REPORT

EVERPOWER BARON WINDS PRE-CONSTRUCTION NOISE IMPACT ASSESSMENT

11.20.2017

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1.0 EXECUTIVE SUMMARY

Baron Winds, LLC, a wholly owned subsidiary of EverPower Wind Holdings, Inc., is proposing to construct a wind power project in Steuben County, New York with a generating capacity of up to 300 MW (the "Project").

This study addresses the noise impact of the proposed Project on receptors in the surrounding area. It was conducted consistent with:

- The applicable noise regulations of the towns of Fremont, Cohocton, Dansville, and Wayland, New York.
- Article 10's "Exhibit 19" noise provisions.
- Stipulations with the New York State Department of Environmental Conservation (NYSDEC) and the New York Department of Public Service (NYSDPS).

1.1 | PROJECT INFORMATION

The proposed Baron Winds Project is proposed to be located just northwest of the intersection of Interstates I-86 and I-390, about 50 miles south of Rochester, New York. The project will be composed of up to 76 wind turbines, with a collector substation, point of interconnection substation, and other infrastructure.

The area surrounding the project is mostly farmland, with some forested areas on flat-to-hilly terrain.

A turbine model has not been selected at this time, but the Vestas V136 3.6 MW wind turbine, combined with the highest low-frequency sound power of any other turbine presented in the Application, was used in this study to represent an acoustically worst-case example. All other wind turbines presented in the Application have low-frequency and audible frequency emission lesser or equal to what was modeled. This hybrid turbine was used in the modeling of sound pressure levels expected around the Project.

1.2 | PROJECT NOISE DESIGN GOAL AND SUGGESTED REGULATORY LIMITS

A Project Noise Design Goal is a sound level limit to which the project is designed. A Regulatory Limit is an enforceable limit that would be imposed on the project after the project is constructed.

Many design goals are not translatable into regulatory limits because they may be difficult or impractical to measure or enforce. Therefore, the limit is set during design, and we conduct modeling and design mitigation to meet those goals. Those designs are then carried forward into the construction and operation of the facility.

The design goals and recommended regulatory limits are shown in Table 1. The design goals and regulatory limits shown apply to sensitive sound receptors (nonparticipating receptors) as defined in the Project Stipulations, unless otherwise noted.

TABLE 1: PROJECT DESIGN GOALS AND REGULATORY LIMITS

TO ADDRESS	DESIGN GOAL	EXISTING REGULATORY LIMIT	PROPOSED CONDITION
WHO 1999 Sleep disturbance guideline at nonparticipants	45 dBA L_{8h} at night	-	45 dBA L_{8h} at night at nonparticipating homes (sensitive sound receptors)
Vibration at nonparticipants	65 dBA at 16 Hz, 31.5 Hz, and 63 Hz	-	ANSI S2.71 in response to vibration complaints
WHO Europe 2009 NOAEL at nonparticipants	40 dBA $L_{night,\ outside}$	-	-
WHO Europe 2009 Interim Target at Participants	50 dBA $L_{night,\ outside}$ 55 dBA L_{8h} at night	-	55 dBA L_{8h} at night at participating homes
Town of Fremont	48 dBA L_{1h}	50 dBA 1-hour L_{10}	-
Town of Cohocton[1]		45 dBA L_{eq} (three 15 second periods) at nonparticipating residences 50 dBA L_{eq} (three 15-second periods) at nonparticipating property lines	-
Town of Wayland	-	45 dBA L_{8h} at nonparticipating receptors. If the ambient exceeds 45 dBA, the limit is the ambient plus 6 dB. 50 dBA L_{8h} at nonparticipating property lines and participating receptors	- -

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[1] A 1.1 dB difference is used for the difference between the L_{1h} and the average of three 15 second L_{eq}s. This difference is based on compliance monitoring results from the Cohocton Wind project.

TO ADDRESS	DESIGN GOAL	EXISTING REGULATORY LIMIT	PROPOSED CONDITION
Town of Dansville		45 dBA L_{1h} at nonparticipating receptors. If the ambient sound pressure level exceeds 45 dBA, the limit is the ambient plus 6 dB.	- -
WHO 2009 Interim Target at potential building sites	55 dBA L_{8h} within 150 feet of a road at nonparticipating parcels unless there is a more stringent Town property line limit.	-	-
Substation Transformer	40 dBA L_{1h} at nonparticipating sensitive sound receptors, assuming tonal sound emissions.	-	45 dBA L_{1h} at nonparticipating receptors (sensitive sound receptors). A 5 dB tonal penalty would apply to tonal sound.
Tonal penalty	5 dB		5 dB

1.3 | BACKGROUND SOUND LEVEL MONITORING

To determine the existing ambient sound levels in representative soundscapes in the project area, sound level monitoring was performed at seven locations over two weeks in both the summer and winter.

A-WEIGHTED SOUND LEVELS

Sound levels were logged each second for the 1/3 octave band range of at least 20 Hz to 10 kHz. Periods with environmental conditions outside the specifications of the monitoring equipment were removed. Seasonal and intermittent noise was also removed in accordance with ANSI 12.9 Part 3. When seasonal tonal high-frequency sound, such as from insects and birds, was detected, the “ANS”-weighting (ANSI 12.100-2014) was used to filter out these sounds.

Sound levels were then summarized into 10-minute and period-long statistics. The overall equivalent continuous average sound levels ranged from 36 to 49 dBA during the day and 32 to 45 dBA during the night. Measured sound levels were widely distributed, depending on the proximity to human activity and industry.

TABLE 2: PRECONSTRUCTION SOUND MONITORING SUMMARY

	Location	Sound Pressure Level (dBA)											
		Overall				Day				Night			
		Leq	L90	L50	L10	Leq	L90	L50	L10	Leq	L90	L50	L10
Combined	Brasted Road	46	19	28	42	47	22	31	45	41	17	24	35
	Loon Lake	48	25	37	51	49	29	40	53	45	22	30	46
	Dye/Rex Road	37	21	28	38	38	22	29	39	34	20	27	36
	Haskinville Road	42	21	34	45	43	27	37	46	39	19	26	42
	Rose Road	35	22	29	37	36	23	30	38	32	20	27	35
	Henkle Hollow Road	38	23	30	40	39	24	32	41	35	22	29	37
	Walter Kurtz Road	38	20	29	41	39	22	30	42	34	19	27	38

During estimated turbine hub-height wind speeds sufficient for wind turbines to operate (4 m/s), both equivalent average (L_{eq}) and lower 10th percentile (L_{90}) sound levels were positively correlated with wind speed. L_{90} sound levels showed a better correlation with wind speed than L_{eq}. With either metric there is a large spread among sound levels, so wind speeds are not the sole determinant of measured sound level.

An analysis of the temporal accuracy of the monitoring data according to ANSI 12.9 Part 2 showed that all locations showed high temporal accuracy (Class A or B).

1.4 | SOUND PROPAGATION MODELING

Sound propagation modeling was performed for the sensitive sound receptors (nonparticipating receptors) around the project. These included 1,484 nonparticipating permanent residences, of which 19 are cabins, 1 is a church, 1,293 are full-time or seasonal residences, and 171 are of unknown usage. In addition, 43 participating residences were modeled along with 10 property line locations.[2]

Two types of modeling were performed. The first estimated the highest one-hour L_{eq} (L_{1h}) that will be produced by the project. This modeling was performed according to ISO 9613-2. The second method was used to calculate seasonal and annualized long-term average and statistical project sound levels. This method used the ISO 9613-2 methodology with CONCAWE meteorological adjustments along with a year's worth of site-specific meteorological data to calculate sound levels at each receptor for every hour of that year. From this nightly, daily, seasonal, and annual statistical sound levels were calculated

MODELING OF ONE-HOUR SOUND LEVELS

ISO 9613-2 modeling was conducted with the proposed turbine array along with a hybrid wind turbine that featured the highest overall sound power of those presented in the Application and the highest low-frequency octave bands of turbines presented in the Application.

With this hybrid wind turbine, the modeling indicated that mitigation was needed to meet the Project noise design goals and regulatory limits presented in Table 1. In particular, one turbine would need to be removed and several others would need to operate under Noise Reduced Operation (NRO).[3] With this mitigation, the quantitative noise limits of the Towns of Freemont, Cohocton, Wayland, and Dansville are modeled to be met.

Based upon the dose-response curves of Michaud et al 2016, we conducted an analysis of the statistical likelihood of individuals being annoyed by exposure to wind turbine sound. The results are that at approximately 22 locations, or 2.3 percent of the receptors in the study area, there would be individuals that could be highly annoyed by the wind turbine sound indoors. It is not possible to identify in advanced which (if any) locations these would be, as response to wind turbine noise is largely subjective.

Sound levels at project property lines will range between 29 and 50 dBA. This meets all applicable project noise design goals.

The modeling results show that exterior infrasound from the project will exceed the interior threshold to produce moderately perceptible building vibrations under ANSI 12.2-2008 by up to 1 dB at the closest nonparticipating receptors in the 16 Hz 1/1 octave band. This is assuming low-frequency and infrasound data for the worst-case turbine considered for this project applied to the turbine with the worst-cause audible frequency sound and there is no outside to inside sound attenuation at this frequency. Taking into consideration an outside to

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[2] All receptors, regardless of type are considered either participating or nonparticipating for sound propagation modeling. Cabins have not yet been studied to determine whether they have running water or septic systems and meet the criteria for inclusion.

[3] Other methods exist to bring the project into compliance with the noise design goals and regulatory limits, such as signing new project participants, new turbine technologies that would further reduce sound power levels or selection of a turbine with a lower sound power level.

inside attenuation of 3 dB at the 16 Hz octave band,[4] the interior infrasound threshold of ANSI S12.2-2008 would not be exceeded.

The modeling also showed that the highest sound level of the substation transformer would be 38 dBA with cooling fans operating. This is below the applicable 40 dBA L_{8h} design goal.

When the Cohocton/Dutch Hill Wind Farm is added to the model, the combined sound levels do not exceed 45 dBA L_{1h} at sensitive sound receptors where the Baron Winds project provides the dominant contribution to the overall sound level.

LONG-TERM MODELING

Some sound level design goals are based on averaging times longer than one hour. As noted above, this was modeled using ISO 9613-2 with hourly meteorological adjustments calculated with CONCAWE.

The long-term modeling showed that all nonparticipating sensitive receptors met all long-term design goals. These include the design goals of 45 dBA L_{8h} at night and 40 dBA $L_{night, outside}$, which is an annual average at night. In addition, the long-term participant design goals of 55 dBA L_{8h} and 50 dBA $L_{night, outside}$ were also met.

With the addition of the Cohocton/Dutch Hill project, sound levels do not exceed either non-participating receptor design goal (L_{8h} or $L_{night, outside}$) where the sound level contribution from Baron Winds is greater than 1.5 dB.

CONSTRUCTION NOISE MODELING

Construction noise was modeled at three sites:

- The turbine location with a minimum setback to a nonparticipating receptor closest to EverPower's internal criteria (1,500 feet or 428 meters), T40.
- At both of the project laydown yards (northern and southern).

Modeling was performed with the ISO 9613-2 sound propagation model. Two different modeling scenarios were run. The first scenario modeled the one-second maximum L_{eq} with all construction noise sources operating at their maximum sound level simultaneously. Under this scenario, sound levels were 63 dBA. Since, this is an unrealistic scenario, with types of equipment modeled simultaneously that are from different phases of construction, and would not be run simultaneously in a single location, the different construction phases were modeled separately. The phases modeled were:

- Clearing.
- Excavation.
- Foundation construction.

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[4] See O'Neal, R. et al. "Low frequency noise and infrasound from wind turbines." Noise Control Engineering J. 59 (2), 2011.

- Turbine erection.

Of these phases, the Clearing phase has the highest predicted sound levels, with maximum one-second L_{eq} of 63 dBA near the nonparticipating receptor at a 1,500 foot setback.

Sound is also generated at the two laydown yards where concrete batch plants may operate. The maximum sound level at a permanent nonparticipating receptor was 65 dBA near the northern laydown yard and 62 dBA near the southern laydown yard.

These sound levels are typical of wind turbine construction. Given the setbacks involved and the relatively short duration of construction, no undue adverse impacts are expected. However, if noise issues do occur, there is a complaint resolution process in place. This includes a phone number for complaints and procedures for Baron Winds to respond.

1.5 | WIND SHEAR AND TURBULENCE INTENSITY

An analysis of wind shear and turbulence intensity was performed to determine the likelihood turbines at the Project will produce excessive amplitude modulation. While it is possible to The number of hours of amplitude modulation at various depth from wind turbines cannot be reliably predicted before a project is built.

Turbulence intensity at the site is typical, if not slightly lower, than proposed wind farm sites RSG has worked on previously. Turbulence is also typically more prevalent during the day than at night. Wind shear is higher than other sites RSG has worked on, that have not exhibited excessive amplitude modulation. High wind shear alone does not typically produce excessive amplitude modulation, but can exacerbate amplitude modulation. For amplitude modulation to take place, blade stall or detached flow must occur, which is usually caused by turbulence.[5] At the Project site, periods with high wind shear do not typically have high turbulence intensity. Consequently, the Project site does not appear to be conducive to excessive amplitude modulation. Wakes from upwind turbines though, can increase turbulence for downwind turbines under certain conditions.

1.6 | GROUND-BORNE VIBRATION

The closest seismological stations to the Project are well outside of recommended distances to prevent interference due to ground-borne vibration.

1.7 | CONCLUSIONS

Based upon results from the analysis completed in this report, showing adherence of the project to the proposed noise design goals, regulatory limits, and Town noise ordinances, we can conclude that adverse impacts due to sound from construction and operation of the proposed Baron Winds Project have been minimized to the extent practicable.

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[5] "Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect." *RenewableUK*. December 2013.

2.0 INTRODUCTION

This report is a noise impact assessment of the proposed Baron Winds Project (the "Project") as part of its permit application under Article 10 of the New York Public Service Law.

The project will be located in the towns of Fremont, Cohocton, Wayland, and Dansville in Steuben County, New York. The area around the project is primarily farmland with some forested and residential areas. The Project is proposed as a 76-turbine facility with supporting infrastructure, and a total output of up to 300 MW. The following noise study was conducting in accordance with Article 10 and the wind turbine noise regulations of the Towns of Cohocton, Wayland, Dansville, and Fremont.

This report includes:

1) A description of the project.
2) Discussion of sound level limit standards and guidelines applicable to the project.
3) Discussion of noise issues particular to wind turbines as well as research on human response to wind turbine noise.
4) Sound level monitoring procedures.
5) Sound monitoring results from monitoring conducted within the project area.
6) Sound propagation modeling procedures.
7) Sound Propagation modeling results.
8) Construction sound propagation modeling.
9) Discussion.
10) Conclusions.

3.0 PROJECT SOUND LEVEL DESIGN GOAL (ARTICLE 10/STIPULATION 19(G))

This section describes the Project sound level design goals. We first review local regulatory limits for nearby towns, branching in to Article 10 guidelines, Stipulations developed for this project, national and international guidelines, a review of scientific literature regarding human response to wind turbine noise, and development of project design goals and suggested regulatory limits.

3.1 | TOWN STANDARDS

TOWN OF FREMONT

The Town of Fremont has a wind power project sound level limit in its *A Local Law Governing Wind Energy Facilities in the Town of Fremont*. Section 8.8.A.17.(d) states requirement for a noise study.

> *(d) Noise Analysis: a noise analysis by a competent acoustical consultant documenting the noise levels associated with the proposed WECS. The study shall document noise levels at property lines and at the nearest residence not on the Site (if access to the nearest residence is not available, the Town Board may modify this requirement). The noise analysis shall provide pre-existing ambient noise levels and include low frequency noise.*

The actual sound level limit is found in 8.13.A. A tonal noise criterion is found in 8.13.B and further clarification in the situation that ambient sound level exceeds 50 dBA is included in 8.13.C. Section 8.13.D specifies that sound levels between two integer values should be rounded down. The relevant portions of Section 8.13 reads:

> *A. The statistical sound pressure level generated by a WECS shall not exceed* L_{10}*- 50 dBA measured at the closest exterior wall of any residence existing at the time of completing the SEQRA review of the application. If the ambient sound pressure level exceeds 50 dBA, the standard shall be ambient dBA plus 5 dBA. Independent certification shall be provided before and after construction demonstrating compliance with this requirement.*
>
> *B. In the event audible noise due to WECS operations contains a steady pure tone, such as a whine, screech, or hum, the standards for audible noise set forth in subparagraph 1) of this subsection shall be reduced by five (5) dBA. A pure tone is defined to exist if the one-third (1/3) octave band sound pressure level in the band, including the tone, exceeds the arithmetic average of the sound pressure levels of the two (2) contiguous one third (1/3) octave bands by five (5) dBA for center frequencies of five hundred (500) Hz and above, by eight (8) dBA for center frequencies between one hundred and sixty (160) Hz and four hundred (400) Hz, or by fifteen (15) dBA for center frequencies less than or equal to one hundred and twenty-five (125) Hz.*
>
> *C. In the event the ambient noise level (exclusive of the development in question) exceeds the applicable standard given above, the applicable standard shall be adjusted so as to equal the ambient noise level. The ambient noise level shall be expressed in terms of the highest whole*

> *number sound pressure level in dBA, which is exceeded for more than five (5) minutes per hour. Ambient noise levels shall be measured at the exterior of potentially affected existing residences. Ambient noise level measurement techniques shall employ all practical means of reducing the effect of wind generated noise at the microphone. Ambient noise level measurements may be performed when wind velocities at the proposed project Site are sufficient to allow Wind Turbine operation, provided that the wind velocity does not exceed thirty (30) mph at the ambient noise measurement location.*
>
> *D. Any noise level falling between two whole decibels shall be the lower of the two.*

Section 8.14 outlines requirements for noise and setback easements.

> *A. In the event the noise levels resulting from a WECS exceed the criteria established in this Section, or a setback requirement is not met, a waiver is hereby granted from such requirement where the adjoining owner's property is considered part of the Site.*
>
> > *1. Written consent from the affected property owners shall be obtained stating that they are aware of the WECS and the noise and/or setback limitations imposed by this Section, and that they wish to be part of the Site as defined herein, and that consent is granted to (1) allow noise levels to exceed the maximum limits otherwise allowed or (2) allow setbacks less than required; and*
> >
> > *2. In order to advise all subsequent owners of the burdened property, the consent, in the form required for an easement, shall be recorded in the County Clerk's Office describing the benefited and burdened properties. Such easements shall be permanent and may not be revoked without the consent of the Town Board, which consent shall be granted upon either the completion of the decommissioning of the benefited WECS in accordance with this Section, or the acquisition of the burdened parcel by the owner of the benefited parcel or the WECS.*
> >
> > *3. In any case where written consent is not obtained, and therefore a property is not part of the Site, a variance from the Board of Appeals shall be required.*

Section 8.18 of the ordinance deals, in part, with postconstruction noise testing:

> *A. Testing fund. A Special Use Permit shall contain a requirement that the applicant fund periodic noise testing by a qualified independent third-party acoustical measurement consultant, which may be required as often as every two years, or more frequently upon request of the Town Board in response to complaints by neighbors. The scope of the noise testing shall be to demonstrate compliance with the terms and conditions of the Special Use Permit and this Section and shall also include an evaluation of any complaints received by the Town. The applicant shall have 90 days after written notice from the Town Board, to cure any deficiency. An extension of the 90 day period may be considered by the Town Board, but the total period may not exceed 180 days.*

The definition of "sound pressure level" if sound in Section 8.4:

4. *SOUND PRESSURE LEVEL - means the level which is equaled or exceeded a stated percentage of time. An* L_{10} *- 50 dBA indicates that in any hour of the day 50 dBA can be equaled or exceeded only l 0% of the time, or for 6 minutes. The measurement of the sound pressure level can be done according to the International Standard for Acoustic Noise Measurement Techniques for Wind Generators (IEC 61400-ll), or other accepted procedures*

In summary, the sound level limit for Fremont is 50 dBA L_{10} in any hour, unless the ambient is above 50 dBA, then the limit is the ambient sound level plus 6 dB. For the purposes of this study, we will not analyze the potential for any limit above an hourly L_{10} of 50 dBA. The Freemont standard adds a 5 dB penalty for tonal noise. The criteria for tonality roughly equivalent to the criteria of ANSI S12.9 Part 4 Annex C.

TOWN OF COHOCTON

Section 1120 of the Cohocton Zoning Law regulates wind turbine sound. Under 3(c), the rules state:

> *i. A noise level analysis shall be prepared to determine predicted windmill-only noise and pure tone components at property lines of the wind development project which abut non-project parcels and existing residences.*
>
> *ii. Windmill only noise shall be predicted based upon appropriate reference noise levels obtained from field measurements of the windmill proposed to be installed.*
>
> *iii. Except as otherwise provided herein, windmills shall be located so that predicted windmill only noise at non-project property lines shall not exceed 50 dB(A), and windmill only noise at existing residences located on non-project parcels shall not exceed 45 dB(A).*
>
> *iv. In the event that the noise generated by any windmill contains a pure tone component, as set forth herein, windmills shall be located so that predicted windmill only noise at non-project property lines shall not exceed 45dB(A), and windmill only noise at existing residences located on non-project parcels shall not exceed 40 dB(A).*
>
> *A pure tone is defined to exist when a one-third (1/3) octave band noise level exceeds the arithmetic average of the two adjacent one third (1/3) octave band levels by the following:*

Band Range	*Exceedance*
31.5 — 125 H	*15 dB(A)*
160 — 400 Hz	*8 dB(A)*
500 — 8,000 Hz	*5 dB(A)*

Under Section 1130(2)(a)(iii), Review Standards, the noise limit in iv, above, is repeated. However, additional information is added under 1130(1)(d)(vi), which states,

> *Windmill only noise levels at non-project property lines shall not exceed 50 dB(A) at on-project property lines, when measured at the minimum wind speed at which the windmill will achieve its rated electric output as set forth in the project related special use permit*

> *As set forth herein, compliance with windmill only noise level requirements shall periodically be determined by the Town Code Enforcement Officer, or such other officer or employee which the Town Board may designate. The Code Enforcement Officer, or such other designated officer or employee of the Town, shall take three successive A-weighted fifteen (15) second Leq measurements at an appropriate position on non-project property lines, If the arithmetic average of noise at non-project property lines is equal to or below 50 dB(A), then the project shall be considered in compliance with this Article. If an arithmetic average of higher than 50 dB(A) is measured, then the project sponsor shall cease operation of the nearest windmill, and the Code Enforcement Officer, or such other designated officer or employee of the Town, shall take another series of three, 15-second Leq measurements. Appropriate places from which to take the sound measurements include areas where background noise is minimized and constant.*
>
> *Windmill only noise shall be determined based upon the following formula:*
>
> $10 \, Log_{10}(10^{0.1 C} - 10^{0.1 A})$
>
> **C = the recorded ambient noise level when the turbine is on;*
>
> *A = the recorded noise level when the turbine is off.*
>
> *Windmill only noise levels at non-project property lines may exceed the thresholds set forth herein only if the affected non-project property owner provides written consent to the Town Code Enforcement Officer.*

In summary, the limit is 45 dBA L_{eq} at an existing nonparticipating residence, measured in three 15-second periods. The nonparticipating property line standard is 50 dBA L_{eq}. A 5 dB tonal penalty applies, similar to the that found in ANSI S12.9 Part 4 Annex C.

TOWN OF WAYLAND

The Town of Wayland is currently in a rule-making process to change local law (2017-1), “Amended Local Law Regulating Wind Energy-Deriving Towers.” The most recently proposed language is shown below, as is found in Article VII Section 4.

> *4. The level of noise produced during wind tower operation shall not exceed forty-five (45) (dBA) Leq (8-hour) measured at the nearest non-participating, permanent residential structure, and (50) (dBA) Leq (8-hour) measured at a participating residence or, or from any nonparticipating property boundary, whichever is less. Should a permanent, non-participating residence be constructed prior to the Tower Facility going into operations, the level of noise shall not exceed (45) (dBA) Leq (8-hour) at the non-participating permanent residence. If the ambient noise level exceeds 45 dba, then the permissible noise level shall be no more than the ambient noise lever plus 6 dba. If a participating property owner requests a waiver from these noise limitations, written documentation from said property owner must be provided for consideration by the Planning Board.*

This sets sound level limits of 45 dBA L_{8h} at nonparticipating receptors, unless the ambient sound level exceeds 45 dBA. in which case the sound level limit is the ambient sound level plus 6 dB. At nonparticipating property lines and participating receptors, the sound level limit is 50 dBA L_{8h}.

TOWN OF DANSVILLE

The Town of Dansville is also modifying their "Wind Energy Facility" law. The most recent version is show below, as is found in Section 15 or the law.

> A. *Sound Levels. The statistical sound pressure level generated by a WTG shall not exceed Leq - 45 dBA measured at the nearest residence located off the Site. Sites can include more than one piece of property and the requirement shall apply to the combined properties. If the ambient sound pressure level exceeds 45 dBA, the standard shall be ambient dBA plus 6 dBA.*

This sets a sound level limit of 45 dBA L_{1h} (the direction of the period is found elsewhere in the law), unless the ambient sound level exceeds 45 dBA. If this is the case, the sound level limit is the ambient sound level plus 6 dB.

