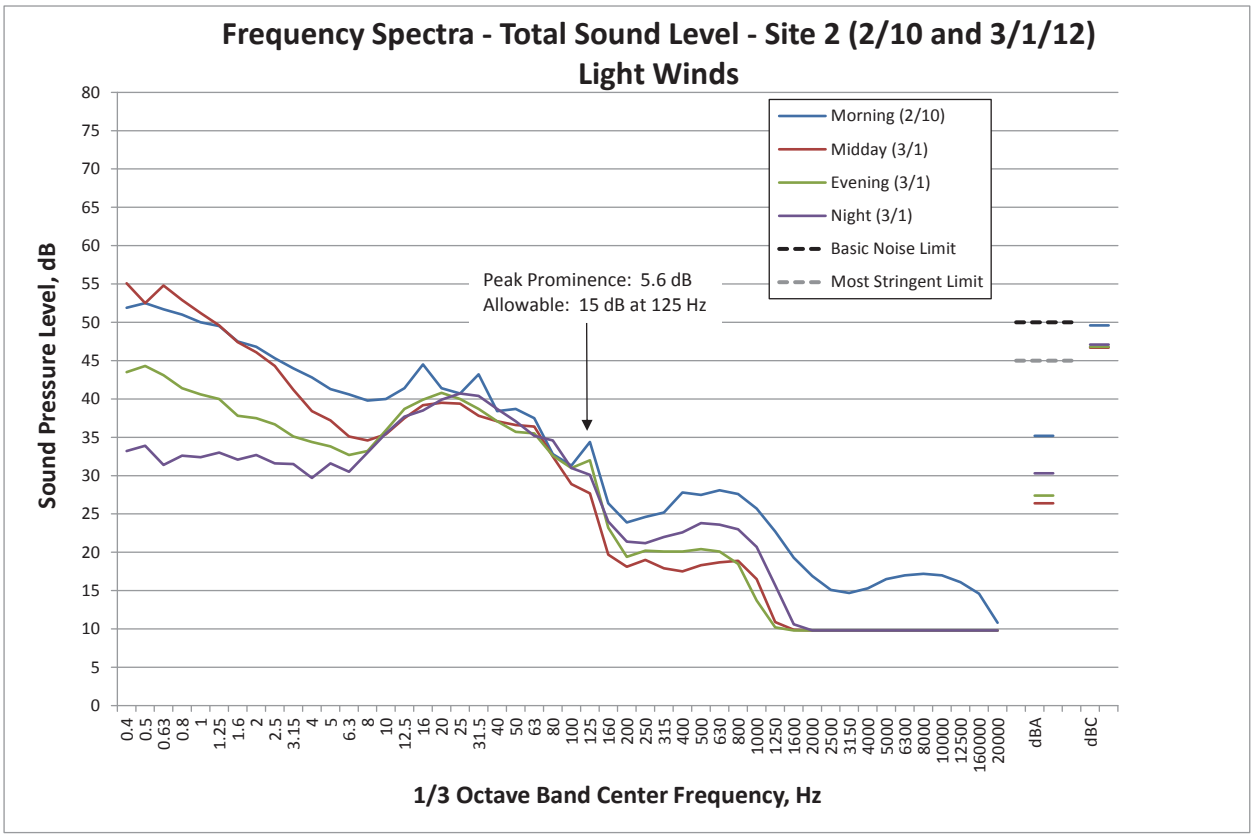
Frequency Spectra - Total Sound Level - Site 2 (2/10 and 3/1/12)
Light Winds
Sound Pressure Level, dB
1/3 Octave Band Center Frequency, Hz
Morning (2/10)
Midday (3/1)
Evening (3/1)
Night (3/1)
Basic Noise Limit
Most Stringent Limit
Peak Prominence: 5.6 dB
Allowable: 15 dB at 125 Hz
dBA
dBC