3.2 | STATE POLICIES, GUIDELINES, AND REGULATIONS

NYSDEC PROGRAM POLICY

No quantitative state noise limit exists that applies to this project.

In October 2000, the NYSDEC, published a Program Policy, *Assessing and Mitigating Noise Impacts*. This document includes information about background sound level measurements, jurisdiction limits of the NYSDEC, and a review of guidelines from the other sources, among other topics. The purpose of the Policy is as follows:

> "This policy is intended to provide direction to the staff of the Department of Environmental Conservation for the evaluation of sound levels and characteristics (such as pitch and duration) generated from proposed or existing facilities. This guidance also serves to identify when noise levels may cause a significant environmental impact and gives methods for noise impact assessment, avoidance, and reduction measures…."

The sound level guidelines are found in Section V.B.1.c. Two types of thresholds are mentioned – one that is relative to existing background sound levels, and the other that is fixed.

> "The goal for any permitted operation should be to minimize increases in sound pressure level above ambient levels at the chosen point of sound reception. Increases ranging from 0-3 dB should have no appreciable effect on receptors. Increases from 3-6 dB may have potential for adverse noise impact only in cases where the most sensitive of receptors are present. Sound pressure increases of more than 6 dB may require a closer analysis of impact potential depending on existing SPLs and the character of surrounding land use and receptors. SPL increases approaching 10 dB result in a perceived doubling of SPL. The perceived doubling of the SPL results from the fact that SPLs are measured on a logarithmic scale. An increase of 10 dB(A) deserves consideration of avoidance and mitigation measures in most cases. The above thresholds as indicators of impact potential should be

> viewed as guidelines subject to adjustment as appropriate for the specific circumstances one encounters.
>
> "Establishing a maximum SPL at the point of reception can be an appropriate approach to addressing potential adverse noise impacts. Noise thresholds are established for solid waste management facilities in the Department's Solid Waste regulations, 6 NYCRR Part 360. Most humans find a sound level of 60–70 dB(A) as beginning to create a condition of significant noise effect (EPA 550/9-79-100, November 1978). In general, the EPA's "Protective Noise Levels" guidance found that ambient noise levels of 55 dBA $L_{(dn)}$ was sufficient to protect public health and welfare and, in most cases, did not create an annoyance (EPA 550/9-79-100, November 1978). In non-industrial settings the SPL should probably not exceed ambient noise by more than 6 dB(A) at the receptor. An increase of 6 dB(A) may cause complaints. There may be occasions where an increase in SPLs of greater than 6 dB(A) might be acceptable. The addition of any noise source, in a nonindustrial setting, should not raise the ambient noise level above a maximum of 65 dB(A). This would be considered the "upper end" limit since 65 dB(A) allows for undisturbed speech at a distance of approximately three feet. Some outdoor activities can be conducted at a SPL of 65 dB(A). Still lower ambient noise levels may be necessary if there are sensitive receptors nearby. These goals can be attained by using the mitigative techniques outlined in this guidance."

Precedent established by such cases as the Arkwright Summit Wind Farm call for the use of the equivalent average sound level (L_{eq}) for both the existing and build sound levels.

The guidelines state that they do "not supersede any local noise ordinances or regulations."

NYSDPS CHAPTER 10

In 2012, the NYSDPS revised its rules for electric generation and siting, contained in New York Code, Rules, and Regulations 16, Chapter 10. Exhibit 19 (1001.19) pertains to noise.

The NYSDPS regulations do not list a specific sound level limit, but instead describe information requirements and analysis requirements for a permit application. The relevant excerpt from the regulation is found below. Shown within square brackets are the sections in this report where specific provisions are found.

> Exhibit 19 shall contain:
>
> A study of the noise impacts of the construction and operation of the facility, related facilities and ancillary equipment. The name and qualifications to perform such analyses of the preparer of the study shall be stated. If the results of the study are certified in any manner by a member of a relevant professional society, the details of such certification shall be stated. If any noise assessment methodology standards are applied in the preparation of the study, an identification and description of such standards shall be stated. The study shall include:

(a) A map of the study area showing the location of sensitive sound receptors in relation to the facility, related facilities and ancillary equipment (including any related substations). The sensitive sound receptors shown shall include residences, outdoor public facilities and areas, hospitals, schools and other noise-sensitive receptors. *[Section 4]*

(b) An evaluation of ambient pre-construction baseline noise conditions, including A-weighted/dBA sound levels, prominent discrete (pure) tones, at representative potentially impacted noise receptors, using actual measurement data recorded in winter and summer and during day and night as a function of time and frequency using a suitable and suitably calibrated sound level meter (SLM) and octave band frequency spectrum analyzer, or similar equipment. The ambient pre-construction baseline sound level should be filtered to exclude seasonal and intermittent noise. *[Sections 5, 6, and 7]*

(c) An evaluation of future noise levels during construction of the facility and related facilities including predicted A-weighted/dBA sound levels, at potentially impacted and representative noise receptors, using computer noise modeling. *[Section 12]*

(d) An estimate of the noise level to be produced by operation of the facility, related facilities and ancillary equipment assuming wind-induced background noise or stable atmospheric conditions, as appropriate, and not assuming any attenuation of sound that transiently occurs due to weather or temperature. *[Section 9]*

(e) An evaluation of future noise levels during operation of the facility, related facilities and ancillary equipment including predicted A-weighted/dBA sound levels, prominent discrete (pure) tones, and amplitude modulated sound, at potentially impacted and representative noise receptors, using computer noise modeling, and an analysis of whether the facility will produce significant levels of low frequency noise or infrasound. *[Sections 9, 10, and 11]*

(f) A statement in tabular form of the A-weighted/dBA sound levels indicated by measurements and computer noise modeling at the representative external property boundary lines of the facility and related facilities and ancillary equipment sites, and at the representative nearest and average noise receptors, for the following scenarios: *[Sections 9 and Appendix C]*

> (1) Daytime ambient noise level—a single value of sound level equivalent to the level of sound exceeded for 90% of the time during the daytime hours (7 am–10 pm) of a year (L((90))).

(2) Summer nighttime ambient noise level—a single value of sound level equivalent to the level of sound exceeded for 90% of the time during the nighttime hours (10 pm–7 am) during the summer (L((90))).

(3) Winter nighttime ambient noise level—a single value of sound level equivalent to the level of sound exceeded for 90% of the time during the nighttime hours (10 pm–7 am) during the winter (L((90))).

(4) Worst case future noise level during the daytime period – the daytime ambient noise level (L((90))), plus the noise level from the proposed new sources modeled as a single value of sound level equivalent to the level of sound exceeded for 10% of the time by such sources under normal operating conditions by such sources in a year (L((10))).

(5) Worst case future noise level during the summer nighttime period—the summer nighttime ambient noise level (L((90)), plus the noise level from the proposed new sources modeled as a single value of sound level equivalent to the level of sound exceeded for 10% of the time by such sources under normal operating conditions by such sources in a year (L((10))).

(6) Worst case future noise level during the winter nighttime period—the winter nighttime ambient noise level (L((90))), plus the noise level from the proposed new sources modeled as a single value of sound level equivalent to the level of sound exceeded for 10% of the time by such sources under normal operating conditions by such sources in a year (L((10))).

(7) Daytime ambient average noise level—a single value of sound level equivalent to the energy-average ambient sound levels (L_{eq}) during daytime hours (7 am–10 pm); and

(8) Typical facility noise levels—the noise level from the proposed new sources modeled as a single value of sound level equivalent to the level of the sound exceeded 50% of the time by such sources under normal operating conditions by such sources in a year (L_{50}).

(9) Typical future noise level during the daytime period – the energy-average ambient sound level during daytime hours (L_{eq}), plus the noise level from the proposed new sources modeled as a single value of sound level equivalent to the level of the sound exceeded 50% of the time by such sources under normal operating conditions by such sources in a year (L_{50}).

(g) A description of the noise standards applicable to the facility, including any local requirements, and noise design goals for the facility at representative potentially impacted noise receptors, including residences, outdoor public facilities and areas, hospitals, schools, other noise-sensitive receptors, and at representative external property boundary lines of the facility and related facilities and ancillary equipment sites. *[Section 3]*

(h) A tabular comparison of the noise standards applicable to the facility, including any local requirements, and noise design goals for the facility, and the degree of compliance indicated by computer noise modeling at the representative external property boundary lines of the facility and related facilities and ancillary equipment sites, and at the representative nearest and average noise receptors. *[Appendix E]*

(i) An identification and evaluation of reasonable noise abatement measures for construction activities, including a description of a complaint-handling procedure that shall be provided during the construction period.

(j) An identification and evaluation of reasonable noise abatement measures for the final design and operation of the facility including the use of alternative technologies, alternative designs, and alternative facility arrangements. *[Section 9]*

(k) An evaluation of the following potential community noise impacts: hearing damage (as addressed by applicable Occupational Safety and Health Administration standards); indoor and outdoor speech interference; interference in the use of outdoor public facilities and areas; community complaint potential; the potential for structural damage; and the potential for interference with technological, industrial or medical activities that are sensitive to vibration or infrasound. *[Sections 3, 9.4, and 11]*

(l) A description of post-construction noise evaluation studies that shall be performed to establish conformance with operational noise design goals *[Separate to the Noise Impact Assessment]*.

(m) An identification of practicable post-construction operational controls and other mitigation measures that will be available to address reasonable complaints, including a description of a complaint-handling procedure that shall be provided during periods of operation *[Section 8.6]*.

(n) The computer noise modeling values used for the major noise-producing components of the facility shall fairly match the unique operational noise characteristics of the particular equipment models and configurations proposed for the facility. The software input parameters, assumptions, and associated data used for the computer modeling shall be provided. *[Section 9.1 and Appendix B]*

STIPULATION 19

Stipulations were developed along with the NYSDPS and NYSDOH, based on the Article 10 guidelines. These stipulations are reproduced below. We have added, within square brackets, the sections in this report where information pertaining to specific stipulations can be found.

> Exhibit 19 shall comply with the requirements of 16 NYCRR § 1001.19 by containing:
>
> A study of the noise impacts of the construction and operation of the facility. The name and qualifications to perform such analyses of the preparer of the study shall be stated. If the results of the study are certified in any manner by a member of a relevant professional society, the details of such certification shall be stated. *[Title page]* If any noise assessment methodology standards are applied in the preparation of the study, an identification and description of such standards shall be stated.
>
> For proposes of this stipulation the term Facility shall include the wind turbines, the related facilities (i.e. the substation) and ancillary equipment.
>
> *a)* A map of the Study Area showing the location of sensitive sound receptors[6] and participating receptors within one mile from any proposed turbine location in relation to the Facility. The map will be created using aerial imagery, field verification and consultation with local municipalities. *[Section 4.0 and Appendix C]*
>
> b) An evaluation of ambient pre-construction baseline noise conditions, including identification of A-weighted sound levels, pure tones[7] if any, at representative, potentially impacted sensitive sound receptors, using actual measurement data recorded in winter and summer (i.e., leaf off and leaf on) during the day and at night as a function of time and frequency. Ambient baseline sound levels will be measured utilizing suitable and suitably calibrated sound level meter(s) and fractional octave band analyzer(s). Brand, specifications (such as sound floor, temperature, and relative humidity ranges of operation), certificates of calibration, and model number of the sound level meters and calibrators used will be specified and included in the Application; locations, dates, and times of testing, weather

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[6] Sensitive sound receptors will be defined as non-participating residences, including non-participating seasonal cabins or hunting camps identified by property tax codes (e.g., 260-seasonal residences) at the time of the filing of the application and those with septic systems/running water, hospitals, care centers, schools, libraries, places of worship, public areas and public facilities. Participating residences will be identified and may have different design goal(s) than sensitive sound receptors.

[7] Tonal prominence of one-third octave bands will be quantified for all valid periods for each monitor in each season. Tonality is defined by ANSI S12.9-2005 Part 4 (R2015) Annex C. A particular one-third octave band is considered tonal if it exceeds the level of the adjacent one-third octave by the prescribed Kt constant level difference. Every second of monitor ambient pre-construction data will be analyzed for tonality, which is expressed as seconds of tonality per 10-minute period (up to 600 seconds).

conditions[8] (wind speed,[9] wind direction, temperature, relative humidity and precipitation), frequency range of measurement, meter settings and general methodology and procedures will be specified and described.[10] Graphs for low frequency and "audible" noise levels (L_{eq} and L_{90}) as a function of frequency will be included. Measured noise levels (L_{eq} and L_{90}) will be illustrated with graphs showing sound levels at evaluated positions as a function of wind speed at 10 meters as extrapolated from the meteorological tower(s) in 10-minute intervals.

Noise descriptors including L_{eq} and L_{90} will be calculated and included as part of the tabular results provided in Section f) below. The A-weighted L_{eq} and L_{90} for each 10-minute period will be calculated from one-second equivalent average sound levels and charted. The 10-minute L_{90}s are used for charting sound levels over time. The L_{90}, under 19(f) is calculated for daytime in (1), summer nighttime in (2) and winter nighttime in (3). These will be calculated from the 1-second L_{eq} data collected at each monitoring location. For each location, results will be presented as graphs of sound level and maximum wind gust speed as a function of time throughout the monitoring period. Each point on the graph will represent data summarized for a single 10-minute interval. The data from periods which were excluded from processing will be included in the graphs but shown in lighter colors. Bands at the bottom of each graph will indicate the reason that data were excluded. Wind data will be presented as the maximum gust speed occurring at any time during the 10-minute interval; they are not averaged. Plots of overall broad-band and one-third octave band unweighted (Z or linear) spectral levels for all valid periods will be provided for each monitoring site. Each point on the plot will represent the L_{90}, L_{eq} and median (L_{50}) of the respective one-third octave band for the specified period. Five sets of L_{90}'s, L_{50}'s and L_{eq}'s, will be presented in each plot: the overall level, and the day and night for winter and summer monitoring periods.

Temporal accuracy (for the number of days tested) will be calculated and reported based on a 95% confidence interval for the L_{90}'s and L_{eq}'s indicating the mean value and the lower and upper ends of the confidence interval.

Weather information can be supplemented with data from the most representative and proximal weather station(s) unless the weather conditions at the site are not similar to those at the weather station.

The ambient pre-construction baseline sound level will be filtered to exclude seasonal and intermittent noise, periods of rain, thunderstorms and excessive wind and gusts as appropriate. The ANS frequency-weighting network will be used where appropriate (i.e. bird and insect sound is prominent), also called ANS-

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[8] Weather conditions are used to evaluate validity of the ambient measurement. Relevant conditions include wind speed, temperature (check if within equipment tolerances) and precipitation. (Rainfall, thunderstorms and periods with excessive wind speed will be excluded from calculation of results).

[9]. Weather data will be reported in graphical formats. Tabular weather data will be provided electronically.

[10] Data will include GPS coordinates of the microphones and AADT of the nearest road, to the extent the data is available from the County and/or NYSDOT.

weighted sound levels in ANSI/ASA S3/SC1.100-2014–S12.100-2014. If "ANS" frequency weighting network is used, then results will be shown for both "A-"and "ANS-" weighting. *[Sections 5, 6, and 7, and Appendix D]*

c) An evaluation of future noise levels during construction of the proposed Facility including predicted A-weighted sound levels at proximate potentially impacted and representative sensitive sound receptors using ISO 9613-2 as implemented by the Cadna/A computer program or similar, predicted construction traffic levels, construction equipment and construction activities sound emissions, and by following the guidelines and recommendations of FHWA Highway Construction Noise Handbook FHWA-HEP-06-015 as applicable. Information will include noise contours at one representative location including all construction related noise emissions for the main phases of construction (e.g., excavation, foundation, erection of turbines) and at any proposed batch plant area/laydown area, if a batch plant or laydown areas are proposed in the Application. *[Section 12]*

d) An estimate of the noise level to be produced by operation of the proposed Facility using computer noise modeling which incorporates the ISO 9613-2 and the CONCAWE sound propagation standards as follows:[11] *[Section 9]*

  1) ISO 9613-2: Originally developed to predict outdoor sound propagation for well-developed moderate ground-based temperature inversions or, equivalently, downwind propagation, which commonly occurs at night, will be used by assuming the least attenuation due to temperature and humidity.[12] *[Section 9.3]*

  Modeling and noise contours for the wind turbine model with the highest broad-band A-weighted sound power levels will be provided.

  2) Noise modeling and calculation of the CONCAWE meteorological adjustments will be done in Cadna/A and to include 64 different meteorological conditions and one year of turbine sound levels at each receiver by the use of computer noise model with estimates of hourly turbine power and one year of met tower data.[13] The met tower data will be submitted under confidential cover pursuant to 16 NYCRR Section 6-1.4. These will be used to provide A-weighted sound levels with averaging times greater than one hour at all sensitive and participating sound

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[11] "For the purposes of this stipulation the term "ISO-9613-2" will refer to the ISO 9613-2:1996 Standard or equivalently the ANSI/ASA S12.62-2012/ISO 9613-2:1996 (Modified) Standard with no meteorological correction (Cmet) or equivalently with the meteorological correction Cmet equaled to a value of zero. For the purposes of this stipulation the term "CONCAWE" will refer to the ISO 9613-2:1996 Standard or equivalently the ANSI/ASA S12.62-2012/ISO 9613-2:1996 (Modified) Standard with the CONCAWE meteorological correction (denoted K4 in the CONCAWE standard) instead of the ISO 9613-2 meteorological correction Cmet or equivalently with the ISO 9613-2 meteorological Cmet equaled to the value of the CONCAWE meteorological correction K4. "

[12] 10 degrees Celsius and 70% relative humidity.

[13] Any corrections applied to manual or computer calculations will be reported, discussed, and justified. If any corrections are applied, results both with and without corrections will be reported in the Application.

receptors, as required by Section (f) below. The model will also include relevant noise sources from substations. *[Section 9.6]*

3) Applicable to both the ISO 9613 and CONCAWE modeling:

  i) Information from the manufacturer(s) to include Sound Power Levels for the turbine model(s) used in conjunction with the computer noise modeling required in this section will be forwarded to the NYSDPS by digital means and may be requested to be treated as confidential by the wind turbine manufacturer(s) or the Applicant

  ii) A ground absorption factor value of zero (G=0) will be used to represent water bodies, if any.

  iii) The Application will include a discussion about the accuracy of selected outdoor propagation models (ISO 9613-2 and CONCAWE), methodologies, ground absorption values[14] or meteorological corrections, input parameters, assumptions, and the correlation between measurements and predictions for documented cases as compared to other alternatives. *[Section 9.1 and Appendix B]*

4) The Application will include a description and discussion of the site topography between turbines and receptor locations as applicable to the site, and its effects on accuracy of modeling results (e.g., flat, steady or concave slopes). *[Section 9.1]*

5) The analysis of cumulative noise impacts from other existing or proposed nearby projects will be performed in the following way: *[Section 9.5]*

  i) Sound level contribution from existing neighboring wind power generating facilities (Howard and Cohocton) will be determined by comparison of ambient sound levels from the monitoring location(s) ("ambient" location(s)) that are the closest to the existing operating facility(ies), with other more distant monitoring locations ("background" locations). Relative contribution will be determined by logarithmic subtraction of the most appropriate L90-10-minute statistical sound levels from the same period at both the ambient location and background locations. This analysis will be performed for the most appropriate time periods, such as those with minimal contamination from other sound sources, and meteorological conditions conducive for producing maximal wind power generator sound emissions, as determined from project meteorological towers. For screening purposes prior to cumulative impact assessment, if noise contributions from any existing projects are at least 10 dB lower than any noise standard applicable to the Facility, including any local requirements and noise design goals for the Facility, no cumulative assessment will be necessary for such goal, limit or identified threshold. Otherwise a cumulative assessment will be conducted.

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[14] The assumptions for ground absorption will be discussed in the Application with justification for selection in the context of, the identified threshold, limit, guideline or goal to be evaluated (including noise descriptor, weighting, time frame of evaluation, etc.), the selected propagation standards, other input model parameters, and correlation between predicted and measured values.

    - *ii)* In a cumulative impact analysis, any goal, limit or identified threshold is evaluated with and without the noise contributions from other proximal projects.

- *e)* An evaluation of:

1) future noise levels during operation of the proposed Facility including predicting and reporting A-weighted sound levels and un-weighted (Z or linear) full octave band (low, mid and high frequency) levels at all sensitive sound receptors and participating receptors. Modeling for the wind turbine model with the highest broad-band A-weighted sound power levels will be provided. If other turbine models have lower broadband A-weighted sound power levels but greater maximum un-weighted sound power levels at the 31.5 Hz or 63 Hz full-octave bands, the discussion of low frequency noise impacts for those bands will be based either on the use of the highest sound power levels at those bands, on additional modeling scenarios that use the maximum sound power levels at those low frequency bands, or by applying corrections to the low-frequency band results of the computer noise modeling for the turbine with the greatest A-weighted sound power levels, provided all the turbines correspond to the same model operating at the same conditions with the same maximum power levels at the 31.5 and 63 Hertz octave bands (e.g., no different turbine models are used or no noise reduction operations are applied). *[Section 9.2 and Appendix C]*

- *2)* a tonal evaluation based on the reported sound power levels of the wind turbines and substation transformers;[15] Tonality and tonal audibility according to IEC 61400-11 will be reported if available and may be requested to be treated as confidential by the wind turbine manufacturer(s) or the Applicant. *[Section 9.3]*
- *3)* Noise modeling shall be performed for the turbine model with the highest sound power levels discussed in the Application as specified in this stipulation. The Application will contain an identification and evaluation of reasonable noise abatement measures as indicated in section (j).
- *4)* A discussion of the potential for low frequency and infrasound emissions using literature and manufacturer data, extrapolated as applicable and appropriate (giving consideration to the decay rate as a function of distance and frequency), and manufacturer low frequency and infrasound data if available. *[Section 9.3]*
- *5)* The Application will state the basis for the sound power levels used. *[Section 9.1]*
- *6)* Amplitude modulation*: [Section 10]*
    - *i)* The Application will include a literature review of amplitude modulation from wind turbines with a summary of findings. Estimates of existing wind shear and turbulence conditions in the Site area will be based on

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[15] The definition of tonal sound and tonality corrections from any applicable municipality will be used if it exists. If not, the method from Annex C from ANSI S12.9-2005/Part 4 will be used for definition of tonal sound, pure tones or prominent tones, with the following prominence Kt values: 15 dB in low-frequency one-third-octave bands (25-125 Hz), 8 dB in middle-frequency bands (160-400 Hz), and 5 dB in high-frequency bands (500-10,000 Hz).

the information collected from the on-site meteorological tower(s) and will reference the formulae and procedures outlined in IEC 61400-11 Annexes B and D as applicable and appropriate.

ii) One year of meteorological data will be evaluated to determine current magnitude and frequency of wind shear and turbulent conditions at the Project Site.

iii) Procedures, definitions, methods of calculation and associated formulae will be described in the Application.

iv) Summary wind shear and turbulence data from the on-site meteorological tower will be provided in the Application in tabular and/or graphical format.

f) A summary, in tabular[16] and/or graphical[17] format, of A-weighted sound levels indicated by measurements at evaluated receptors and computer noise modeling at the representative external property boundaries of the Facility, and at all sensitive sound receptors and participating receptors. Participant, non-participant and potentially-participant homes will also be differentiated in sound contour drawings. The summary will report the sound results at each sensitive sound receptor and participant receptor within 1 mile from any turbine (Study Area) and will address the following scenarios*:[Section 9.6 and Appendix C]*

1) Daytime ambient noise level – a single value of sound level equivalent to the level of sound exceeded for 90 percent of the time during the daytime hours (7 am to 10 pm) of a year (L_{90}). This is based on the L_{90} of the

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[16] Data reported in tabular format will be clearly identified to include headers and summary footer rows as follows: Headers will include identification of the information contained on each columns, noise descriptors (e.g., L_{eq}, L_{10}, L_{50}, L_{90}, etc.); duration of evaluation (Eq: 8-hour, 9-hour, daytime, nighttime, one-week, 2-week, summer, winter, full year, etc.); whether the value is a maximum, minimum or average and the corresponding time frame of evaluation (e.g., max 1-hour in a year, etc.). Titles should identify whether the values correspond to the “un-mitigated” or “mitigated” results, if any mitigation measures are evaluated. Columns with results related to a specific requirement of the Town, or Article 10 regulations, or the stipulations, or design goals, should identify the requirement the information is related to. (e.g., (c), (f) (1), (g), (k) (2), etc.). Compliance or non-compliance with a specific goal, guideline, threshold or regulation will be stated. Tables will include summary notes at the bottom with rows summarizing the results to include maximum, minimum and mean or arithmetic averages of the information contained in the columns. For this purpose, sound receptors will be separated in different tables according to its use (e.g., participant residences, non-participant residences, etc.).

[17] Graphical format sound contours will be depicted for all properties and property boundaries within one mile of any proposed turbine location in 1 dBA increments in Noise contours representing sound levels in multiples of 5 dB will be differentiated from other noise contours. The property boundaries of participant parcels and non-participant unoccupied parcels will be differentiated (otherwise, non-participant property lines will not be shown). The noise contours will be rendered above the maps described in section (a) of this stipulation with turbine locations and parcel lines depicted. All parcels will be labeled with ID numbers. Drawings will be submitted in full-sized digital and two hard copies by using proper scale so that labels and symbols for receptors, turbine locations and boundary lines are legible and facilitate its reading and review. Tabular summaries will designate receptors by parcel ID and/or tax ID numbers to the extent this information is available. Alternatively, cross-reference tables with receptor’s identifications and ID tax numbers shall be included. Computer noise modeling results will be reported to include broadband A weighted and unweighted (z or linear) sound levels for the full octave bands from 31.5 to 8,000 Hz. Estimated sound levels at the 16 Hz. 31.5 and 63 Hz full octave bands will be reported.

measured preconstruction daytime $L_{eq\ (1\text{-sec})}$ sound levels for the winter and summer seasons after exclusions. The L_{90} is the sound level exceeded 90 percent of the time. In Section f, each receptor is assigned to the ambient levels of a particular sound monitoring location based on the similarity of their soundscapes.

2) Summer nighttime ambient noise level – a single value of sound level equivalent to the level of sound exceeded for 90 percent of the time during the nighttime hours (10 pm to 7 am) during the summer (L90) after exclusions. This is based on the L_{90} of the measured preconstruction nighttime $L_{eq\ (1\text{-sec})}$ sound levels for the summer season.

3) Winter nighttime ambient noise level – a single value of sound level equivalent to the level of sound exceeded for 90 percent of the time during the nighttime hours (10 pm to 7 am) during the winter (L_{90}). This is based on the L_{90} of the measured preconstruction nighttime $L_{eq\ (1\text{-sec})}$ sound levels for the winter season after exclusions.

4) Worst case future noise level during the daytime period – the daytime ambient noise level (L_{90}) as indicated in (f) (1) above, plus the modeled upper tenth percentile sound level (L_{10}) of the Facility as estimated for one year. Long-term statistical sound level L_{10} will be determined for scenarios that both include and exclude low wind periods when turbines will not be generating sound.

5) Worst case future noise level during the summer nighttime period—the summer nighttime ambient noise level (L_{90}), as indicated in (f) (2) above, plus the modeled upper tenth percentile sound level (L_{10}) of the Facility as estimated for one year. Long-term statistical sound level L_{10} will be determined for scenarios that both include and exclude low wind periods when turbines will not be in operation.

6) Worst case future noise level during the winter nighttime period—the winter nighttime ambient noise level (L_{90}), as indicated in (f) (3) above, plus the modeled upper tenth percentile sound level (L_{10}) of the Facility. Long-term statistical sound level L_{10} will be determined for scenarios that both include and exclude low wind periods when turbines will not be in operation.

7) Daytime ambient average noise level – a single value of sound level equivalent to the energy-average ambient sound levels (L_{eq}) during daytime hours (7 am to 10 pm). This is based on the L_{eq} of the measured preconstruction daytime $L_{eq\ (1\text{-sec})}$ sound levels for the winter and summer seasons, after exclusions.

8) Nighttime ambient average noise level – a single value of sound level equivalent to the energy-average ambient sound levels (L_{eq}) during nighttime hours (10 pm to 7 am). This is based on the L_{eq} of the measured preconstruction nighttime $L_{eq\ (1\text{-sec})}$ sound levels for the winter and summer seasons, after exclusions.

9) Typical facility noise levels—the noise level from the proposed new sources modeled as a single value of sound level equivalent to the level of the sound exceeded 50 percent of the time by such sources under normal operating conditions by such sources in a year (L_{50}) during the daytime hours, and in combination with the energy-average ambient sound level during the daytime hours (L_{eq}) after exclusions, as indicated above in (f) (7). Long-term statistical sound level L_{50} will be determined for scenarios that both include and exclude time periods when turbines will not be in operation.

10) Tabulation of facility one night (8 hour) noise level ("Maximum L(8)") and the average annual night-time facility noise levels ($L_{eq\ (night,outside)}$) for all non-participating and participating receptors. *[Appendix C]*

g) A description of noise standards applicable to the Facility, including any local regulations, noise design goal(s)[18] at representative sensitive sound receptors, participating receptors, and at representative external property boundaries. *[Section 3]*

h) A table outlining noise standards applicable to the Facility, including any local regulations, and noise design goals at representative sensitive sound receptors, participating receptors and at representative external property boundaries, including the degree of compliance indicated by computer noise modeling at all sensitive and participating sound receptors and all Facility site boundaries. *[Appendix E]*

i) A noise complaint resolution plan covering the construction period including identification, evaluation and implementation of reasonable noise abatement measures for Facility activities along with procedures for handling complaints.

j) An identification and evaluation of reasonable noise abatement measures for the final design and operation of the Facility including the use of alternative technologies, alternative designs, and alternative Facility arrangements. *[Section 8.6]*

k) A discussion of*:*

  1) The potential for the Facility to result in hearing damage based on the Occupational Safety and Health Administration (OSHA) standards, the recommendations of the United States Environmental Protection Agency (USEPA 1974[19] and 1978[20]) and the guidelines of the World Health Organization (WHO 1999[21]). *[Section 3]*

  2) A discussion of the potential for indoor and outdoor speech interference based on guidelines from the World Health Organization (1999), including

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[18] The noise design goal(s) will take into consideration local standards, NYSDEC guidelines for lands under the jurisdiction of NYSDEC, and other guidelines, including WHO Guidelines for Community Noise (1999) and WHO Night Noise Guidelines for Europe (2009), the regulatory limit set forth in 2012 NARUC Wind Energy and Wind Siting Report, and ANSI standards S12.9 -2005/Part 4 Annex D. ANSI S2.71-1983 will be considered as a regulatory standard for vibration impacts, but not a design goal for modeling.

[19] US EPA, "Information on levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety," March 1974.

[20] US EPA "Protective noise levels: Condensed Version of EPA Levels document," November 1978.

[21] WHO, "Guidelines for community noise," 1999.

discussion of sound spectra at the appropriate frequency bands and outdoor to indoor noise reductions. *[Section 3.7]*

3) A literature review of studies, peer reviewed publications, government, scientific and professional publications, specific to the relationship between wind turbine noise, tones and annoyance/complaints will be included. Community complaint potential will be evaluated based upon identified factors, thresholds and guidelines*; [Sections 3 and 9.4]*

4) At a minimum, the potential for airborne-sound-induced vibration and annoyance at the low frequency bands of 16, 31.5 and 63 Hz will be assessed using outdoor criteria established in Annex D of ANSI standard S12.9 -2005/Part 4. Applicable portions of ANSI 12.2 (2008) may be used for the evaluation of frequency bands where ANSI 12.2 (2008) may be a more restrictive criteria or if it is expected ANSI S12.9-2005/Part 4- Annex D guidelines being met but still represent a potential for perceptible vibrations at indoor locations of sensitive sound receptors. *[Section 9.3]*

5) The potential for ground-borne transmitted vibrations from the operation of the Facility to be perceptible at sensitive receptors and participating residences. *[Section 11]*

6) The Application will identify whether low-frequency noise including infrasound and vibration from operation of the facility will cause any interference with the closest seismological and infrasound monitoring systems or any other technological, industrial or medical activities sensitive to vibration or infrasound. The application will also include a map in proper size and scale to show the location of the closest seismological and infrasound stations on both sides of the US- Canada border in relation to the Facility Site, and any other in close proximity with the site as well as a table with the approximate GPS coordinates and distances from identified locations to the Facility Site.

7) the potential for structural damage. *[Section 11]*

l) A proposed post-construction noise evaluation protocol and studies that will be performed to establish conformance with operational noise design goals, local regulations and identified thresholds.

m) An identification of practicable post-construction operational controls and other mitigation measures that will be available to address reasonable complaints, including a description of a complaint-handling and resolution procedure that shall be applied during periods of operation.

n) Noise Modeling Information*:*

1) The computer noise modeling values used for the major noise-producing components of the Facility shall fairly match the unique operational noise characteristics of the particular equipment models and configurations proposed for the Facility. *[Section 9.1and Appendix B]*

2) The software input parameters, assumptions, and associated data used for the computer modeling will be provided as an appendix. *[Appendices B, C, and D]*

        3) GIS files that contain modeled topography (Topographical contour lines and elevations), proposed turbine and substation noise source locations, sensitive sound receptors and participating receptors, and all representative boundary lines (differentiating participating, potentially-participating and Nonparticipating boundary lines), identified by Parcel ID number, will be provided to DPS-Staff and DOH-staff by electronic means.

o) The Application will also include*:*

- *1)* A comparison between future noise levels or change in noise levels at sound sensitive receptors against any identified noise levels, regulations, goals or thresholds by using the noise descriptors and specific requirements of local town laws, WHO guidelines (1999 and 2009[22]), 16 NYCRR § 1001.19, and any identified and applicable annoyance/complaint thresholds, standards or guidelines identified in sections (g) and (k) of this stipulation. *[Section 9.5 and Appendix E]*
- *2)* Estimates of: *[Section 13]*
    - *i)* the percentage of the participating and non-participating households expected to be impacted by sound levels lower or higher than the threshold values or identified ranges, and
    - *ii)* absolute values of the participating and non-participating households expected to be impacted by sound levels lower or higher than the threshold values or identified ranges.
- *3)* A glossary and a list with complete information of the references cited in the Application *[Appendices G and F]*.
- *4)* As practicable, the findings and results of Exhibit 19 will be reported and presented in the Application in the same order as listed in this stipulation. Some contents can be presented as Appendixes (e.g., Pre-construction Ambient Sound Level survey data).

Evaluation of potential effects from noise on human health will be included in Exhibit 15.

3.3 | WORLD HEALTH ORGANIZATION

The United Nation's World Health Organization (WHO) has published "Guidelines for Community Noise" (1999) which uses research on the health impacts of noise to develop guideline sound levels for communities. The foreword of the report states, "The scope of WHO's effort to derive guidelines for community noise is to consolidate actual scientific knowledge on the health impacts of community noise and to provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments."

Table 4.1 of the WHO's "Guidelines for Community Noise" (1999) provides guideline values for community noise in specific environments. The WHO guidelines suggest a

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[22] Calculations of annualized sound levels for evaluation of conformance with WHO Night Noise Guidelines for Europe (2009) (L_{eq} nighttime-1-year) will be determined for scenarios that both include and exclude wind periods when turbines will not be generating sound.

daytime and nighttime protective noise level. During the day, the levels are 55 dBA $L_{eq(16)}$, that is, an average over a 16-hour day, to protect against serious annoyance and 50 dBA $L_{eq(16)}$ to protect against moderate annoyance.

During the night, the WHO recommends limits of 45 dBA L_{8h}[23] and an instantaneous maximum of 60 dBA L_{Fmax} (fast response maximum). These are to be measured outside the bedroom window. These guidelines are based on the assumption that sound levels indoors would be reduced by 15 dBA with windows partially open. That is, the sound level inside the bedroom that is protective of sleep is 30 dBA L_{8h}. So long as the sound levels outside of the house remains at or below 45 dBA, sound levels in the bedroom will generally remain below 30 dBA. Given the climate in this region, this is essentially a summertime standard, since residents are less likely to have their windows open during other times of the year. By closing windows, an additional ~10 dB of sound attenuation will result. In addition to protection against annoyance, these guidelines are intended to protect against speech intelligibility, sleep disturbance, and hearing impairment. Of these factors, protection against annoyance and sleep disturbance require the lowest limits.

The WHO suggest that full-sentence intelligibility requires a signal-to-noise ratio of about 15 dB. For speech volume of 50 dBA, this would indicate some speech interference as low as 35 dBA for “smaller rooms.” Although speech interference is influenced by the spectrum of the masking sound, no particular guidance is given to adjust the WHO’s guidelines for sound sources of different frequency content. Since speech may range from 100 Hz to 6 kHz, there will be overlap between the spectra of wind turbine noise and speech. This guideline is generally intended for classrooms and so includes corrections for the hearing impaired, reverberation, children, and lack of language proficiency. 50 dBA is also a low sound level for speech at close distances, with most normal speech being 60 dBA at close distances, as is stated in ANSI 12.65-2011 (Figure 1).

The WHO long-term guideline to protect against hearing impairment is 70 dBA L_{24h} over a lifetime exposure, and higher for occupational or recreational exposure.

The WHO indicates that sound sources with high levels of low-frequency sound can be more intrusive. The guidelines do not include specific limits and instead state:

> “When noise is continuous, the equivalent sound pressure level should not exceed 30 dB(A) indoors, if negative effects on sleep are to be avoided. For noise with a large portion of low-frequency sound a still lower guideline is recommended.”

No specific definition is given for what entails a “large portion” of low-frequency sound. The WHO recommends doing a frequency analysis if the difference between the C- and A-weighted sound levels exceeds 10 dB. As WHO indicates, this only gives “crude information” about low-frequency content, and is not an indicator in and of itself.

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[23] This is the equivalent average sound level, averaged over eight nighttime hours, measured outside the bedroom window.

Since the WHO guidelines were developed to protect human health, all suggested limits apply to sound levels at residences or areas where humans typically frequent. For example, the guidelines reflective of sleep disturbance are specified to be measured outside the bedroom window.

In October 2009, WHO Europe conducted an updated literature review and built upon WHO's guidelines for nighttime noise in Europe. They added an *annual average* nighttime guideline level to protect against adverse effects on sleep disturbance. This guideline is 40 dBA $L_{night, outside}$, measured outside the bedroom window.

Neither the 1999 or 2009 guidelines were developed specifically for wind turbine noise.

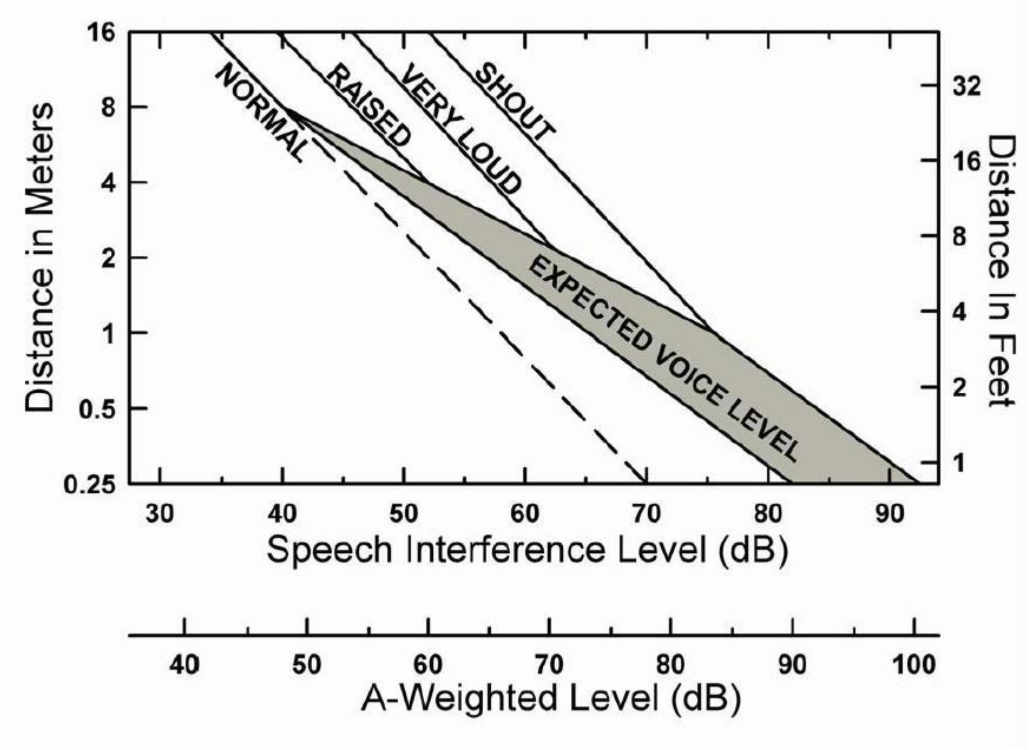

FIGURE 1: SOUND PRESSURE LEVEL OF SPEECH (FROM ANSI S12.65-2011)

3.4 | NATIONAL ASSOCIATION OF REGULATORY UTILITY COMMISIONERS

In 2012, the National Association of Regulatory Utility Commissioners (NARUC) sponsored a report by the National Regulatory Research Institute, "Put it There! Wind Energy & Wind Park Siting and Zoning Best Practices and Guidance for States" (Stanton/NARUC 2012). This document recommends, in part, noise standards that could be applied to wind energy facilities. Table ES5 of the report summarizes the author's recommended approach to wind park siting and zoning criteria. Under "Noise, sound, and infrasound," the report recommends the following:

- "Noise standards should allow some flexibility.

- Noise standards should vary depending on the area's existing and expected land uses, taking into account the noise sensitivity of different areas (e.g., agricultural, commercial, industrial, residential).
- Determine pre-construction compliance using turbine manufacturer's data and best available sound modeling practices.
- Apply a planning guideline of 40 dBA as an ideal design goal and 45 dBA as an appropriate regulatory limit (following Hessler's proposed approach, 2011).
- Allow participating land owners to waive noise limits.
- Establish required procedures for complaint handling.
- Identify circumstances that will trigger, and techniques to be used for: (a) mandatory sound monitoring; (b) arbitration; and (c) mitigation.
- Do not regulate setback distance; regulate sound."

The 40 dBA ideal design goal and 45 dBA regulatory limit referred to above are long term mean sound levels. That is, they are not maximum hourly or nightly levels, but arithmetic averages over a period of weeks. This study does not adopt these levels as design goals, but note that the specific design goals of 45 dBA L_{8h} at night and 40 dBA $L_{night, outside}$ are more protective than a long-term mean of 45 dBA as recommended by Stanton/NARUC (2012).

Stanton/NARUC (2012) does not recommend specific standards for low-frequency sound, infrasound, amplitude modulation, or vibration impacts. Hessler /NARUC (2011) writes, "When the swishing, thumping or beating noise alluded to above does occurs [sic] it is usually at a rate of about once per second, or 1 Hz, which is the blade passing frequency of a typical three-bladed rotor turning at 20 rpm. Although the "frequency" of its occurrence at 1 Hz obviously falls at the very low end of the frequency spectrum, this noise is not "low frequency" or infrasonic noise, per se. It is simply a periodic noise where the actual frequency spectrum may contain some slightly elevated levels in the lower frequencies, but where the prominent noise is roughly centered around 500 Hz near the middle of the audible frequency spectrum. In general, the widespread belief that wind turbines produce elevated or even harmful levels of low frequency and infrasonic sound is utterly untrue as proven repeatedly and independently by numerous investigators. And probably arose from a confusion between this periodic amplitude modulation noise and actual low frequency noise. Problematic levels of low frequency noise (i.e. those resulting in perceptible vibration and complaints) are most commonly associated with simple cycle gas turbines, which produce tremendous energy in the 20 to 50 Hz region the spectrum – vastly more than could ever be produced by a wind turbine." [footnotes removed]

3.5 | FEDERAL STANDARDS AND GUIDELINES

No federal standards apply to wind turbines on private land.

Many federal agencies have adopted guidelines and standards that apply to other types of facilities. A summary of some of these standards is shown in Table 3. Note that these standards are in terms of L_{eq}, L_{dn}, or L_{10}. The L_{eq} is the pressure weighted average sound level, over a specified period of time. The L_{dn} is the A-weighted day-night L_{eq}, where a penalty of 10 dB is applied to nighttime sound. The L_{10} is the 10th percentile sound level. It is the level that is exceeded 10% of the time, and thus represents the higher sound levels over a period of time.

TABLE 3: SUMMARY OF FEDERAL GUIDELINES AND STANDARDS FOR EXTERIOR NOISE

Agency	Applies to	Standard (dBA)
Environmental Protection Agency	Guideline to protect public health and welfare with an adequate margin of safety	55 dB L_{dn}
Environmental Protection Agency	Level of intermittent noise identified to protect against hearing loss	70 dB L_{24h}
Environmental Protection Agency	100 percent speech intelligibility indoors and 99 percent speech intelligibility outdoors at 1 meter (3.3 feet)	55 dB L_{dn}
Occupational Safety and Health Administration	Maximum allowable sound level for an 8-hour work day	90 dB L_{8h}
Bureau of Land Management (BLM)	Guidelines for the development of wind turbines on federal lands managed by BLM	Refers to the EPA 55 dB L_{dn} guideline.
Federal Energy Regulatory Commission (FERC)	Compressor facilities under FERC jurisdiction	55 dB L_{dn}
Federal Highway Administration (FHWA)	Federally funded highway projects. For "Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential for the area to continue to serve its intended purpose."	57 dBA L_{eq} or 60 dBA L_{10} during peak traffic noise hour.
	For residential, active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings	67 dBA L_{eq} or 70 dBA L_{10} during the peak traffic noise hour
Federal Interagency Task Force	This Taskforce is set up to develop consistency of noise standards among federal agencies	55 to 65 dB L_{dn} for impacts on residential areas

BUREAU OF LAND MANAGEMENT

The United States Department of the Interior, Bureau of Land Management (BLM) has developed a Programmatic Environmental Impact Statement (PEIS) for Wind Energy Development on BLM Lands in the Western United States. Noise is addressed in several sections of the PEIS. Several relevant points made in the PEIS are listed below:

- From Section 4.5.1: "at many wind energy project sites on BLM-administered lands, large fluctuations in broadband noise are common, and even a 10-dB increase would be unlikely to cause an adverse community response. In addition, noise containing discrete tones (tonal noise) is much more noticeable and more annoying at the same relative loudness level than other types of noise, because it stands out against background noise."
- From Section 4.5.2: "In general, background noise levels (i.e., noise from all sources not associated with a wind energy facility) are higher during the day than at night. For a typical rural environment, background noise is expected to be approximately 40 dB(A) during the day and 30 dB(A) at night (Harris 1979), or about 35 dB(A) as DNL (Miller 2002)."
- From Section 4.5.4: "The EPA guideline recommends an L_{dn} of 55 dB(A) to protect the public from the effect of broadband environmental noise in typically quiet outdoor and residential areas (EPA 1974). This level is not a regulatory goal but is 'intentionally conservative to protect the most sensitive portion of the American population' with 'an additional margin of safety.' For protection against hearing loss in the general population from non-impulsive noise, the EPA guideline recommends an L_{eq} of 70 dB(A) or less over a 40-year period."
- From Section 5.5.3.1: "aerodynamic noise is the dominant source from modern wind turbines (Fégeant 1999)."
- From Section 5.5.3.1: "Considering geometric spreading only, this results in a sound pressure level of 58 to 62 dB(A) at a distance of 50 m (164 ft.) from the turbine, which is about the same level as conversational speech at a 1 m (3 ft.) distance. At a receptor approximately 2,000 ft. (600 m) away, the equivalent sound pressure level would be 36 to 40 dB(A) when the wind is blowing from the turbine toward the receptor. This level is typical of background levels of a rural environment (Section 4.5.2). To estimate combined noise levels from multiple turbines, the sound pressure level from each turbine should be estimated and summed. Different arrangements of multiple wind turbines (e.g., in a line along a ridge versus in clusters) would result in different noise levels; however, the resultant noise levels would not vary by more than 10 dB."
- From Section 5.5.3.1: "In general, the effects of wind speed on noise propagation would generally dominate over those of temperature gradient."
- From Section 5.5.3.1: "Wind-generated noise would increase by about 2.5 dB(A) per each 3 ft./s (1 m/s) wind speed increase (Hau 2000); the noise level of a wind

turbine, however, would increase only by about 1 dB(A) per 3 ft./s (1 m/s). In general, if the background noise level exceeds the calculated noise level of a wind turbine by about 6 dB(A), the latter no longer contributes to a perceptible increase of noise. At wind speed of about 33 ft./s (10 m/s), wind-generated noise is higher than aerodynamic noise. In addition, it is difficult to measure sound from modern wind turbines above a wind speed of 26 ft./s (8 m/s) because the background wind-generated noise masks the wind turbine noise at that speed (DWIA 2003)."

- From Section 6.4.1.6: "Noise generated by turbines, substations, transmission lines, and maintenance activities during the operational phase would approach typical background levels for rural areas at distances of 2,000 ft. (600 m) or less and, therefore, would not be expected to result in cumulative impacts to local residents."

These statements from the BLM's Wind Energy Development PEIS do not represent a regulatory standard itself, but they do provide some insight on how one federal agency is approaching noise generated from wind turbine projects.

The EPA discussed speech intelligibility relative to a day-night exterior sound level of 55 dBA (55 dBA L_{dn} is the EPA's guideline sound level to protect public health). 55 dBA L_{dn} is equivalent to a 45 dBA L_{eq} sound level at night and 55 dBA L_{eq} sound level during the day. Or alternatively a sound level of 48.6 dBA L_{eq} through the night and day. The EPA states that on average this will yield 100 percent speech intelligibility indoors, with a 5 dB margin of safety and 99 percent speech intelligibility at 1 meter (3.3 feet) outdoors.