Figure C10

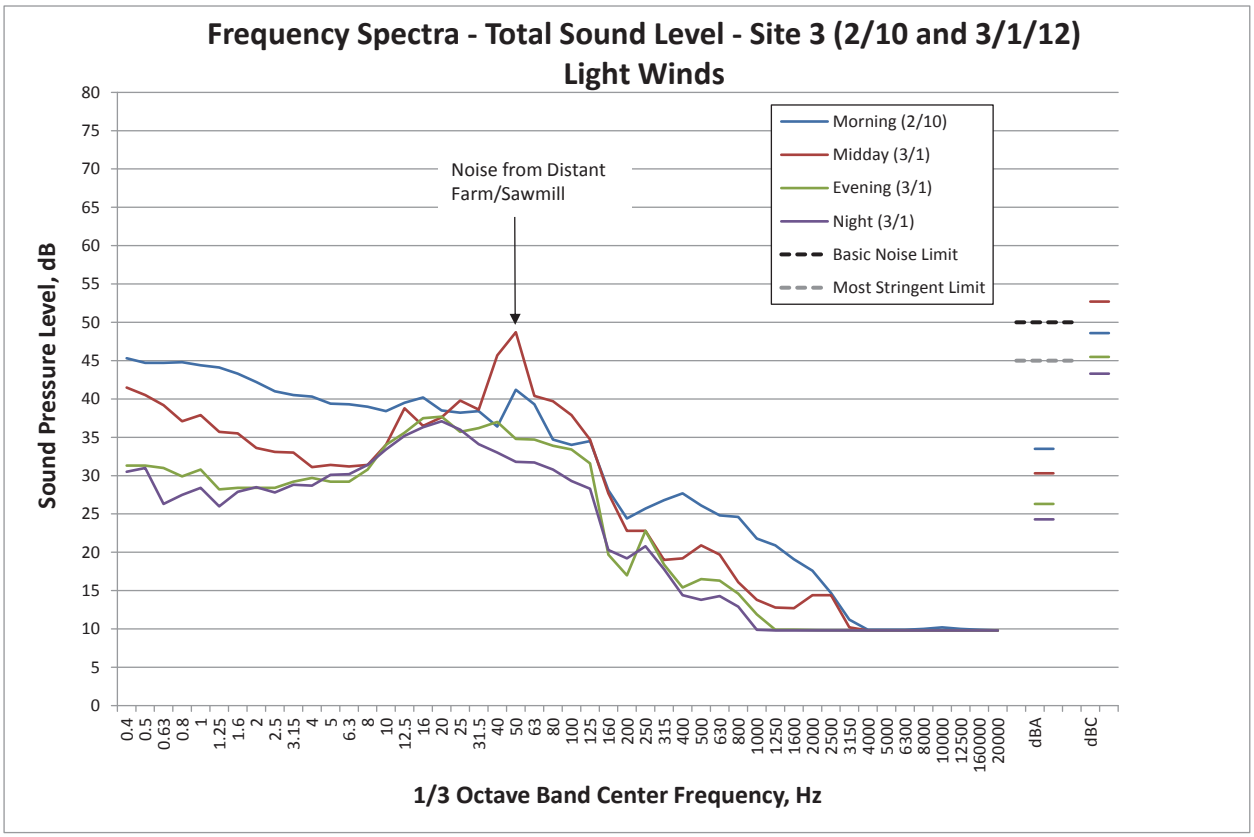
Frequency Spectra - Total Sound Level - Site 3 (2/10 and 3/1/12)
Light Winds
Sound Pressure Level, dB
1/3 Octave Band Center Frequency, Hz
Noise from Distant Farm/Sawmill
Morning (2/10)
Midday (3/1)
Evening (3/1)
Night (3/1)
Basic Noise Limit
Most Stringent Limit
dBA
dBC

Figure C11

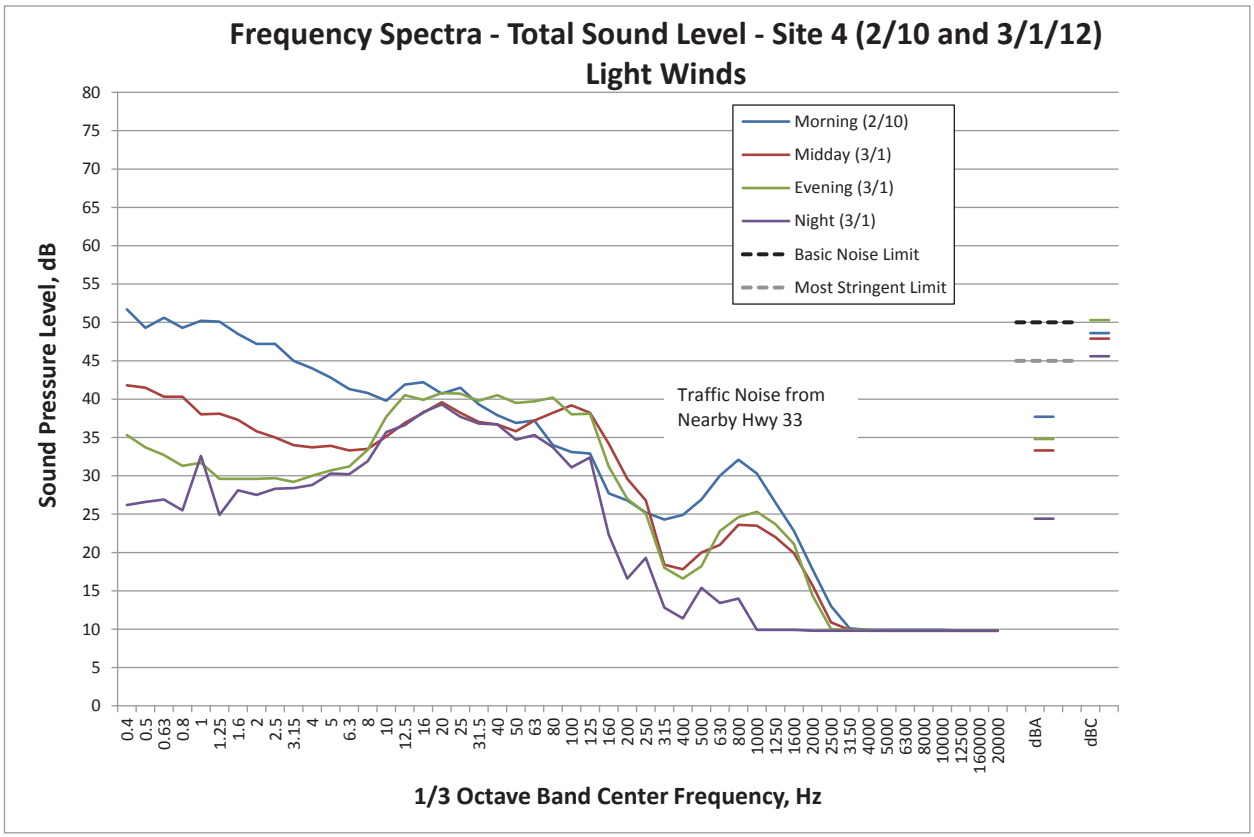
Frequency Spectra - Total Sound Level - Site 4 (2/10 and 3/1/12)
Light Winds
Morning (2/10)
Midday (3/1)
Evening (3/1)
Night (3/1)
Basic Noise Limit
Most Stringent Limit
Traffic Noise from
Nearby Hwy 33
Sound Pressure Level, dB
1/3 Octave Band Center Frequency, Hz
dBA
dBC

Figure C12