NATIONAL ACADEMY OF SCIENCES STUDY

In 2008, the National Research Council of the National Academy of Sciences issued a report "Environmental Impacts of Wind-Energy Projects." This report summarized the state of understanding of wind energy projects with respect to its ecological and human impacts, the latter of which includes noise.

With respect to noise, the report concludes,

> "Noise produced by wind turbines generally is not a major concern for humans beyond a half mile or so because various measures to reduce noise have been implemented in the design of modern turbines. The mechanical sound emanating from rotating machinery can be controlled by sound-isolating techniques. Furthermore, different types of wind turbines have different noise characteristics. As mentioned earlier, modern upwind turbines are less noisy than downwind turbines. Variable-speed turbines (where rotor speeds are lower at low wind speeds) create less noise at lower wind speeds when ambient noise is also low, compared with constant-speed turbines. Direct-drive machines, which have no gearbox or high speed mechanical components, are much quieter."

The Baron Winds Project is proposing to use variable speed upwind turbines. The gearbox and other mechanical components include noise isolation to reduce impacts.

3.6 | WIND TURBINE COMMUNITY COMPLAINT POTENTIAL

Sound level standards and guidelines such as those published by WHO are typically based on research conducted for transportation noise. There have been some studies that conclude that wind turbine noise is more intrusive to some listeners than a transportation source of equivalent magnitude. Suggested reasons for increased annoyance include: amplitude modulation, tonality, low-frequency content, and the newness of wind turbine noise as an environmental noise source.

Some studies have looked at the response of residents surrounding wind farms relative to the audio frequency[24] sound level emitted by the wind turbines. Similar wide-spread studies have not compared annoyance to low frequency or infrasound levels, though there is a high correlation between A- and C-weighted sound levels.[25]

The studies that have been performed for human response to low frequency sound and infrasound from wind turbines have largely been laboratory studies.

The following subsection of this report reviews these studies that have been performed comparing human response to audible sound and infrasound from wind turbines.

RESPONSE IN THE AUDIO FREQUENCY RANGE

Studies of human response to wind turbine sound were performed in Sweden (in 2000 and 2005) and The Netherlands (2007) by Eja Pederson and other authors (Waye, Lassman, etc.).[26,27,28,29] There have been several papers about these studies, including a summary written by Janssen et al (2011) that included a combined dose-response curve.[30] The Pederson studies were performed by sending self-reporting surveys to respondents living in and around wind farms and comparing responses from these surveys to modeled sound levels at those residences. A total of 1,830 people responded to these surveys.

The Janssen dose-response curve shows that for sound at 45 dBA L_{eq} (calculated outdoors), there is an annoyance rate of approximately 40 percent for residents outdoors and 21 percent for residents indoors. The highly annoyed rate is 23 percent outdoors and 11 percent

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[24] The audio frequency range, also called the audible frequency range, extends from 20 Hz to 20 kHz and includes the frequency range most audible to humans.

[25] Tachibana, Hideki, et al. “Nationwide Field Measurements of Wind Turbine Noise in Japan.” Institute of Noise Control Engineering Journal. 62(2), March-April 2014.

[26] Pedersen, Eja and Waye, Kerstin. “Perception and annoyance due to wind turbine noise - a dose-response relation.” Journal of the Acoustical Society of America. 116(6). pp. 3460-3470.

[27] Pedersen, Eja, et al. “Response to wind turbine noise in the Netherlands.” Acoustics 2008. Paris, France.: 29 June – 4 July 2008.

[28] Pedersen, Eja and Persson Waye, Kerstin. “Wind turbines-low level noise sources interfering with restoration?” Environ. Res. Lett. 3 (January-March 2008). 11 January 2008.

[29] Pedersen, Eja and Larsman Pernilla. “The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines.” Journal of Environmental Psychology. 28(2008). pp. 379-389.

[30] Janssen, Sabine, et al. “A comparison between exposure-response relationships for wind turbine annoyance and annoyance due to other noise sources.” *J. Acoust. Soc. Am.* 130(6). December 2011. pp. 3746-3753.

indoors for this sound level. Note that sound levels were calculated using the equations of the Swedish Environmental Protection Agency and assumes that receptors are always downwind of the source.[31]

A common finding among the various studies is that annoyance was lower among residents who benefited economically from the wind turbines. Annoyance also increases with age, visibility of the turbines from the residence, and noise sensitivity.

Health Canada studied health indicators among populations exposed to wind turbine sound.[32] Just as with Pedersen's studies, self-reporting surveys were distributed to participants (1,238 in total). Correlations were found between wind turbine modeled sound levels and annoyance toward noise, shadow-flicker, turbine visibility, blinking lights, and vibration. Although C-weighted sound levels were calculated for the study, A-weighted levels were primarily assessed, due to the high correlation between A-weighted and C-weighted levels (R^2=0.88). The rate of highly annoyed residents due to wind turbine noise was found to be approximately 18 percent at sound levels between 40 and 46 dBA L_{eq}. This sound level assumes wind turbines emissions at an 8 m/s wind speed measured at a height of 10 meters. Also note, that the Health Canada study assumed a ground absorption factor of G=0.7 with no uncertainty factor added to the wind turbine sound power, so levels modeled by Health Canada will be about 3 dB lower than the equivalent scenario modeled in this report. Therefore, the three percent highly annoyed would be equivalent to a range of 43 to 49 dBA, using the modeling parameters used in this report.

A Japanese study also looked at the relative annoyance of residents surrounding wind farms, compared with the $L_{eq,n}$, or average of the A-weighted 10-minute sound levels from each hour over the night with the wind turbine(s) at their rated capacity.[33] The $L_{eq,n}$ measured by the study is lower, on average, than the sound level downwind with the 10-meter wind speed at 8 m/s, due to the directionality of turbines. Due to differences in wind farm layouts (single turbine, grid layout, ridgeline layout, etc.), this difference was not readily determined. The authors estimated that, on average, the $L_{eq,n}$ will be about 6 dB less than the L_{dn}. Using this assumption, the authors found that wind turbine noise is between 6 and 9 dB more annoying than road traffic noise. The study found that between 41 and 45 dB $L_{eq,n}$ approximately 14 percent of respondents were extremely annoyed, and 19 percent were moderately annoyed.[34] Other findings included that visual disturbance was well correlated with wind turbine noise disturbance, and that insomnia, though low in incidence overall, was more prevalent near wind turbine sites. Insomnia was also found to be related to visual

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[31] The values shown in Janssen et al are the L_{DEN} or day-evening-night sound level. The values shown in this paper have been adjusted to represent a median hourly value.

[32] Michaud, David. "Wind Turbine Noise and Health Study: Summary of Results." *6th International Meeting on Wind Turbine Noise.* Glasgow, Scotland: 20-23 April 2015.

[33] Kuwano, Sonoko, et al. "Social Survey on Wind Turbine Noise in Japan." *Noise Control Engr. J. 62(6). November-December 2014. pp. 503-520.*

[34] Yano, Takashi, et al. "Dose-response relationships for wind turbine noise in Japan." *Internoise 2013.* Innsbruck, Austria: 15-18 September 2013.

disturbance. Wind turbine noise was also found to have an effect on sleep disturbance, when audible, and particularly when sound levels were greater than 40 dB $L_{eq,n}$.

Old, et al. analyzed the modeling metrics used in the Janssen, Michaud, and Kuwano dose-response curves and found that they were not directly comparable.[35] That is, they used different metrics and/or averaging times. He normalized the dose-response curves of the three authors to a common 1-hour L_{eq}, with a mixed ground factor and four-meter receptor height. No uncertainty factor was added to the manufacturer mean sound power level. The resulting dose-response curves are shown in Figure 2.

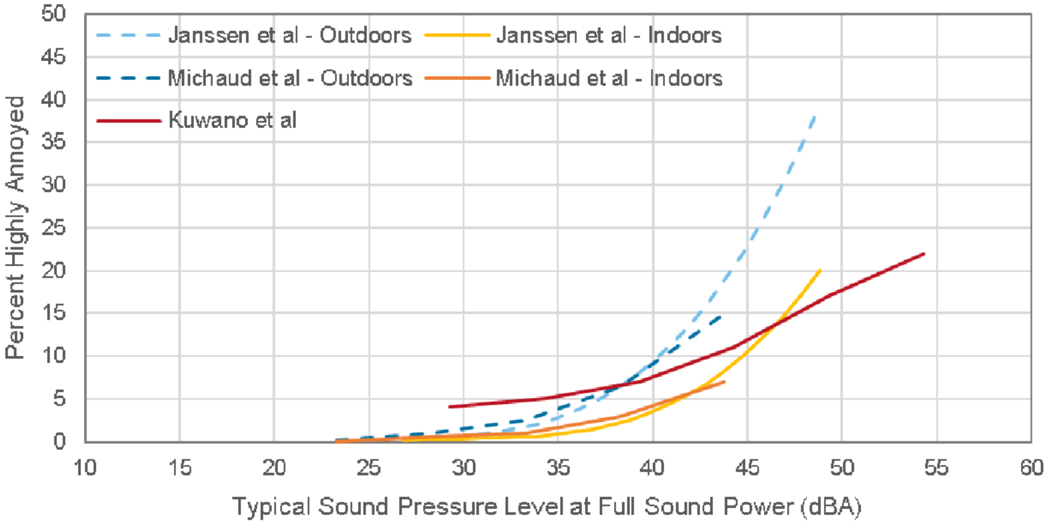

FIGURE 2: WIND TURBINE NOISE DOSE-RESPONSE CURVES NORMALIZED TO 1-HOUR L_{eq}, G=0.5, 4-METER HEIGHT FROM OLD (2017)

INFRASOUND

Infrasound is generally defined as the portion of the frequency spectrum below 20 Hz. Low-frequency sound is generally considered in the frequency range from 20 Hz to 200 Hz.

Measurements of infrasound at distances from wind turbines typical of their nearest residential neighbors have consistently found that infrasound levels are below published audible human perception limits. O'Neal et al. measured sound from wind projects that used the GE 1.5 sle and Siemens SWT 2.3-93 model wind turbines. They found that at typical receptor distances away from a wind turbine, more than 1,000 feet away, wind turbine sound exceeds audibility thresholds starting at 50 Hz.[36]

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[35] Old, I., Kaliski, K., "Wind turbine noise dose response – Comparison of recent studies," Proceedings of the 7th International Conference of Wind Turbine Noise, May 2017.
[36] O'Neal, R. et al. "Low frequency noise and infrasound from wind turbines." Noise Control Engineering J. 59 (2), 2011.

Tachibana et al. measured sound levels from 34 wind projects around Japan over a three-year period.[37] They found that infrasound levels were "much lower than the criterion curve" proposed by Moorehouse et al.[38] RSG et al. studied infrasound levels at two wind turbine projects in the northeastern U.S. Both indoor and outdoor measurements were made.[39] Comparisons between turbine-on periods and adjacent turbine shutdown periods indicated the presence of wind-turbine-generated infrasound, but well below ISO 389-7[40] and Watanabe et al.[41] perception limits. In their review of several wind turbine measurement studies (including O'Neal and Tachibana), McCunney et al. did not find evidence of audible or perceptible infrasound levels at typical residential distances from wind projects.[42]

Authors Salt, Pierpont, and Schomer have theorized that infrasound from wind farms can be perceived by humans and cause adverse reactions, even when it is below measured audibility thresholds.[43,44,45] Some of these theories have focused on the human vestibular system, hypothesizing that subaudible infrasound could stimulate the vestibular system, upsetting the human body's manner of determining balance and causing symptoms such as dizziness, nausea, and headaches, along with disruptions in sleep. More recently Schomer has stated that the hypothesis that subaudible wind turbine infrasound causes adverse health effects and almost be ruled out, though he has not fully abandoned the hypothesis.[46] In response, McCunney et al. and Leventhall contend that there has been no demonstration that humans can perceive subaudible infrasound, citing the relative insensitivity of the inner ear (where the vestibular system is located) to airborne sound and the presence of other low to moderate magnitude infrasound sources in the body and the environment.[47,48]

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[37] Tachibana, et al. "Nationwide field measurements of wind turbine noise in Japan." Noise Control Engr. J. 62 (2) 2014.

[38] Moorehouse, A. T. "A procedure for the assessment of low frequency noise complaints." J. Acoust. Soc. Am. 126 (3) 2009.

[39] RSG, et al. "Massachusetts study on wind turbine acoustics." Prepared for MassCEC and MassDEP, February 2016.

[40] *Acoustics -- Reference zero for the calibration of audiometric equipment -- Part 7: Reference threshold of hearing under free-field and diffuse-field listening conditions,* International Standards Organization, ISO 389-7:2005, last reviewed 2013

[41] Watanabe, T., and Moller, H., "Low frequency hearing thresholds in pressure field and in free field," *J. Low Freq. Noise Vib., Vol. 9(3), 106-115.*

[42] McCunney, Robert, et al. "Wind Turbines and Health: A Critical Review of the Scientific Literature." *Journal of Occupational and Environmental Medicine.* 56(11). November 2014. pp. e108-e130.

[43] Salt, Alec and Hullar, Timothy. "Responses of the Ear to Low-Frequency Sounds, Infrasound, and Wind Turbines." *Hear Res.* 268(2010). pp. 12-21.

[44] Pierpont, Nina. "Wind Turbine Syndrome: A Report on a Natural Experiment." *K-Selected Books*: Santa Fe, New Mexico: 2009.

[45] Schomer, Paul, et al. "A Theory to Explain Some Physiological Effects of the Infrasonic Emissions at Some Wind Farm Sites." *J. Acoust. Soc. Am.* 137(3). March 2015. pp. 1357-1365.

[46] Hessler, George, et al. "Health Effects from Wind Turbine low Frequency noise and Infrasound-Do Wind Turbines Make People Sick? That is the Issue." *Sound and Vibration*. January 2017. pp. 34-44.

[47] McCunney, Robert, et al. "Wind Turbines and Health: A Critical Review of the Scientific Literature." *Journal of Occupational and Environmental Medicine.* 56(11). November 2014. pp. e108-e130.

[48] Leventhall, Geoff. "Infrasound and the ear." *Fifth International Conference on Wind Turbine Noise*. Denver, Colorado: 28-30 August 2013.

Yokoyama et al. conducted laboratory experiments with subjects exposed to synthesized infrasound from wind turbines. In one experiment, synthesized wind turbine sound was filtered to eliminate high-frequency sound at 10 different cutoff frequencies from 10 Hz to 125 Hz.[49] The results indicate that when all sound above 20 Hz was filtered out, none of the respondents could hear or sense the wind turbine sound. In a second experiment correlating the subject response of wind turbine sound to different frequency-weighting schemes, they found that the subjective loudness of wind turbine sound was best described by the A-weighted sound level rather than other weightings that focused on low-frequency sound or infrasound.[50]

Hansen et al. compared subjective response to infrasound and "sham" infrasound.[51] In one case, recordings of wind turbine noise, filtered to exclude sound above 53 Hz, were presented to subjects with the infrasonic content present, with only the infrasonic content present, and with the infrasonic content removed. Results showed that adverse response to the sound, was determined by the low frequency, not infrasonic content of the sound. A study by Walker, et al. found that feelings of nausea and annoyance were more correlated with audible frequency blade swish than infrasonic components.[52]

Research by Tonin, et al. found that response to infrasound was more determined by information the subject had received about the effects of infrasound than the presence of infrasound in a sound signal.[53]

While infrasound from wind farms has not been shown to be audible by humans, infrasound and low-frequency sound can create noise-induced vibration in lightweight structures. ANSI S12.2-2008 Table 4 lists low-frequency noise criteria to prevent "perceptible vibration and rattles in lightweight wall and ceiling structures."[54] These criteria are shown in Table 4. While these are interior levels, the equivalent exterior sound levels will be higher due to building

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[49] Yokoyama S., et al. "Perception of low frequency components in wind turbine noise." Noise Control Engr. J. 62(5) 2014.

[50] Yokoyama et al. "Loudness evaluation of general environmental noise containing low frequency components." Proceedings of InterNoise2013, 2013

[51] Hansen, K, et al. "Perception and Annoyance of Low Frequency Noise Versus Infrasound in the Context of Wind Turbine Noise." *6th International meeting on Wind Turbine Noise*. Glasgow, Scotland: 20-23 April 2015.

[52] Walker, Bruce and Celano, Joseph. "Progress Report on Synthesis of Wind Turbine Noise and Infrasound." *6th International Meeting on Wind Turbine Noise*. Glasgow, Scotland: 20-23 April 2015.

[53] Tonin, Renzo and Brett, James. "Response to Simulated Wind Farm Infrasound Including Effect of Expectation." *6th International Meeting on Wind Turbine Noise*. Glasgow, Scotland: 20-23 April 2015.

[54] "American National Standard Criteria for Evaluating Room Noise", American National Standards Institute ANSI/ASA S12.2-2008, Acoustical Society of America, (2008).

noise reduction.[55, 56, 57] Outside to inside noise reduction is a function of sound frequency and whether windows are open or closed.

ANSI S12.9 Part 4 addresses the annoyance of sounds with strong low-frequency content. Table 5 shows the "Annex D" criteria for minimal annoyance. Annex D suggests that sounds at these frequencies are similar indoors and outdoors as any transmission loss of the walls and windows can be offset by modal resonance amplification in enclosed rooms.

For comparison, Moorehouse's proposed *interior* criteria for infrasound and low-frequency sound are 94 dB, 69 dB, and 52 dB for the 16 Hz, 31.5 Hz, and 63 Hz octave bands, respectively.[58]

TABLE 4: ANSI S12.2 SECTION 6 – INTERIOR SOUND LEVELS FOR PERCEPTIBLE VIBRATION AND RATTLES IN LIGHTWEIGHT WALL AND CEILING STRUCTURES

1/1 Octave Band Center Frequency	16 Hz	31.5 Hz	63 Hz
Clearly perceptible vibration and rattles likely	75 dB	75 dB	80 dB
Moderately perceptible vibration and rattle likely	65 dB	65 dB	70 dB

TABLE 5: ANSI S12.9 PART 4 ANNEX D – LOW-FREQUENCY SOUND LEVELS BELOW WHICH ANNOYANCE IS MINIMAL

1/1 Octave Band Center Frequency	16 Hz	31.5 Hz	63 Hz
Sound Level Below Which Annoyance is Minimal	65 dB	65 dB	65 dB

3.7 | SPEECH INTELLIGIBILITY

For 100 percent speech intelligibility, the WHO recommends a 15 dB signal-to-noise ratio. Assuming a minimum speech volume of 50 dBA, this results in estimated full intelligibility at 35 dBA. Assuming a more moderate speech volume of 60 dBA, this results in full-sentence intelligibility at 45 dBA. The WHO's 15 dB signal-to-noise ratio is conservative, and assumes a variety of things including: neurological immaturity, hearing loss, unfamiliarity with the language, and presence of reverberation.[59] For comparison, other sources cite a 0 dB signal-to-noise ratio necessary for full-sentence speech intelligibility greater than 95 percent.[60] The sound level for speech is also conservative. According to ANSI S12.65-2011, "Normal"

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[55] O'Neal, R. et al. "Low frequency noise and infrasound from wind turbines." Noise Control Engineering J. 59 (2), 2011.

[56] RSG, et al. "Massachusetts study on wind turbine acoustics." Prepared for MassCEC and MassDEP, February 2016.

[57] Delta Electronics Light & Acoustics, *Low frequency noise from large wind turbines, Summary and conclusions on measurements and methods,* Danish Energy Authority, EFP-06 Project, 19 December 2008

[58] Moorehouse, A., et al. "Proposed criteria for the assessment of low frequency noise disturbance," Acoustics Research Centre, Salford University DEFRA NANR45, 2005.

[59] "American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools", American National Standards Institute ANSI/ASA S12.60-2002, Acoustical Society of America, (2002).

[60] Levitt, Harry and Webster, John. "Effects of Noise and Reverberation on Speech." Handbook of Acoustical Measurements and Noise Control. Harris, Cyril. New York, New York: McGraw Hill, Inc., 1991. pp. 16.6-16.8.

speech at 2 meters will be approximately 60 dBA. The EPA has also considered speech intelligibility, relative to their 55 dBA L_{dn} guideline to protect human health. At this level, they predict 100 percent speech intelligibility indoors and 99% speech intelligibility outdoors at a distance of 1 meter (3.3 feet).

3.8 | SOUND DESIGN GOALS FOR BARON WINDS

Given the scientific evidence regarding sleep disturbance and other impacts that were reviewed by WHO, the project is being designed to not exceed 45 dBA L_{8h}, which is averaged over the entire night (11 pm to 7 am) outside at nonparticipating permanent and seasonal residences (nonparticipating receptors or sensitive sound receptors). This would not apply to areas that have transient uses such as camps, driveways, trails, farm fields, and parking areas.[61] This level is more stringent than all of the federal guidelines mentioned above and will be well below the level that can cause hearing impairment according to WHO, the EPA, and OSHA. It is less than or equal to the most applicable NYSDEC guidelines of 55 dBA L_{dn}. This is also below the 50 dBA L_{10} standard of the Town of Fremont and equal to the sound level limit of Wayland. The goal is both protective of human health and hearing loss, and prevents any quality-of-life concerns. It is also below thresholds to prevent speech interference. Due to shorter durations, the town limits of Cohocton and Dansville are effectively lower than 45 dBA L_{8h}, so these will be adhered to.

Since the WHO and EPA guidelines are intended to protect human health and are based on long-term averages, they are applied at sensitive receptors such as residences. Neither the WHO guidelines, EPA guidelines, nor the town standards should be applied to unoccupied property lines. A property line design goal of 55 dBA L_{8h} has been set for nonparticipating property lines within 150 feet of roads. This is intended to apply to nonparticipating properties at locations where development of residences is likely, even if it does not already exist.

A second project design goal will be 48 dBA L_{1h} during the daytime to remain below the Town of Fremont's ordinance limit of 50 dBA L_{10}. This is more conservative than the WHO guidelines of 50 dBA L_{16h} for the daytime, to protect against moderate annoyance. This only applies to the Town of Fremont, since the other town limits are lower than 48 dBA L_{1h} and apply both day and night. The design goal in the Town of Cohocton will be 43.9 dBA L_{eq} at nonparticipating receptors and 48.9 dBA L_{eq} at nonparticipating property lines.[62] This is more conservative than the WHO guidelines of 45 dBA L_{8h} for the nighttime to protect against sleep disturbance.

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[61] Seasonal homes are expected to have operating septic systems or running water whereas "camps" do not.

[62] This is based on post-construction monitoring results for the Cohocton/Dutch Hill wind power project, performed by Tech Environmental. Results over multiple monitoring periods have shown sound levels exceeding RSG's sound propagation modeling results by up to 1.1 dB. This does exclude results from one location where monitoring results were reported as contaminated by noise from a nearby stream.

We also recommend the 45 dBA L_{8h} as the regulatory limit for the project since it corresponds to the 1999 WHO guidelines. In the towns with regulatory limits lower than or equal to the 45 dBA L_{8h} proposed regulatory limit, the town sound level limits will be adhered to.

While the 40 dBA $L_{night,outside}$ guideline of the 2009 WHO guidelines is also being used as a design goal, we do not recommend it as a regulatory limit due to the difficulty of assessing compliance of a wind power project with an annual average sound level limit.

To protect against moderately perceptible noise-induced vibration and rattle, we recommend a design goal of 65 dBZ in the 16 Hz, 31.5 Hz, and 63 Hz octave bands. This is consistent with ANSI S12.9 Part 4 Annex D and is conservative as it assumes no transmission loss from outside to inside the structure, even though some would be expected.[63]

While this is a design goal, it would not be a proposed Certificate condition, as our experience is that manufacturers do not guarantee low-frequency sound powers. Therefore, as a Certificate condition, we would recommend a Project-caused vibration threshold within any residence consistent with ANSI S2.71, "Guide to the Evaluation of Human Exposure to Vibration in Buildings."

The above design goals, town zoning standards, and proposed certificate conditions apply to nonparticipating receptors (sensitive sound receptors) only. To address participating residences, we recommend a design goal of 55 dBA $L_{night,outside}$ and 50 dBA L_{8h} as a maximum nighttime sound level, as modeled at the residence. The 55 dBA L_{8h} we recommend as a Certificate condition.

A summary of the design goals, regulatory limits, and proposed Certificate conditions are shown in Table 6.

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[63] RSG, et al. "Massachusetts study on wind turbine acoustics." Prepared for MassCEC and MassDEP, February 2016.

TABLE 6: PROJECT DESIGN GOALS AND REGULATORY LIMITS

TO ADDRESS	DESIGN GOAL	EXISTING REGULATORY LIMIT	PROPOSED CONDITION
WHO 1999 Sleep disturbance guideline at nonparticipants	45 dBA L_{8h} at night	-	45 dBA L_{8h} at night at nonparticipating homes (sensitive sound receptors)
Vibration at nonparticipants	65 dBA at 16 Hz, 31.5 Hz, and 63 Hz	-	ANSI S2.71 in response to vibration complaints
WHO Europe 2009 NOAEL at nonparticipants	40 dBA $L_{night,\ outside}$	-	-
WHO Europe 2009 Interim Target at participants	50 dBA $L_{night,\ outside}$ 55 dBA L_{8h} at night	-	55 dBA L_{8h} at night at participating homes
Town of Fremont	48 dBA L_{1h}	50 dBA 1-hour L_{10}	-
Town of Cohocton[64]		45 dBA L_{eq} (three 15 second periods) at nonparticipating residences 50 dBA L_{eq} (three 15-second periods) at nonparticipating property lines	-
Town of Wayland	-	45 dBA L_{8h} at nonparticipating receptors. If the ambient exceeds 45 dBA, the limit is the ambient plus 6 dB. 50 dBA L_{8h} at nonparticipating property lines and participating receptors	- -

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[64] A 1.1 dB difference is used for the difference between the L_{1h} and the average of three 15 second L_{eq}s. This difference is based on compliance monitoring results from the Cohocton Wind project.

TO ADDRESS	DESIGN GOAL	EXISTING REGULATORY LIMIT	PROPOSED CONDITION
Town of Dansville		45 dBA L_{1h} at nonparticipating receptors. If the ambient sound pressure level exceeds 45 dBA, the limit is the ambient plus 6 dB.	- -
WHO 2009 Interim Target at potential building sites	55 dBA L_{8h} within 150 feet of a road at nonparticipating parcels unless there is a more stringent Town property line limit.	-	-
Substation Transformer	40 dBA L_{1h} at nonparticipating sensitive receptors, assuming tonal sound emissions.	-	45 dBA L_{1h} at nonparticipating receptors (sensitive sound receptors). A 5 dB tonal penalty would apply to tonal sound.
Tonal penalty	5 dB		5 dB

4.0 SITE DESCRIPTION

4.1 | DESCRIPTION OF PROJECT AREA

The Project area is surrounded by three major roadways, Interstate 86, Interstate 390, and State Route 36. Interstate 86 runs along the southern edge of the Project, Interstate 390 runs along the northeastern edge of the Project, and State Route 36 runs in the north/south direction just to the west of the Project. State Route 21 runs from southwest to northeast through the Project. A map of the project area is shown in Figure 3 including the proposed project and a more general map of the area around the project is shown in Figure 4.

Land within the project boundary is split between forested land and agricultural land. Most flatter sections of the project area (valleys or hill tops) are cultivated. Transitional areas, such as the sides of hills, are mostly forested. Loon Lake, a recreational area, is in the northern portion of the project.

The nonforested areas in the region are dominated by livestock agriculture, that is, the raising of cattle for milk and beef. Beef and milk operations include cornfields and hayfields for livestock feed, open fields for grazing, milking barns, and the operation of farm equipment on local roads and throughout the fields.

Rural residential homesteads are located throughout the region, mostly occupying cleared land and old farm fields. Seasonal hobby activities such as snowmobiling, operation of off-road ATV’s, hunting, fishing, and gardening are widespread.

There two wind farms currently operating in the area.

- The Cohocton/Dutch Hill wind farm is located mostly north and east of the Town of Cohocton, on the east side of Interstate 390, although there are three turbines that are located near or within the Baron Winds Project area, near Cohocton Wind’s Point of Interconnect Substation. This project includes 50 Clipper C96 turbines. At this point, the closest Cohocton wind turbine is 0.7 miles from the closest Baron wind turbine.
- The Howard Wind Farm is located to the south of Interstate 86 near the Town of Howard and includes 27 Repower MM92 turbines. The closest Howard wind turbine is about 2.8 miles from the closest Baron wind turbine.

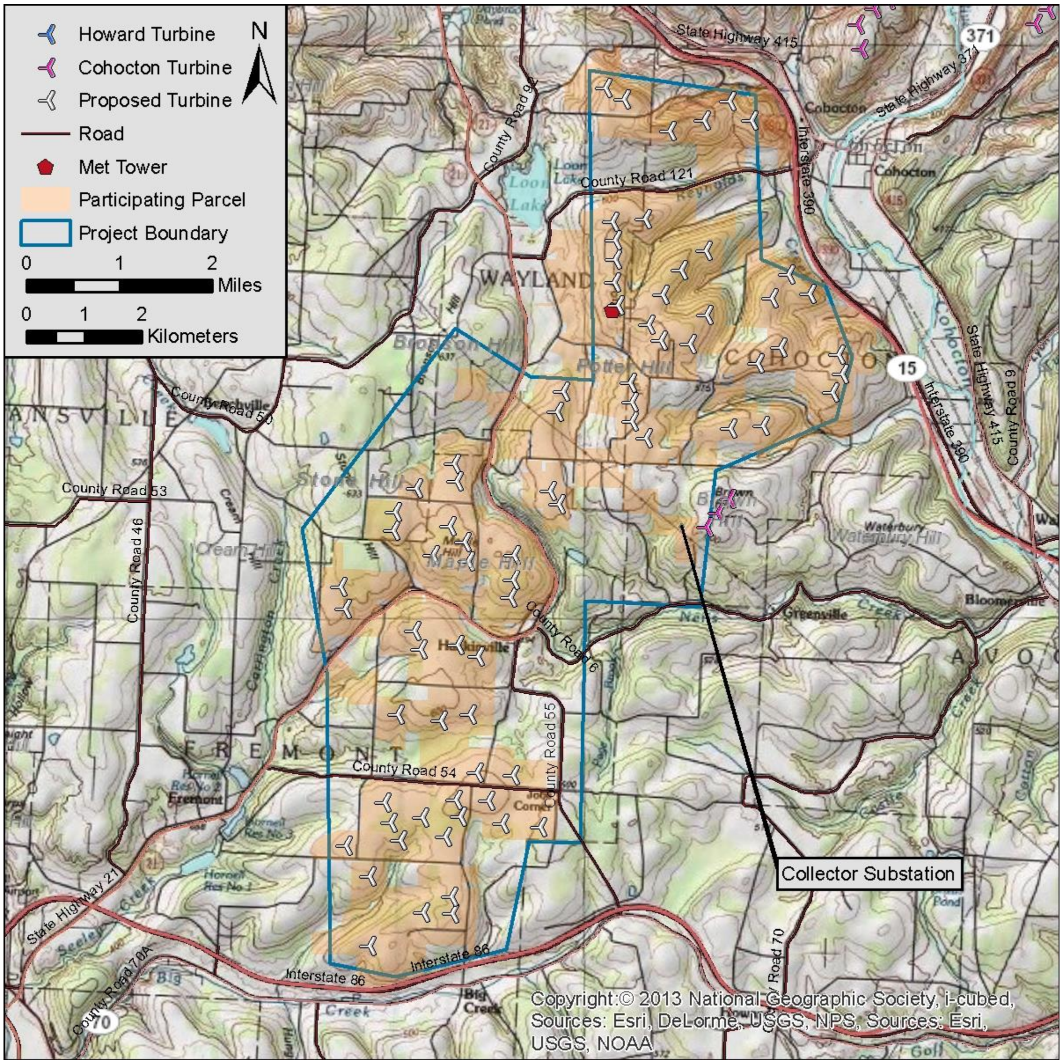

FIGURE 3: BARON WINDS SITE MAP—INCLUDING PROPOSED PROJECT (ARTICLE 10/STIPULATION 19(A))

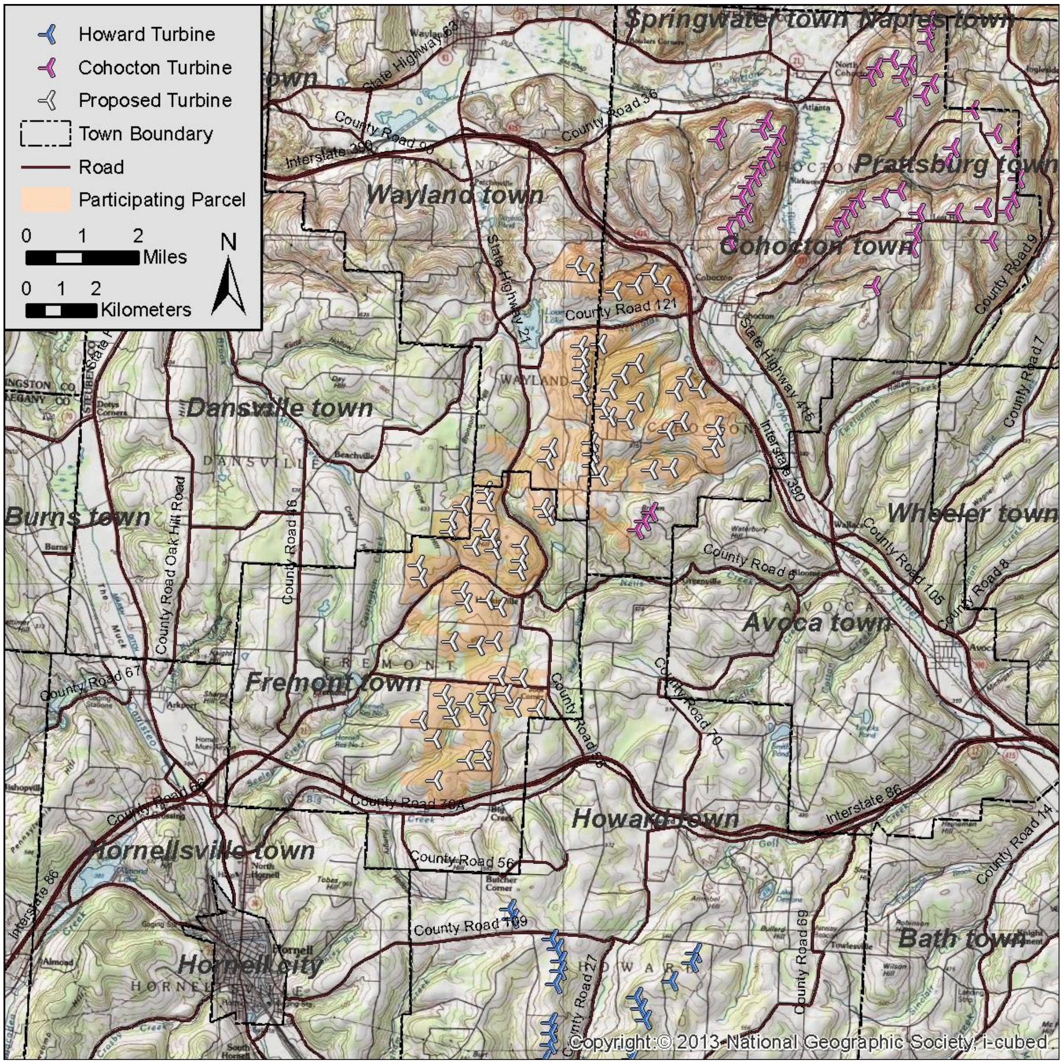

FIGURE 4: BARON WINDS AREA MAP

5.0 BACKGROUND SOUND LEVEL MONITORING (ARTICLE 10/STIPULATION 19(B))

A detailed monitoring program was developed to assess the ambient sound levels for the variety of soundscapes that exist within the Project area. The Project area contains working farms and farmland, rural homesteads, local roads, and the Village of Haskinville. Monitoring sites were distributed throughout the project area to be as representative as possible of the broader local soundscapes experienced in the region.

5.1 | REPRESENTATIVE MONITOR LOCATIONS

Seven monitoring locations, distributed within the Project boundary, were selected as representative of the different ambient soundscapes in the area. The various representative areas included rural residential, farming, small town, low and high traffic roads, and remote areas.

The seven selected monitoring locations that represent these areas are referred to as "Brasted Road," "Rex/Dye Road," "Haskinville Road," "Henkle Hollow," "Loon Lake," "Rose Road," and "Walter Kurtz Road." The monitoring locations are listed in Table 7, which also indicates the defining characteristics of each location. The geographical distribution of the sites is shown on the map in Figure 5. Each of the sites is discussed further below.

TABLE 7: MONITORING LOCATION CHARACTERISTICS

Site Name	Rural Residential	Active Farm	Small Town	Low Traffic	Truck Traffic	High Traffic	Remote Area	Recreational Area
Brasted Road	X	X		X				
Loon Lake						X		X
Dye/Rex Road				X	X			
Haskinville Road			X			X		
Rose Road	X	X		X				
Henkle Hollow Road	X	X		X				
Walter Kurtz Road				X			X	

5.2 | SCOPE OF MONITORING

Long-term sound level monitoring was carried out at the seven sites over two weeks during the winter, from February 24 through March 12, 2015 and two weeks during the summer, from July 15 to July 31, 2015. Monitoring was interrupted between March 3 and March 4, 2015, while batteries were changed and data were downloaded. Monitoring locations are shown as part of the project area in Figure 5.

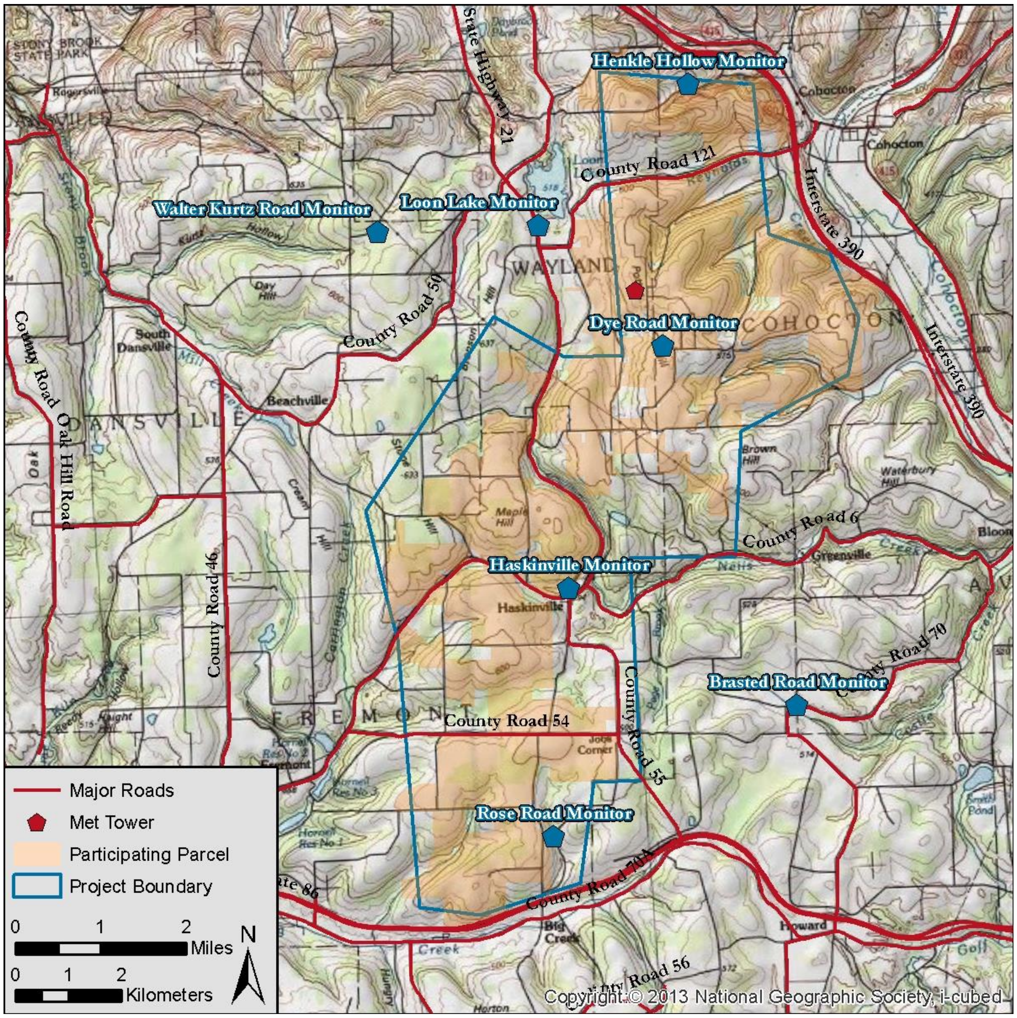

FIGURE 5: OVERVIEW OF MONITORING LOCATIONS FOR BARON WINDS

5.3 | METHODOLOGY

Sound level data were collected using six Cesva SC310 and one Svantek 979 sound level meters during the winter, and six Cesva SC310 and one Larson Davis LD831 sound level meters during the summer.[65] The meters continuously logged overall and 1/3-octave band sound levels once each second. Specific sound level meters used at each location, along with the specific metrics logged by each sound level meter are shown in Table 8. Each sound level meter microphone was mounted on a wooden stake at a height of approximately 1.2 m (4 ft.) and protected by an ACO-Pacific hydrophobic windscreen (170 mm (7 in.) diameter). Audio signals from each microphone were recorded continuously throughout the monitoring period to allow for sound source identification. The Svantek meter was set to record digital audio internally, and the Cesva and Larson Davis meters were connected to Roland R-05 or R-09HR digital sound recorders. All sound level meters were calibrated before and after monitoring periods, with either a Cesva CB-5, Larson Davis CAL200, or Brüel and Kjær 4231 calibrator, emitting a 94 dB tone at 1 kHz.

Wind speeds were logged at four of the seven monitoring sites (Haskinville, Loon Lake, Rose Road, and Walter Kurtz Road). Precipitation and air temperature were logged at Loon Lake.

TABLE 8: SOUND LEVEL METER FREQUENCY RESPONSE AND SETTINGS

Winter				
Monitor Location	**Sound Level Meter Model**	**Serial Number**	**Frequency Range**	**Settings**
Brasted Road	Cesva SC-310	T220294	20 Hz to 10 kHz	1/3 Octave Bands
Loon Lake	Cesva SC-310	T224253	10 Hz to 20 kHz	1/3 Octave Bands, LZeq, LCeq, LAeq, LAfmax, LAI, LAImax, LASmax
Dye/Rex Road	Cesva SC-310	T221731	10 Hz to 20 kHz	1/3 Octave Bands, LZeq, LCeq, LAeq, LAfmax, LAI, LAImax, LASmax
Haskinville Road	Cesva SC-310	T224789	10 Hz to 20 kHz	1/3 Octave Bands, LZeq, LCeq, LAeq, LAfmax, LAI, LAImax, LASmax
Rose Road	Cesva SC-310	T231914	20 Hz to 10 kHz	1/3 Octave Bands
Henkle Hollow Road	Cesva SC-310	T235260	10 Hz to 20 kHz	1/3 Octave Bands, LZeq, LCeq, LAeq, LAfmax, LAI, LAImax, LASmax
Walter Kurtz Road	Svantek SV979	34091	20 Hz to 20 kHz	1/3 Octave Bands, LAeq, LApeak, LAfmax, LAfmin, LCeq, LCpeak, LCfmax, LCfmin, LZeq, LZpeak, LZfmax, LZfmin
Summer				
Brasted Road	Cesva SC-310	T220294	20 Hz to 10 kHz	1/3 Octave Bands
Loon Lake	Cesva SC-310	T224253	10 Hz to 20 kHz	1/3 Octave Bands, LZeq, LCeq, LAeq, LAfmax, LAI, LAImax, LASmax
Dye/Rex Road	Cesva SC-310	T231914	20 Hz to 10 kHz	1/3 Octave Bands
Haskinville Road	Cesva SC-310	T221731	10 Hz to 20 kHz	1/3 Octave Bands, LZeq, LCeq, LAeq, LAfmax, LAI, LAImax, LASmax
Rose Road	Cesva SC-310	T224789	10 Hz to 20 kHz	1/3 Octave Bands, LZeq, LCeq, LAeq, LAfmax, LAI, LAImax, LASmax
Henkle Hollow Road	Cesva SC-310	T235260	10 Hz to 20 kHz	1/3 Octave Bands, LZeq, LCeq, LAeq, LAfmax, LAI, LAImax, LASmax
Walter Kurtz Road	Larson Davis 831	02845	6.3 Hz to 20 kHz	1/3 Octave Bands, LAeq, LAS, LASmax, LAf, LAfmax

FIGURE 6:SOUND LEVEL METER PERFORMANCE SPECIFICATIONS

Brand/Model Number	Noise Floor	Temperature Range (°C)	Relative Humidity Range
Cesva SC-310	9 dBA	-10 to 50	25 to 90 %
Larson Davis 831	21 dB	-10 to 50	30 to 90 % ≤± 0.5 dB
Svantek SV979	< 12 dBA	-10 to 50	Up to 90 %

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[65] These are Type 1 Sound Level Meters in conformance with standards ANSI S1.4-1983 and IEC 61672-1 (2002-05).

TABLE 9: SOUND LEVEL METER LOCATIONS

Monitoring Location	Coordinates (UTM NAD83 Z18N)		Closest Road	Closest Road AADT[66]
	X (m)	Y (m)		
Brasted Road	292977	4697583	Brasted Road	96
Rex/Dye Road	290935	4704515	Dye Road	80
Haskinville Road	288854	4700083	Haskinville Road	NA
Henkle Hollow	291770	4709413	Henkle Hollow Road	NA
Loon Lake	288756	4706954	State Highway 21	2132
Rose Road	288234	4695433	Rose Hill Road	74
Walter Kurtz Road	285732	4707037	Walter Kurtz Road	70

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[66] Annual Average Daily Traffic (AADT) data was obtained from either the traffic study performed for Baron Winds by C&S Engineers or from New York State Department of Transportation (NYSDOT) public data.

Sound level data from each monitor were averaged into 10-minute periods and summarized over the entire monitoring period. Data were excluded from the averaging under the following conditions:

- Wind gust speeds above 5 m/s (11 mph).
- Temperatures below -18° C (0° F).[67]
- Precipitation in the form of rain, sleet, or ice.
- Thunder.
- Anomalous sounds that were out of character for the area being monitored, such as snowmobiles passing immediately adjacent to the monitor; nearby chainsaws, lawn equipment, and nearby farm equipment.[68]
- Seasonal sound sources such as harvesting equipment, lawn mowers, and snow removal equipment.
- During microphone calibration, when the levels are high.

Particularly during summer monitoring, biogenic sounds including insects, amphibians, and birds were present. These are considered "seasonal" sounds. Under Article 10, these are required to be filtered out of the reported sound levels. To exclude these sounds, the "ANS" frequency-weighting network was applied to all logged data for which bird and insect sound was found. If tones[69] above 1.25 kHz were detected, then the A-weighted sound level was recalculated by summing 1/3 octave bands from 20 Hz to 1.25 kHz. This effectively removes the high-frequency portion of the sound.

5.4 | FORMAT OF MONITORING RESULTS

Over 4,000 hours of sound level data were collected for this project. The data were analyzed and are reproduced in this report in both temporal and spectral formats. This section describes how the background sound level results are presented for each monitor over both seasons of monitoring. Following this section, the actual results are presented.

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[68] An exception to this practice occurred for the data gathered at the Loon Lake site. The monitoring location was located 50 m (160 feet) from a well-established snowmobile trail. Only vehicles that were operated very close to the monitor (those not on the trail) were excluded from the data.

[69] Sounds considered tonal that get the ANS weight applied are those for which a prominent discrete high frequency (>1.25 kHz) tone is found using either of the two methods:

1. If a 1/3 octave band exceeds the neighboring 1/3 octave band on either side by more than 5 dB (as in ANSI S12.9 Part 4 Annex C), or
2. If a 1/3 octave band exceeds the average of the two neighboring lower and two neighboring upper 1/3 octave bands on each side by more than 5 dB.

The latter method is used to capture complex bird harmonic sounds that would not be considered tonal under the first method.

TIME HISTORY GRAPHICS

For each monitoring location, results are presented as graphs of sound level and maximum wind gust speed as a function of time throughout the monitoring period in Section 5. Each point on the graph represents data summarized for a single 10-minute interval. Equivalent continuous sound levels (L_{eq}) are the energy-average level over 10 minutes.[70] 10th-percentile sound levels (L_{90}) are the statistical value above which 90% of the sound levels occurred during the 10 minutes. The data from periods which were excluded from processing are included in the graphs but shown in lighter colors. The bands at the bottom of the graph indicates that data were excluded in the particular 10-minute period; the color designates the reason that data were excluded.

Wind speed data came from the three anemometers and were paired with monitoring locations as discussed in Section 5.3. Wind data are presented as the maximum gust speed occurring at any time during the 10-minute interval; they are not averaged.

ONE-THIRD OCTAVE BAND SUMMARIES

Plots of the overall unweighted spectral levels for all valid periods are provided for each monitoring site. Each point on the plot represents the average statistical level of the respective one-third octave band for the specified period. Four sets of L_{50}s, L_{eq}s, or L_{90}s are presented in each plot: day and night for winter and summer monitoring periods.

TONALITY PLOTS

Tonal prominence of one-third octave bands was quantified for all valid periods for each monitor in each season. Tonality is defined by S12.9-2005 Part 4 – Annex C, which sets a frequency dependent quantity, K_T, to indicate if a one-third octave band is tonal or not. A one-third octave band is considered tonal if it exceeds the level of the adjacent one-third octave by the prescribed limit. The tonality limits, K_T, are listed in Table 10. Every second of monitor data was analyzed for tonality, which is expressed as seconds of tonality per 10-minute period (up to 600 seconds).

TABLE 10. LIMITS FOR ONE-THIRD OCTAVE BAND TONALITY DESIGNATION

One-Third Octave Bands	K_T
25 to 125 Hz	15 dB
160 to 400 Hz	8 dB
500 Hz to 10 kHz	5 dB

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[70] All averages of sound pressure levels presented in this report are equivalent continuous averages, as opposed to arithmetic averages. See Appendix A for definitions.

6.0 MONITORING RESULTS AT EACH SITE (ARTICLE 10/STIPULATION 19(B))

6.1 | TIME HISTORY GRAPHICS

For each monitor site, results are presented as graphs of sound level, temperature and gust wind speed as a function of time throughout the monitoring period. Each point on the graph represents data summarized for a single 10-minute interval. Equivalent continuous sound levels (L_{eq}) are the energy-average sound level over 10 minutes. The tenth-percentile sound level (L_{90}) is the sound level that is exceeded 90% of the time during each 10-minute period. Edited data represent sound levels for those periods for which data have been excluded, as explained in Section 5.3. The reason for exclusion of data at a particular 10-minute interval (i.e., low temperature, wind gusts, or anomalous activity) is indicated in the lower portion of each figure. Sound level data during the excluded periods are shown in lighter shade for the L_{eq} and L_{90}.

Wind data are presented as the maximum gust speed occurring at any time during each 10-minute interval: they are not averaged. However, since wind speed data were collected at only four out of the seven sites, wind data from some sites are applied to others nearby. The four northernmost locations had two sites measuring wind speed between them. Henkle Hollow data is shown with the other northern monitor (excluding Loon Lake) as the other monitors were also at higher elevations. For the three sites in the south, the Agricultural site was the only site without an anemometer. The wind gusts at the Haskinville site were typically stronger than those at Rose Road. Therefore, Haskinville wind data is shown for the Agricultural site, since it was in the middle of open fields.

6.2 | MONITOR 1: BRASTED ROAD

The "Brasted Road" monitor was located at 8332 Connor Hill Road in Avoca, New York, near the intersection of Saxton Road and County Road 70. It was located near an active dairy operation. The site is located on the map in Figure 7. The monitor was installed near the fence dividing the lot containing a house and dairy barn from an adjacent pasture. Figure 8 and Figure 13 show the installed monitor in winter and summer conditions, with the microphone (in its windscreen) highlighted in red for the winter case.

WINTER MONITORING

Long-term winter sound level results are plotted as time history graphs in Figure 9, Figure 10, and Figure 11, along with the gust wind speed (measured at Haskinville Road) and temperature (measured at Loon Lake). Higher sound levels during the day were caused by farming activity, which consisted of tractor operation and dairy barn equipment operation. Other contributing sources of sound were aircraft overflights (at least one per hour during the day and about one every two hours at night), dogs barking, and wind. The daytime and nighttime statistical sound levels are close, because farm operations sometimes began before

7AM and continued until after 10PM. When these sources are not present, sound levels at this site are low, leading to low overall nighttime L_{90} sound levels.

Tonality for the site is shown in Figure 12 as the number of tonal seconds per 10-minute period for each 1/3 octave band. At this site during the winter, tonality was not consistently found in any 1/3 octave band. Consistent tonality would be shown as occurring for longer periods of time. Occasional tonality in the 31.5 Hz 1/3 octave band was due to farm equipment.

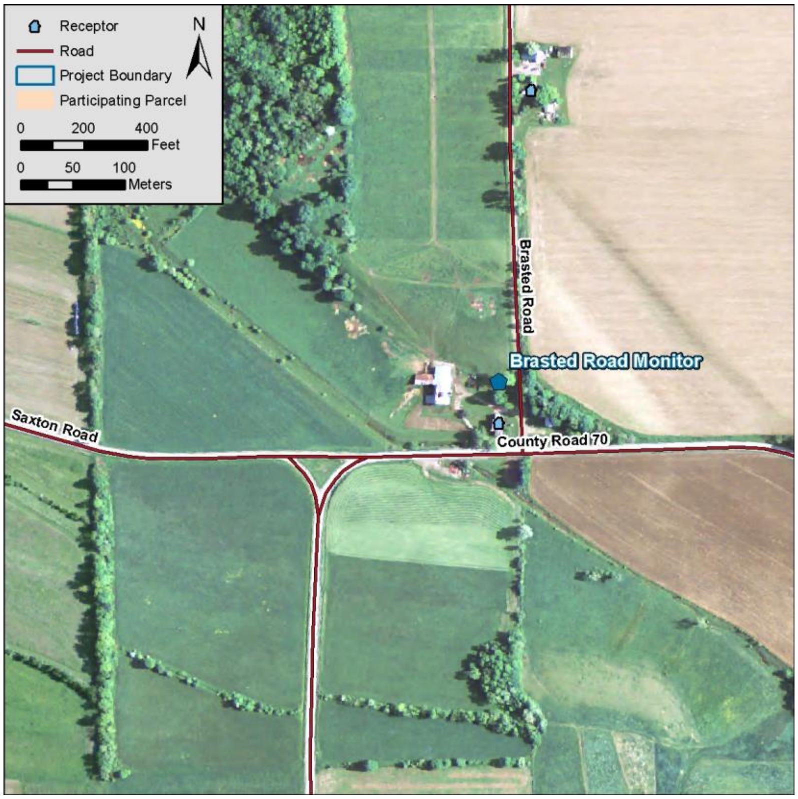

FIGURE 7: LOCATION OF THE BRASTED ROAD MONITOR

FIGURE 8: PHOTOGRAPH OF THE BRASTED ROAD MONITOR SITE IN WINTER, WITH MICROPHONE HIGHLIGHTED

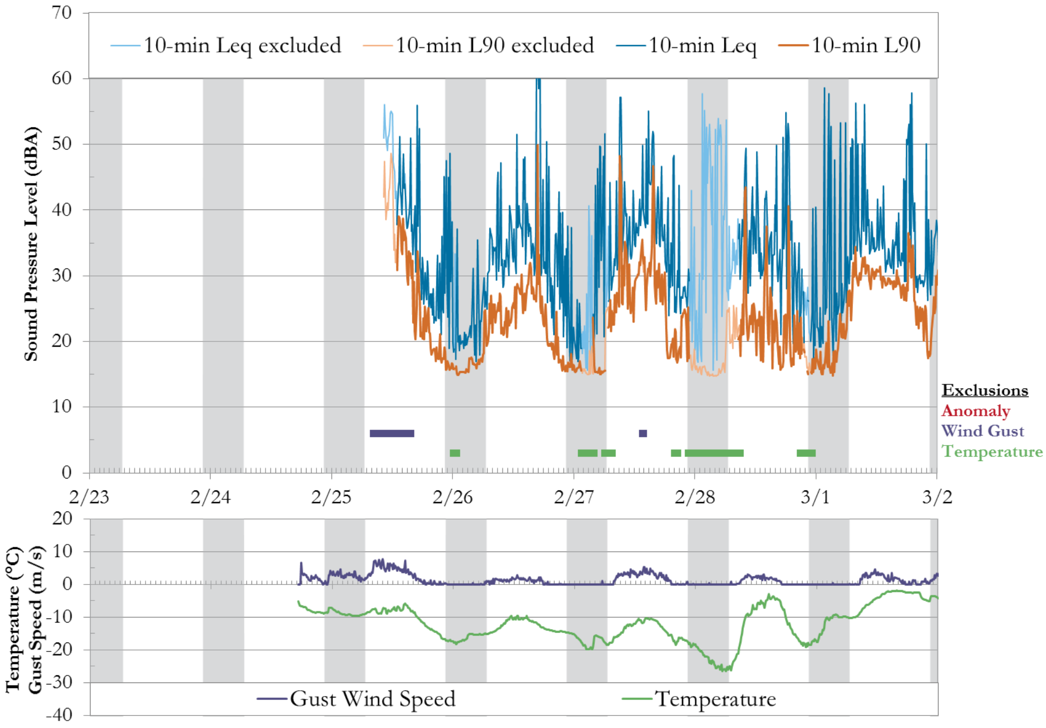

FIGURE 9: BRASTED ROAD MONITOR TIME HISTORY—FEBRUARY 25 TO MARCH 2, 2015

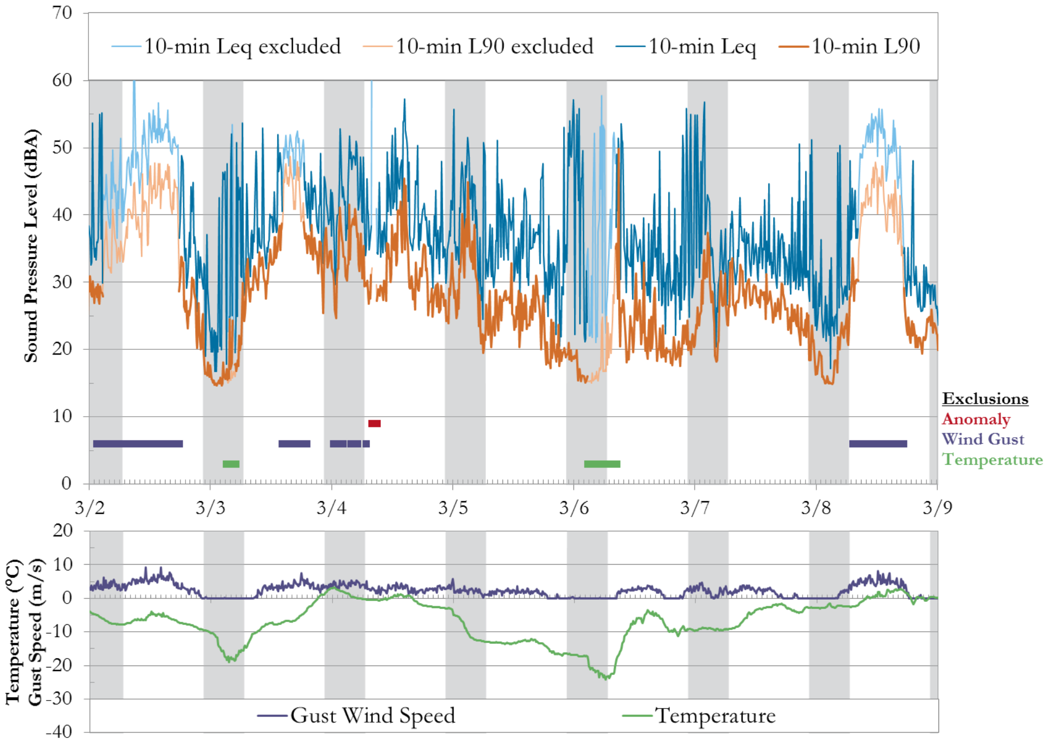

FIGURE 10: BRASTED ROAD MONITOR TIME HISTORY—MARCH 2 TO MARCH 9, 2015

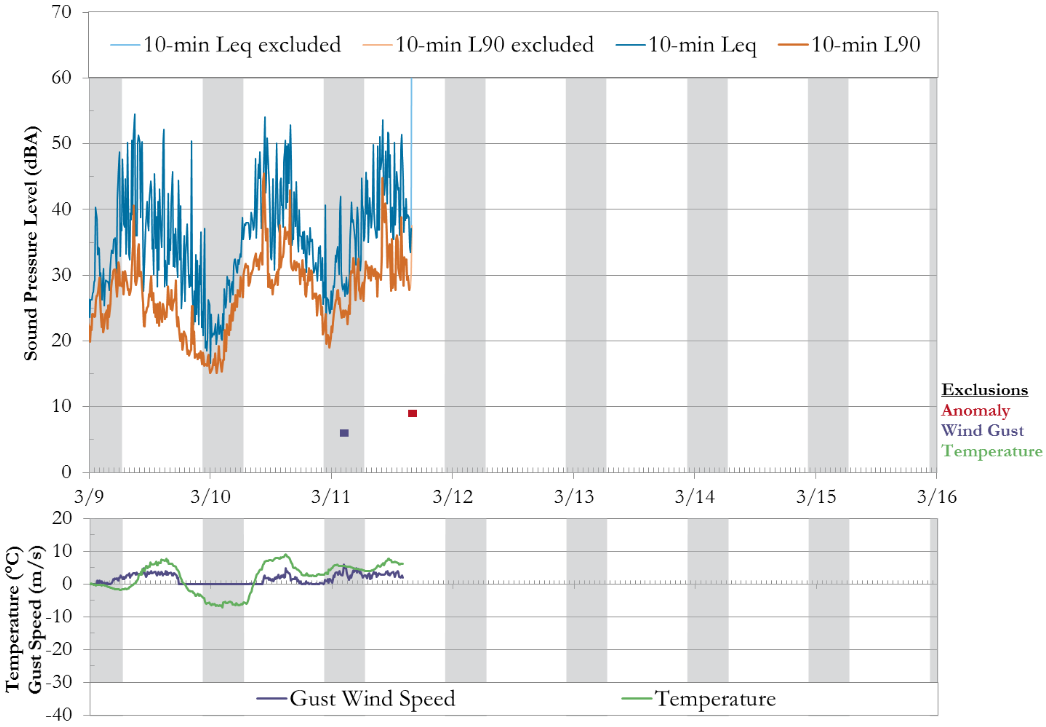

FIGURE 11: BRASTED ROAD MONITOR TIME HISTORY—MARCH 9 TO MARCH 11, 2015

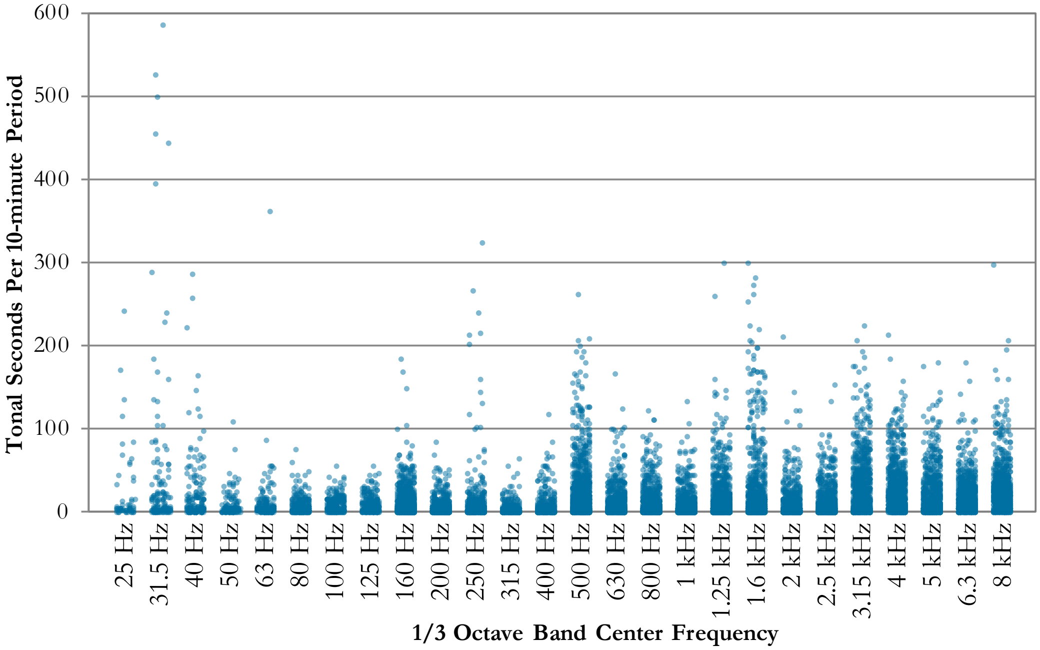

FIGURE 12: BRASTED ROAD WINTER MONITORING PERIOD – TONALITY

SUMMER MONITORING

Time history graphs for the summer monitoring period are shown in Figure 14, Figure 15, and Figure 16, along with the gust wind speed and temperature. Higher sound levels during the day were primarily caused by farm operations and vehicle pass bys. Other sound sources included airplane overflights, dogs barking, voices, and wind. This site has a particularly high number of intermittent, loud sound sources in an area with low sound levels overall.

Tonality is shown in Figure 17. Bird and insect activity appears as a higher incidence of tonality in the 5 kHz, 6.3 kHz, and 8 kHz 1/3 octave bands. Tonality in the 25 Hz, 31.5 Hz, and 250 Hz 1/3 octave band was caused by periodic farm equipment operation.

Figure 18 shows the 1/3 octave band median sound levels (L_{50}) by season and time of day with the lower 10th percentile and equivalent average sound levels (L_{90} and L_{eq}) shown in Figure 19 and Figure 20 respectively. The most prominent difference between summer and winter sound levels, is the increase in mid- to high-frequency sound indicated in the L_{50} and L_{eq}. This is caused by high-frequency biogenic sound sources, such as leaf rustle, birds and insects. The 125 Hz tone visible during the summer at night for L_{50} and L_{90} is due to farm equipment. The midfrequency "hump" (between 100 Hz and 1 kHz) in the winter L_{50} and L_{90} sound level spectrum is due to increased wind during the winter or to a change in the way ground reflections are absorbed, caused by the different sound absorption properties of snow cover relative to grass, or other types of ground cover.

FIGURE 13: PHOTOGRAPH OF THE BRASTED ROAD MONITOR SITE IN SUMMER, WITH MICROPHONE HIGHLIGHTED

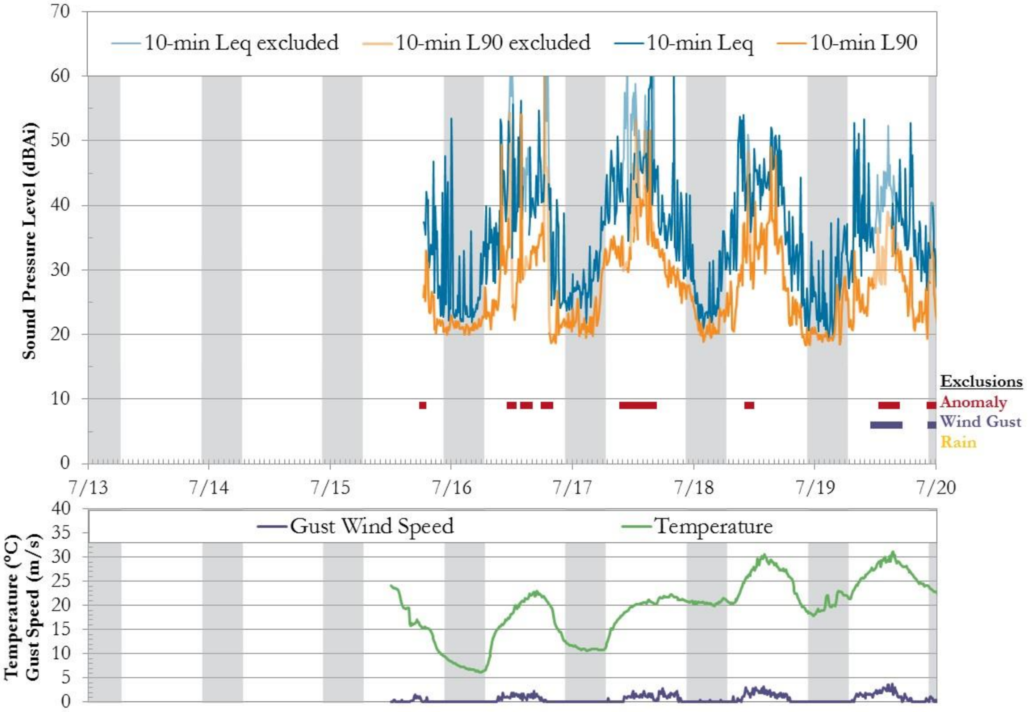

FIGURE 14: BRASTED ROAD MONITOR TIME HISTORY – JULY 13 TO JULY 20, 2015

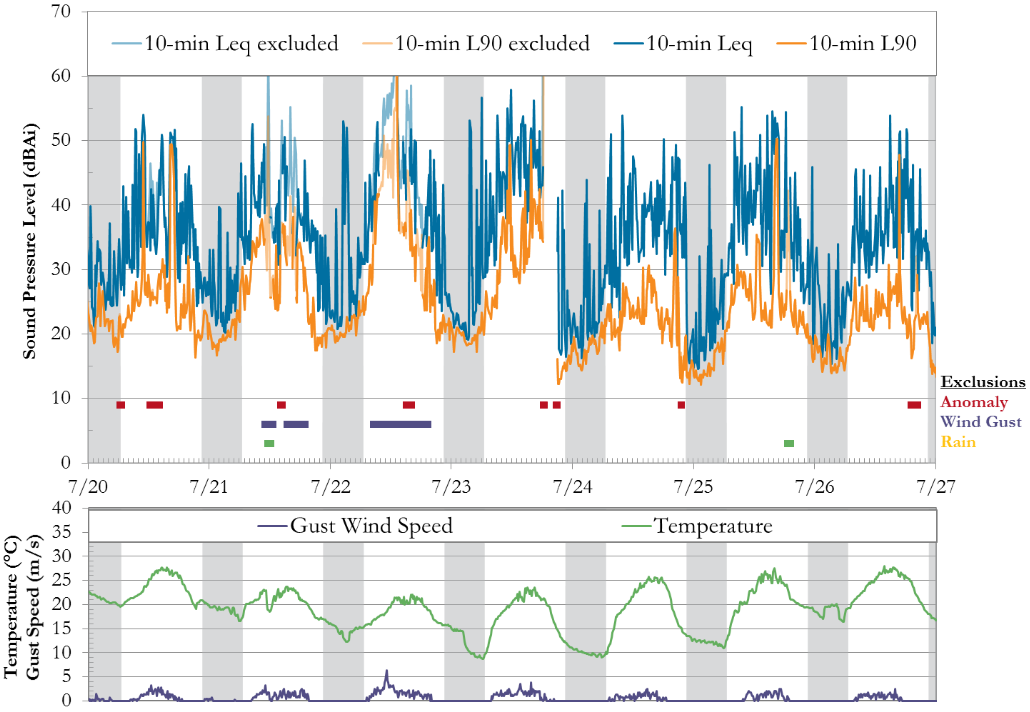

FIGURE 15: BRASTED ROAD MONITOR TIME HISTORY—JULY 20 TO JULY 27, 2015

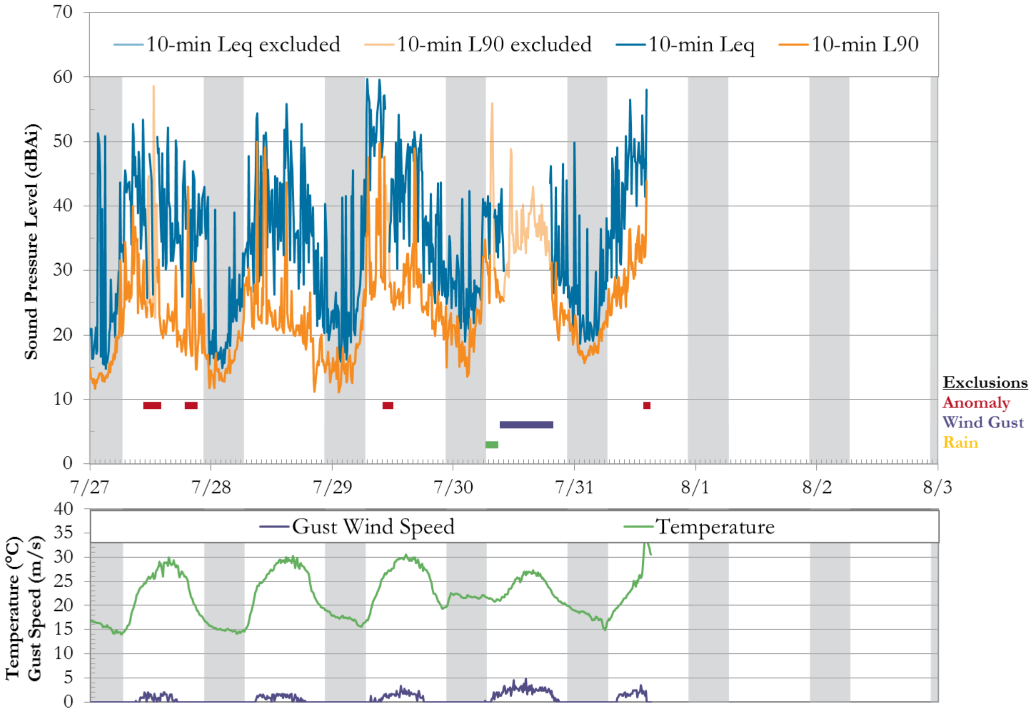

FIGURE 16: BRASTED ROAD MONITOR TIME HISTORY—JULY 27 TO AUGUST 3, 2015

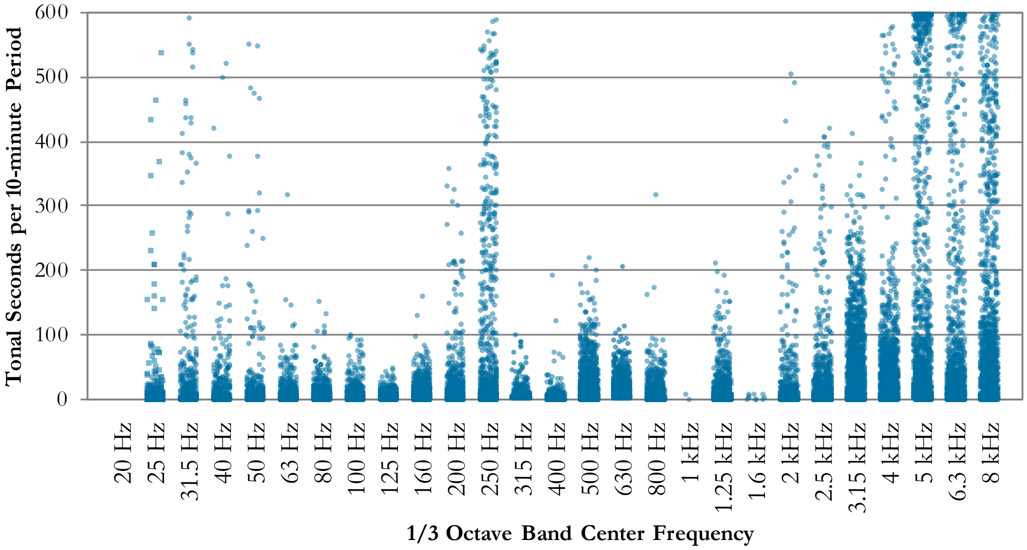

FIGURE 17: BRASTED ROAD SUMMER MONITORING PERIOD – TONALITY

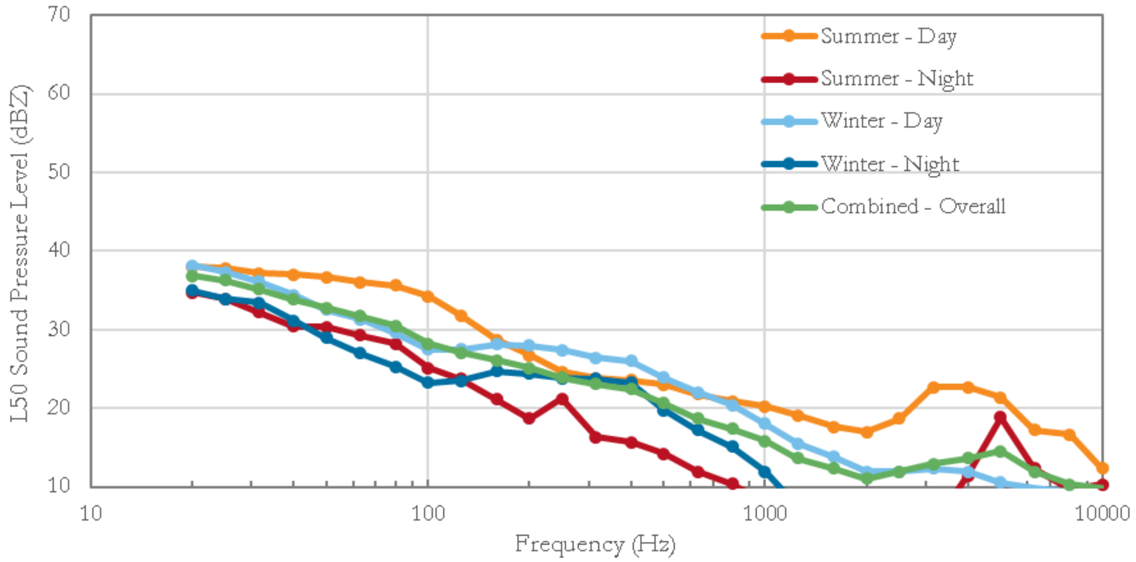

FIGURE 18: BRASTED ROAD 1/3 OCTAVE BAND MEDIAN (L_{50}) SOUND LEVELS BY SEASON AND TIME OF DAY

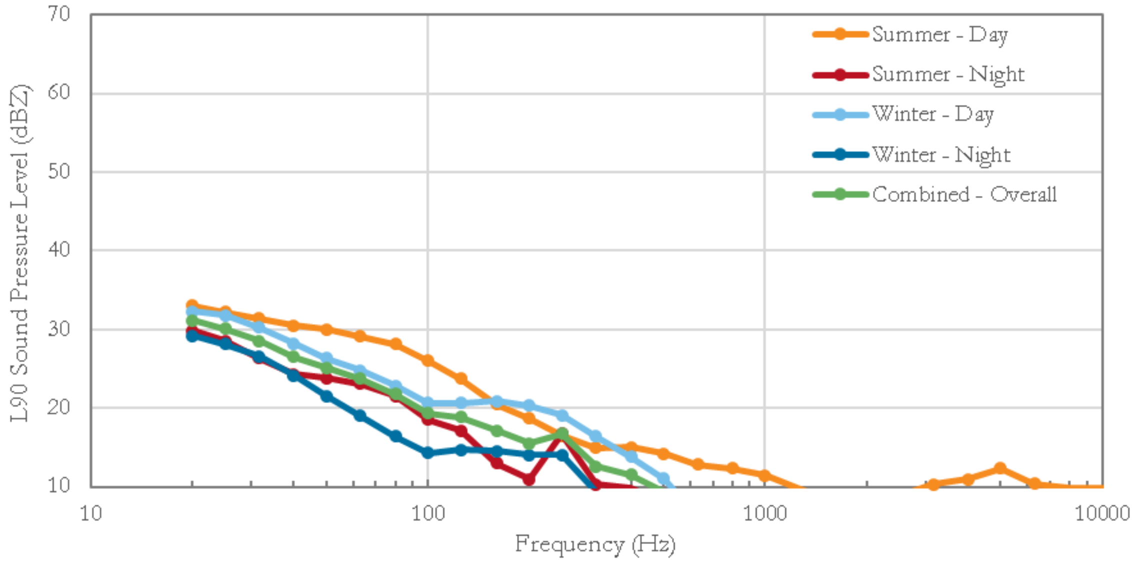

FIGURE 19: BRASTED ROAD 1/3 OCTAVE BAND LOWER 10TH PERCENTILE (L_{90}) SOUND LEVELS BY SEASON AND TIME OF DAY

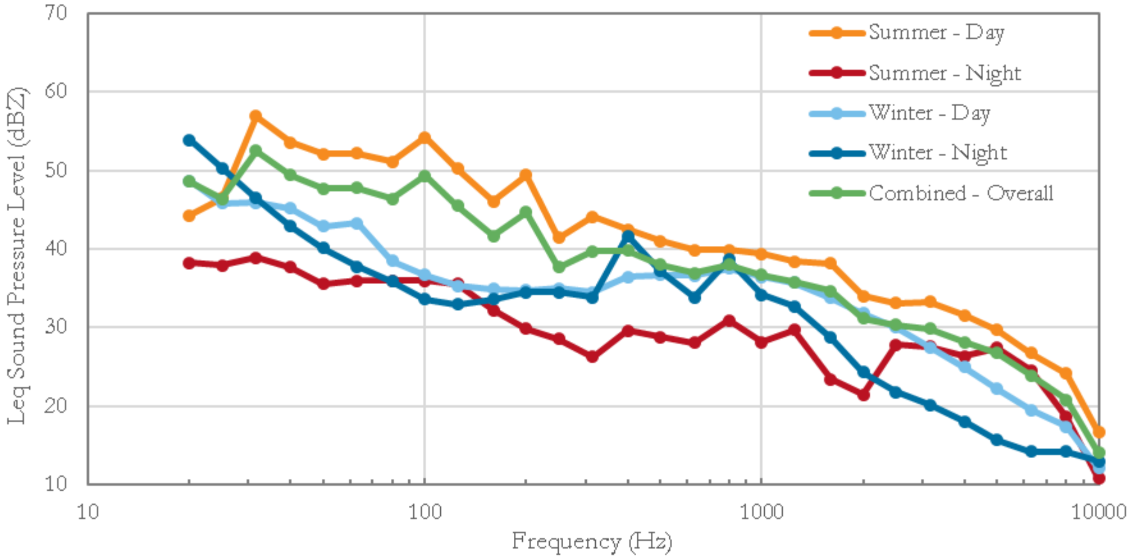

FIGURE 20: BRASTED ROAD 1/3 OCTAVE BAND EQUIVALENT AVERAGE SOUND LEVELS (L_{eq}) BY SEASON AND TIME OF DAY

6.3 | MONITOR 2: REX/DYE ROAD

The “Dye Road” monitor was located near 3101 Rex Road, Cohocton, New York, in a wooded area approximately 48 meters (157 feet) from the road. The site is located on the map in Figure 21 and Figure 22 shows the installation during the winter, looking southeast. The setup during the summer monitoring period is shown in Figure 27, looking northwest.

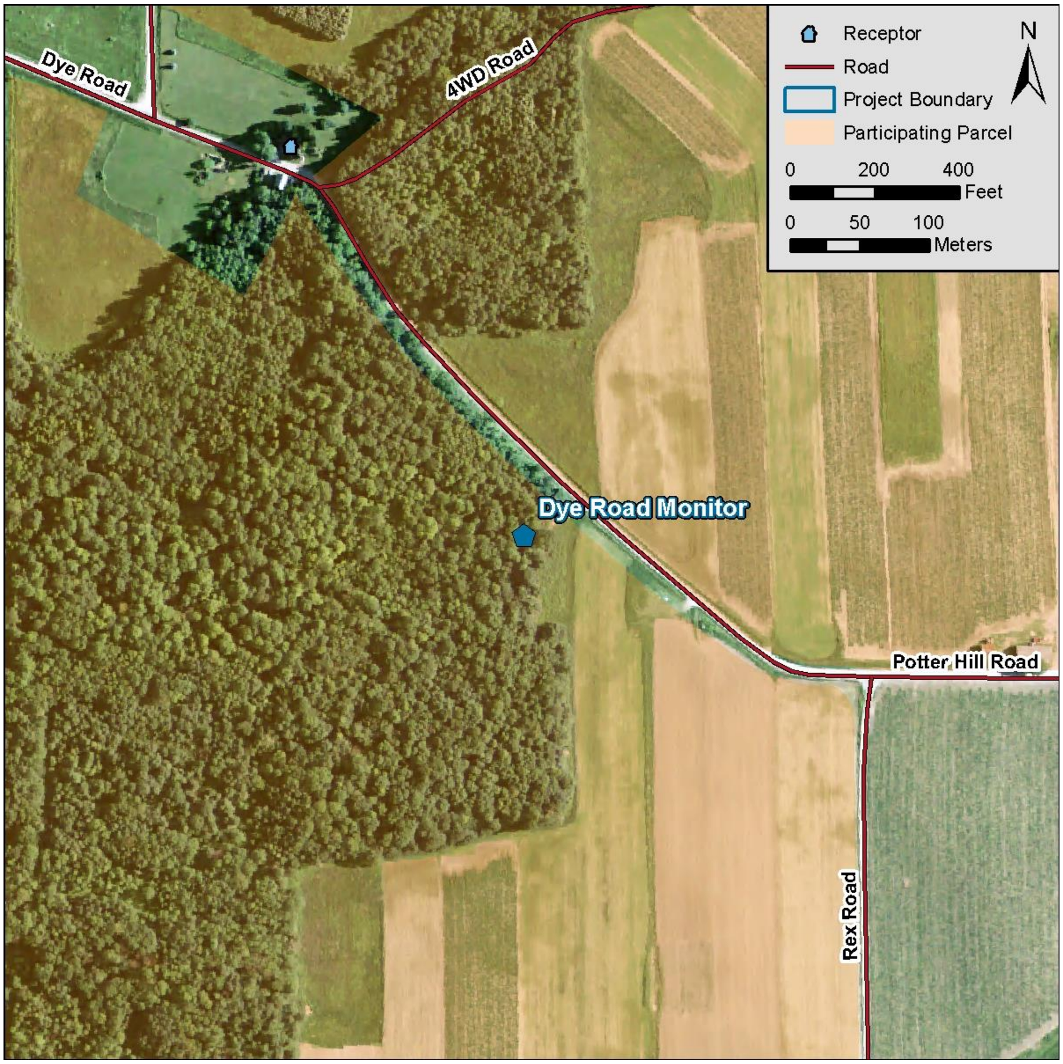

FIGURE 21: LOCATION OF THE REX/DYE ROAD MONITOR

WINTER MONITORING

Winter long-term sound level results are plotted as time history graphs in Figure 23, Figure 24, and Figure 25. Background levels throughout the period were dominated primarily by wind blowing through surrounding trees. Many of the brief periods of high sound levels, visible throughout the plot, resulted from large trucks climbing Dye Road, adjacent to the site. There were also frequent jet aircraft flyovers at cruising altitude and some propeller driven aircraft at lower altitudes. Except for these transient events and wind noise in the trees, the Rex/Dye Road site is a quiet site typical of rural residential areas.

There were no nearby, consistent anthropogenic sources at this site, resulting in a lack of consistent tonality, as is shown in Figure 26. Tonal events were caused by the occasional car or truck pass by and bird call.

FIGURE 22: PHOTOGRAPH OF THE DYE ROAD SITE, LOOKING SOUTHEAST

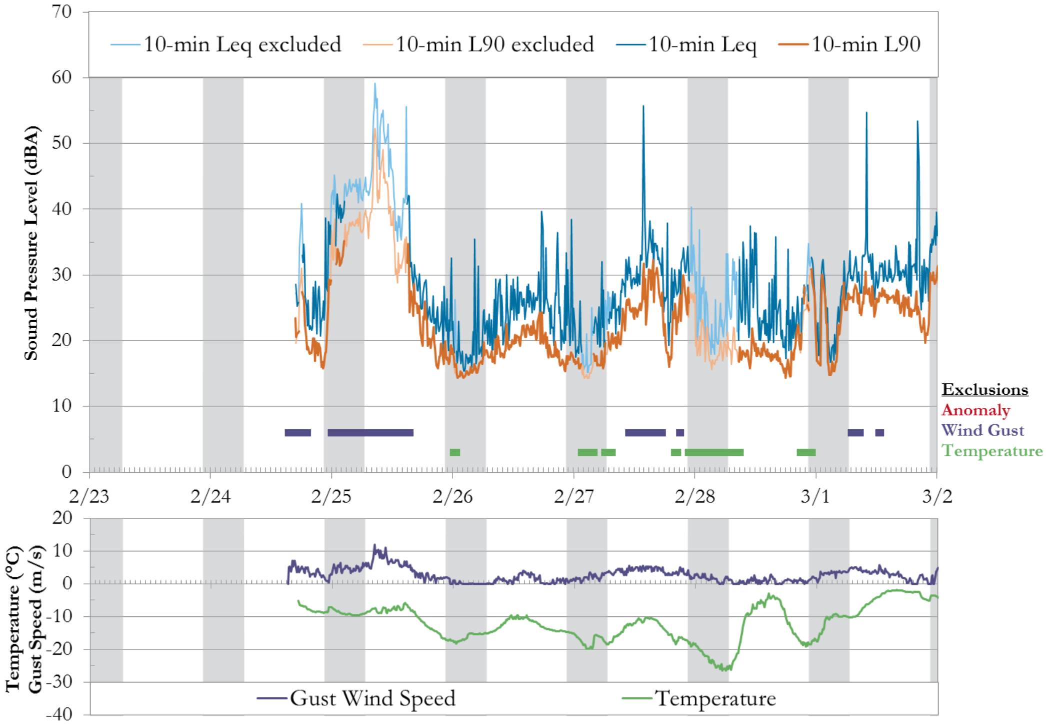

FIGURE 23: DYE ROAD MONITOR DATA, FEBRUARY 24 – MARCH 2, 2015

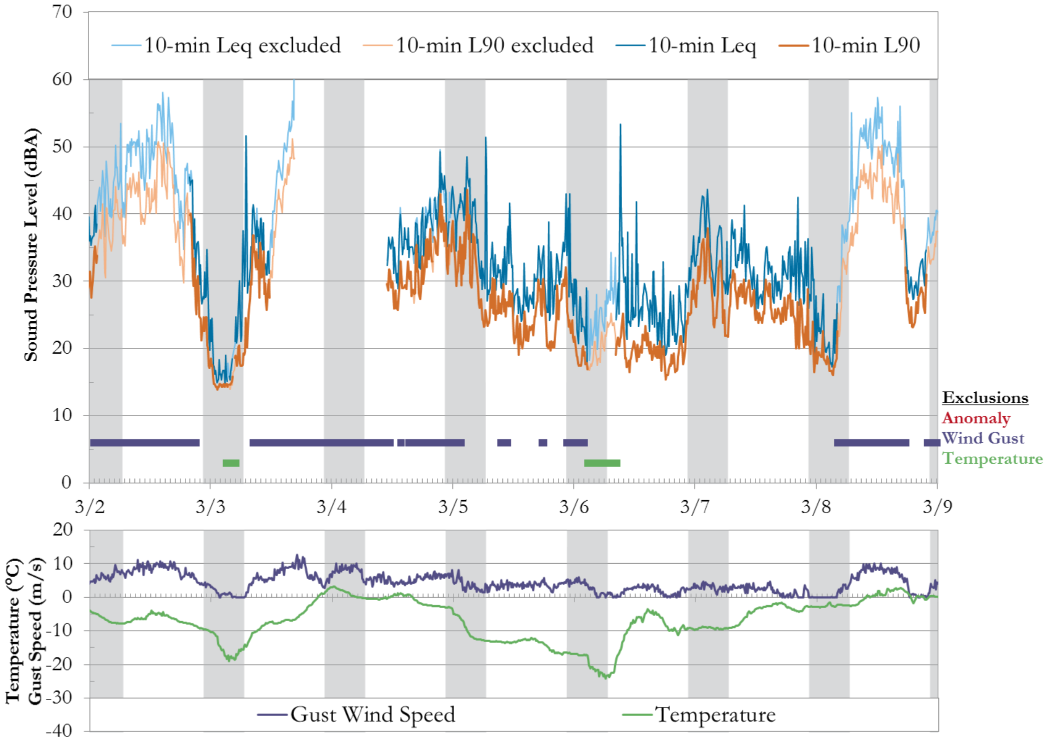

FIGURE 24: DYE ROAD MONITOR DATA, MARCH 2 – MARCH 9, 2015

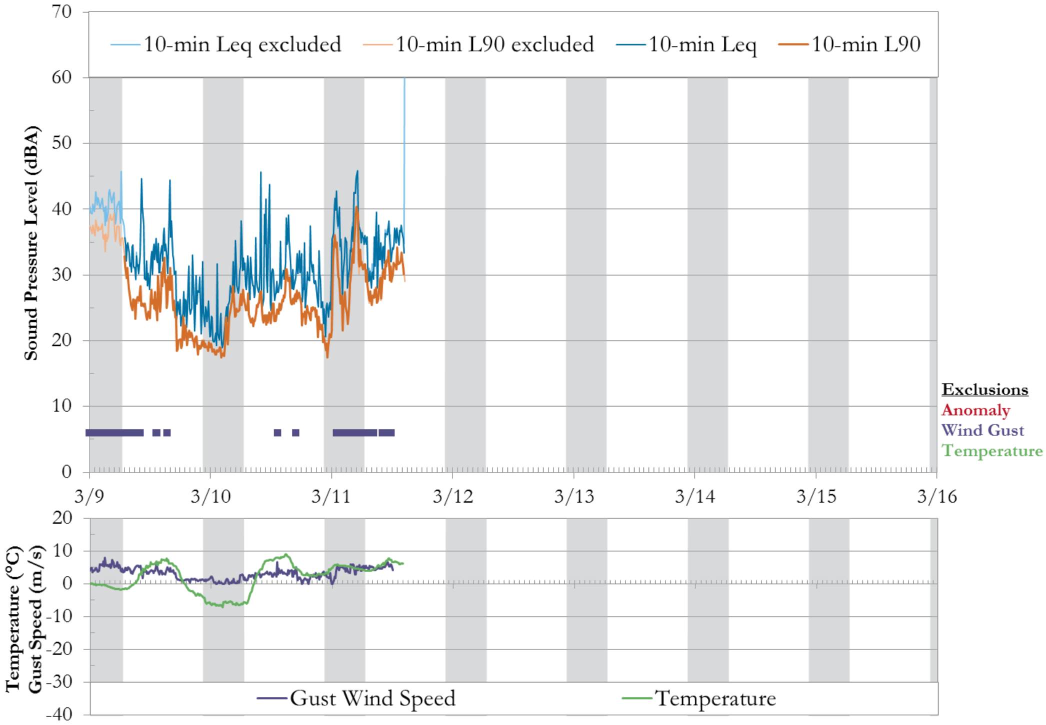

FIGURE 25: DYE ROAD MONITOR DATA, MARCH 9 – MARCH 11, 2015

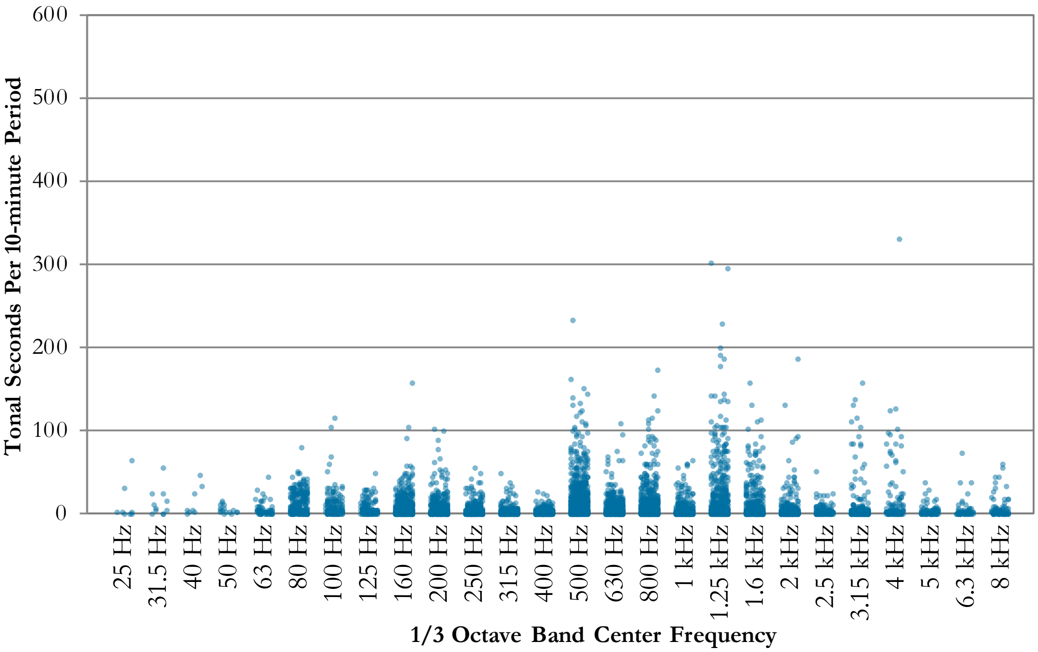

FIGURE 26: DYE ROAD WINTER MONITORING PERIOD – TONALITY

SUMMER MONITORING

Summer monitoring period time histories are shown in Figure 28, Figure 29, and Figure 30. Major sound sources during the summer period were similar to the winter period, with large increases in sound level caused by truck traffic and smaller increases in sound level caused by airplane flyovers. Other sound sources included wind blowing through the trees, which was particularly prominent at this site relative to other sites. During some periods, bird-calls were also present.

Tonality for this summer monitoring period is shown in Figure 31. Just as during the winter, there was minimal tonality due to anthropogenic sources. Tonality was primarily in the 5 kHz and 6.3 kHz 1/3 octave bands and is caused by birds and insects. A lower incidence of tonality is shown in the 1.25 kHz and 1.6 kHz 1/3 octave bands, caused by nearby birds.

Third octave band sound levels for both the summer and winter monitoring periods, by time of day are shown in Figure 32 for the L_{50}, Figure 33 for the L_{90}, and Figure 34 for the L_{eq}. The spectra for the winter and summer are similar, as are the spectra for day and night. The biggest differences between the summer and winter spectra are the midfrequency hump in the winter spectra, and the elevated high-frequency sound levels in the summer data. The former is due to higher overall winds or added sound attenuation caused by snow, and the latter is due to increased biogenic sounds in the summer. The midfrequency hump is most evident for the L_{eq} spectra. The L_{eq} spectra, particularly in the summer, also have elevated sound levels between 50 and 200 Hz caused by passing trucks and aircraft flyovers.

FIGURE 27: DYE ROAD SITE DURING THE SUMMER—LOOKING NORTHWEST

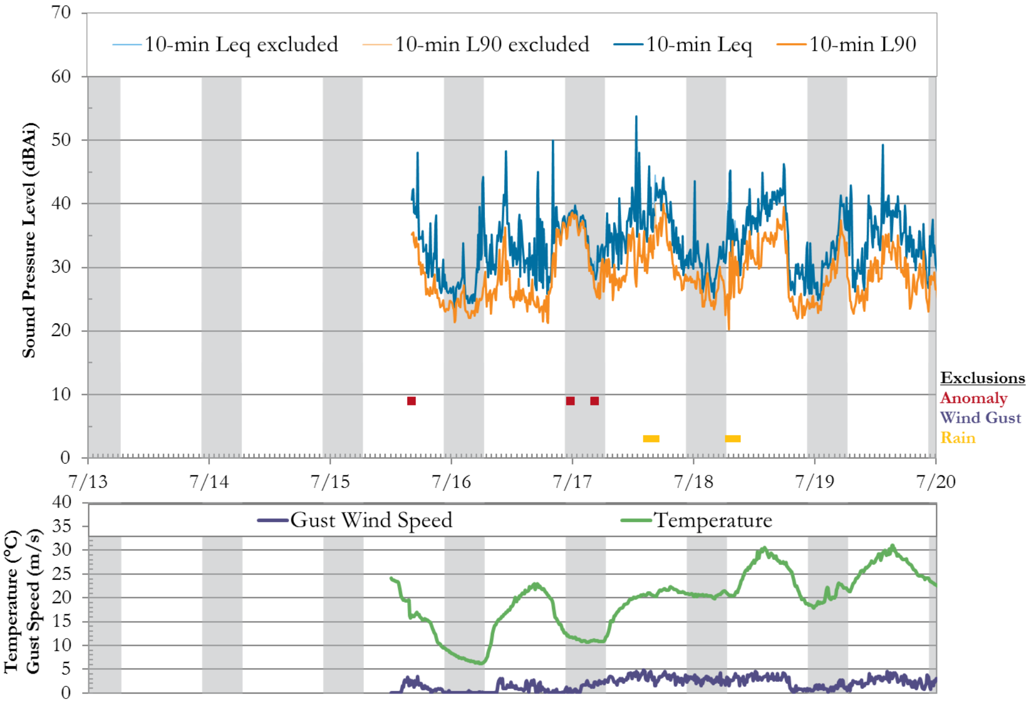

FIGURE 28: DYE ROAD MONITOR DATA, JULY 13 – JULY 20, 2015

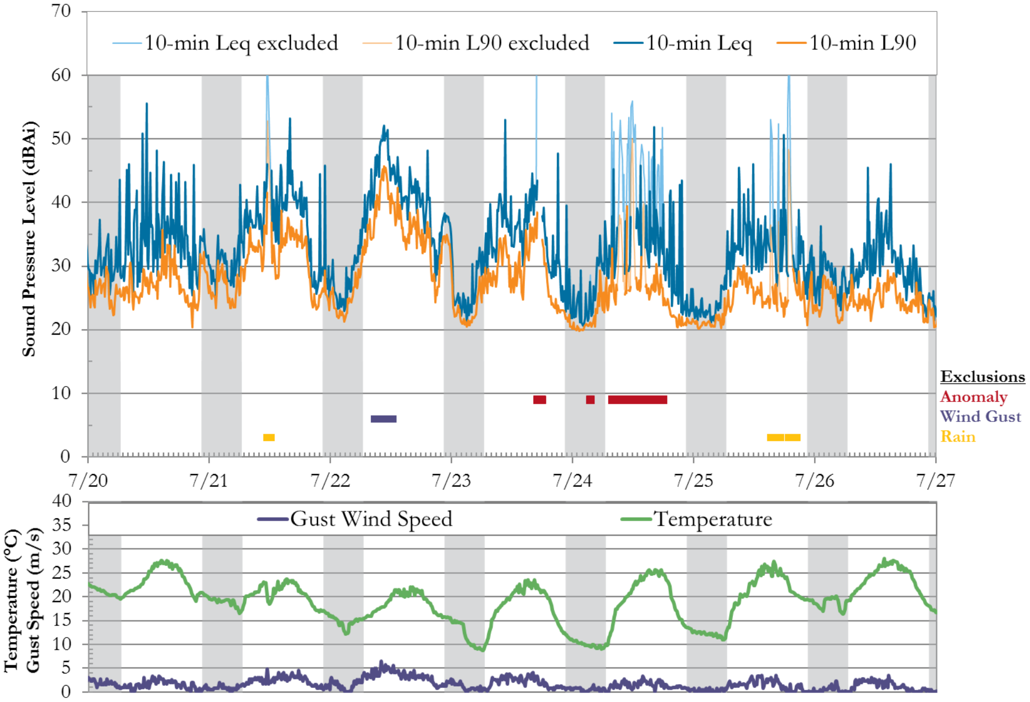

FIGURE 29: DYE ROAD MONITOR DATA, JULY 20 – JULY 27, 2015

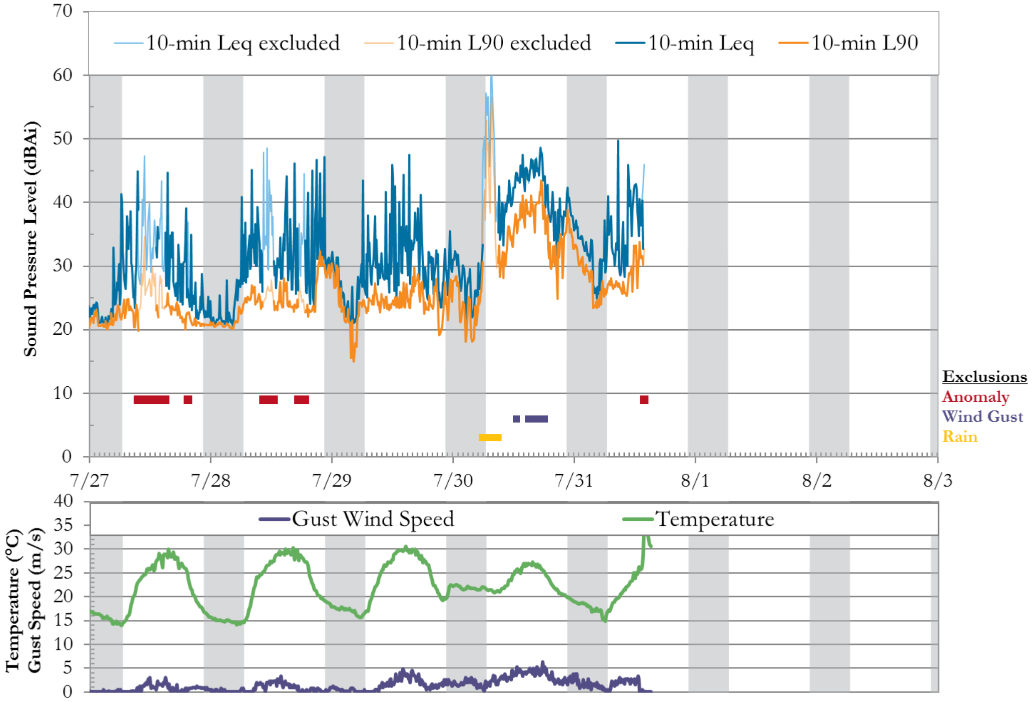

FIGURE 30: DYE ROAD MONITOR DATA, JULY 27 – AUGUST 3, 2015

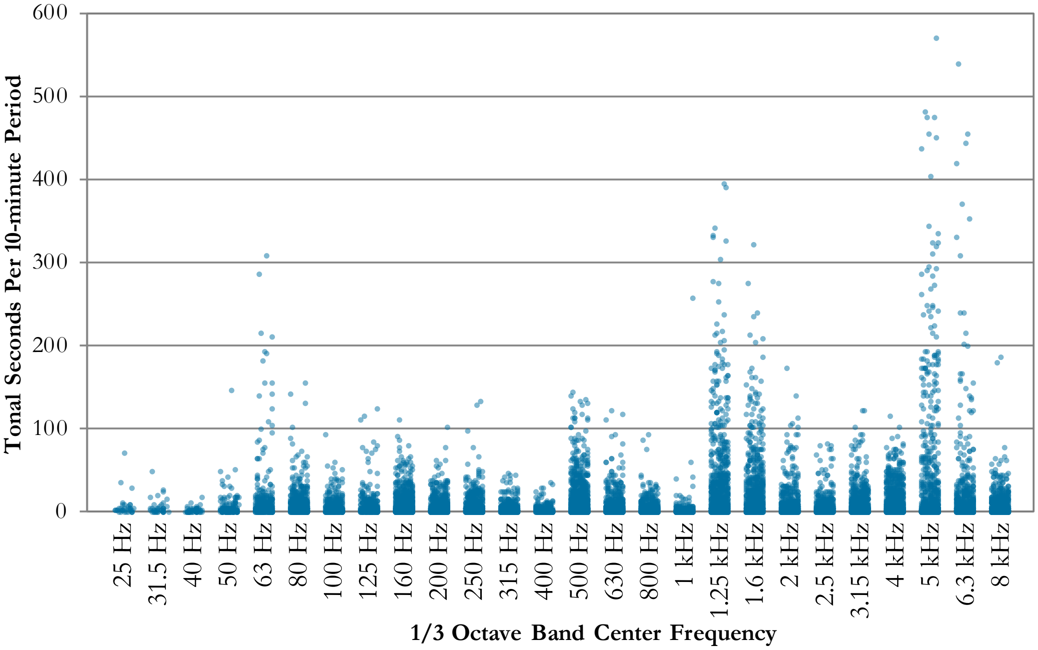

FIGURE 31: DYE ROAD SUMMER MONITORING PERIOD – TONALITY

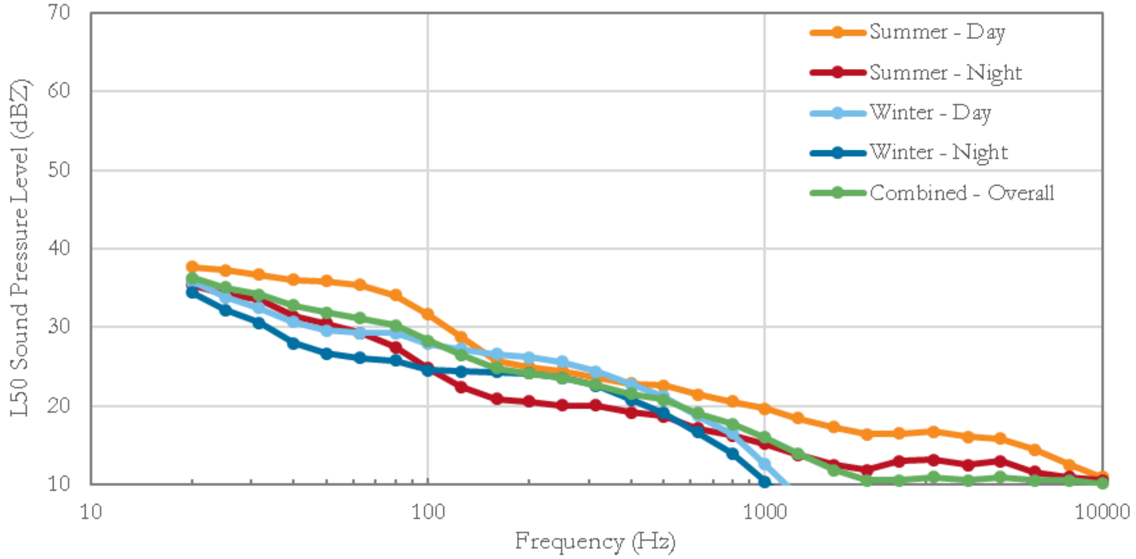

FIGURE 32: DYE ROAD 1/3 OCTAVE BAND MEDIAN SOUND LEVELS (L_{50}) BY SEASON AND TIME OF DAY

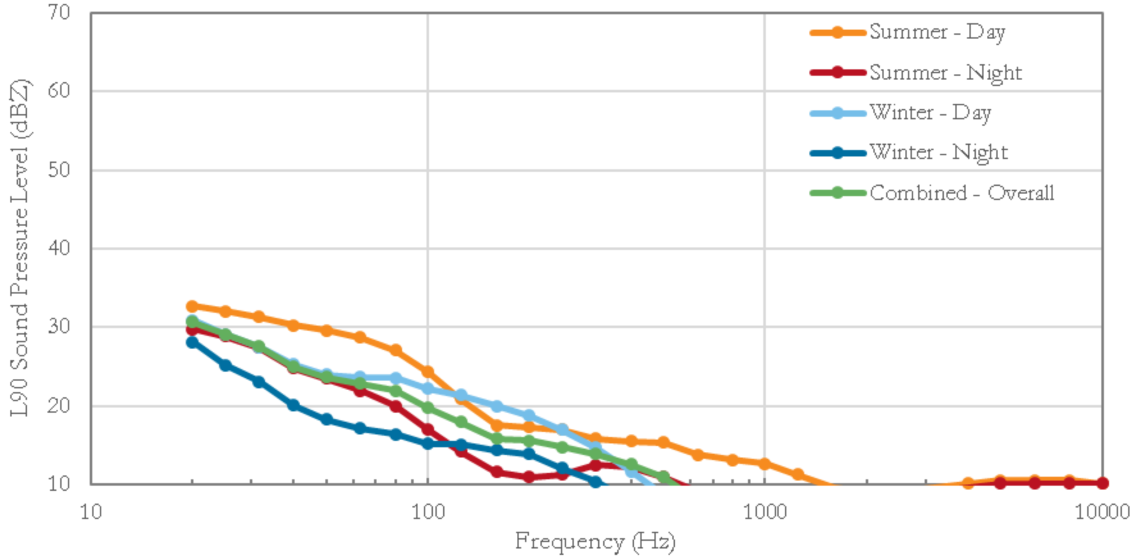

FIGURE 33: DYE ROAD 1/3 OCTAVE BAND LOWER 10TH PERCENTILE SOUND LEVELS (L_{90}) BY SEASON AND TIME OF DAY

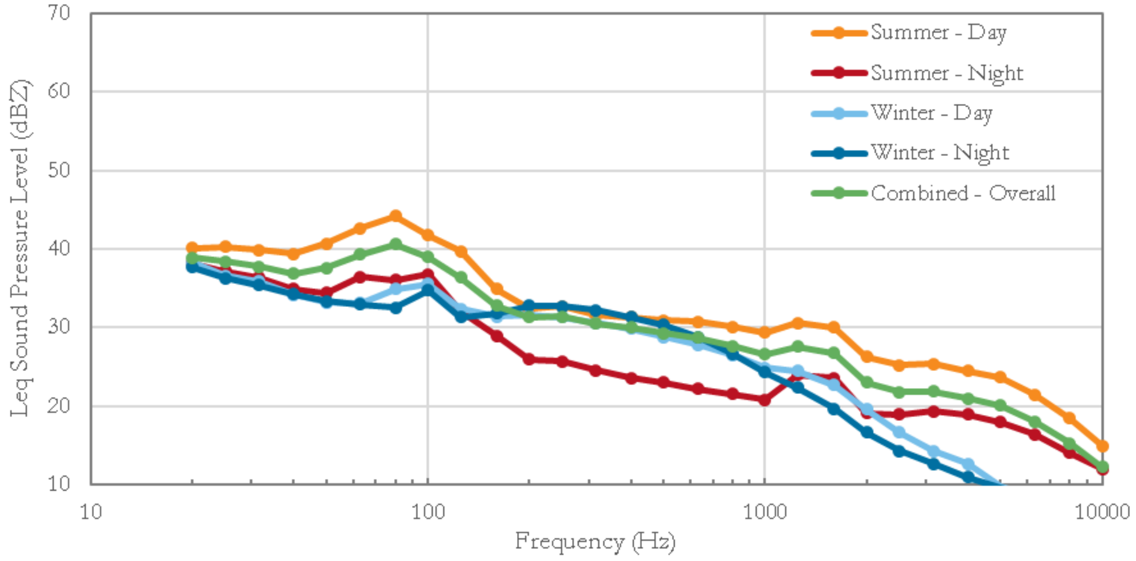

FIGURE 34: DYE ROAD 1/3 OCTAVE BAND EQUIVALENT AVERAGE SOUND LEVELS (L_{eq}) BY SEASON AND TIME OF DAY

6.4 | MONITOR 3: HASKINVILLE ROAD

The Haskinville Road monitor was located under an apple tree on the north side of a church parking lot at 8731 Haskinville Road, Cohocton, NY. The monitor location was approximately 100 meters (328 feet) from Haskinville Road and about 150 meters (492 feet) from the intersection of Highway 21, Haskinville Road, and County Road 55. The site is shown on the map in Figure 35, and a photograph of the monitor is displayed in Figure 36, looking to the northwest. This site also included an anemometer to measure wind speed, which is indicated in the photograph.

WINTER MONITORING

The long-term sound level results are plotted as time history graphs in Figure 37, Figure 38, and Figure 39. As indicated in the corresponding figure, the sound level meter lost power from March 4 to March 11 and did not record any data. As a result, the meter was re-deployed on March 11, 2015 for an additional recording period until the next morning, March 12, 2015. Results show a diurnal pattern at the site that extends slightly beyond the typical daytime hours. This extended diurnal activity was due to car and truck pass bys between the hours of 5AM and midnight. The data also show frequent propeller and commercial aircraft traffic.

Tonality during the winter period, shown in Figure 40, was irregular and not in a consistent frequency range. There were no major tonal sound sources at this location during the winter.

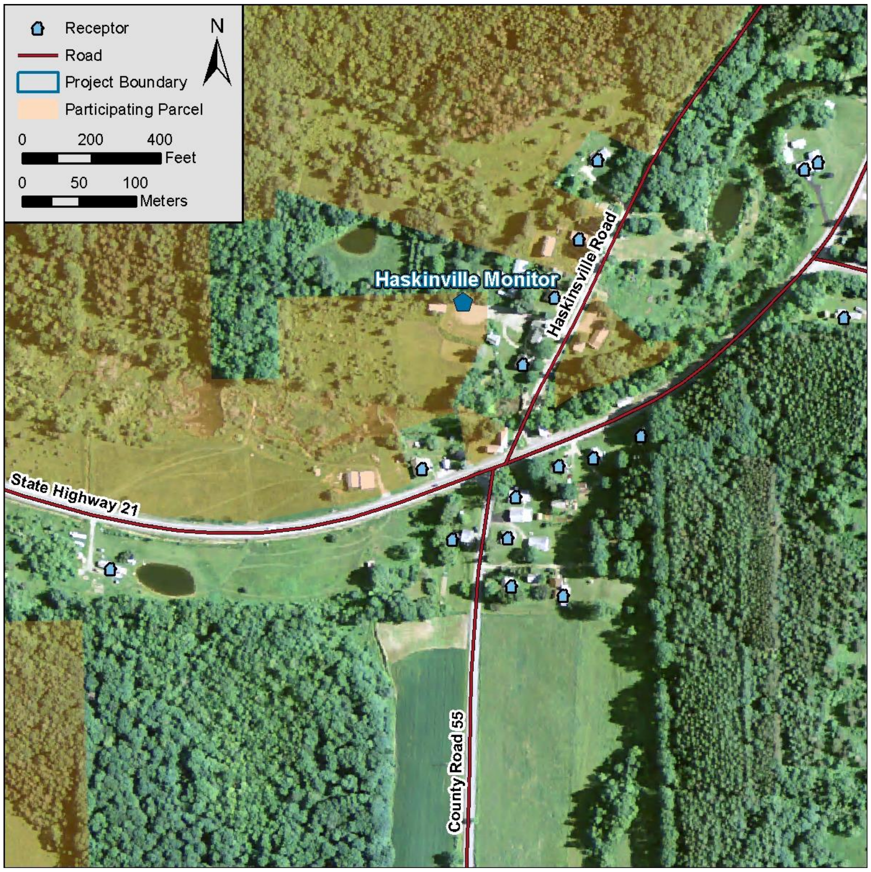

FIGURE 35: LOCATION OF THE HASKINVILLE ROAD MONITOR

FIGURE 36: PHOTOGRAPH OF THE HASKINVILLE ROAD SITE, LOOKING NORTHEAST

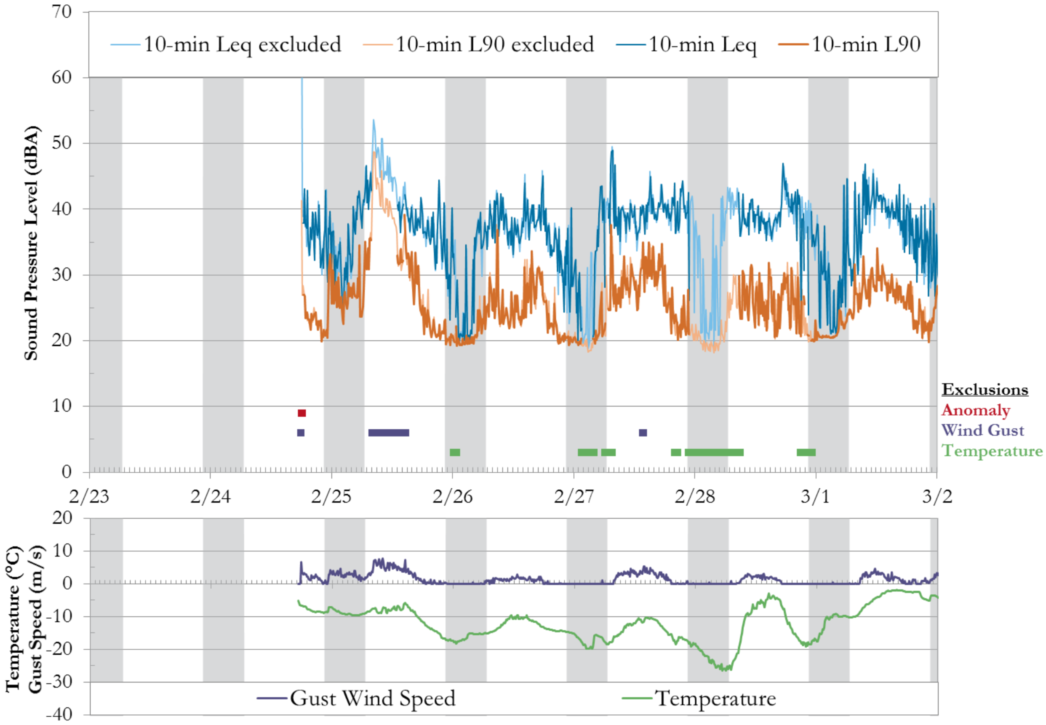

FIGURE 37: HASKINVILLE ROAD MONITOR DATA, FEBRUARY 24 – MARCH 2, 2015

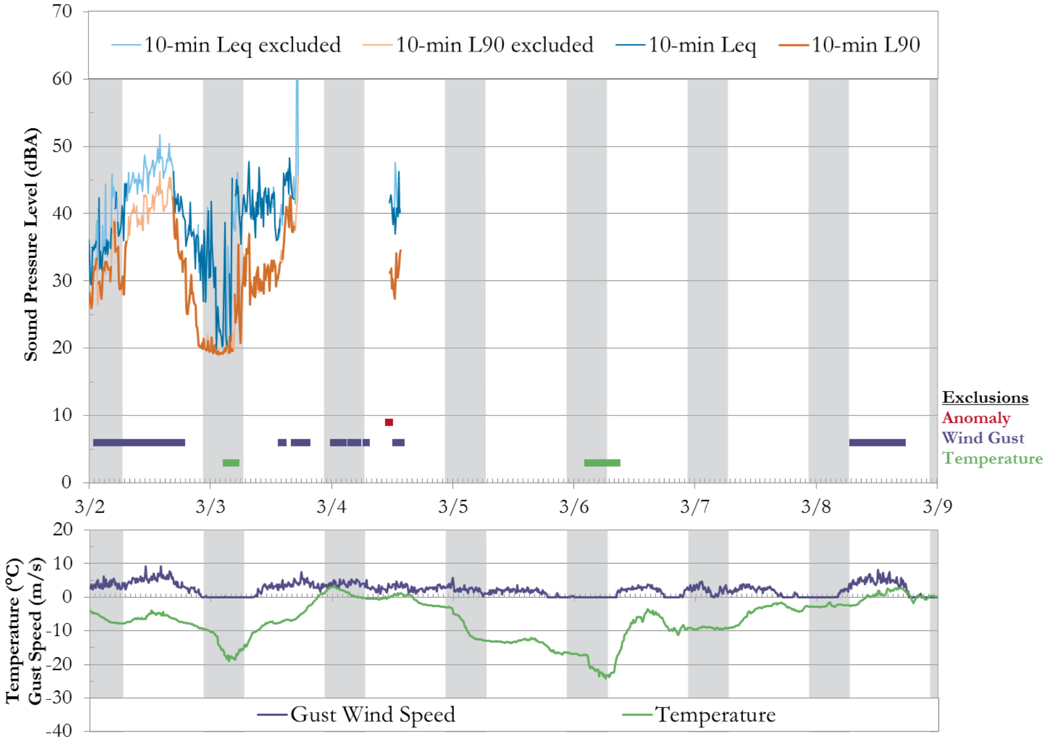

FIGURE 38: HASKINVILLE ROAD MONITOR DATA, MARCH 2 – MARCH 9, 2015

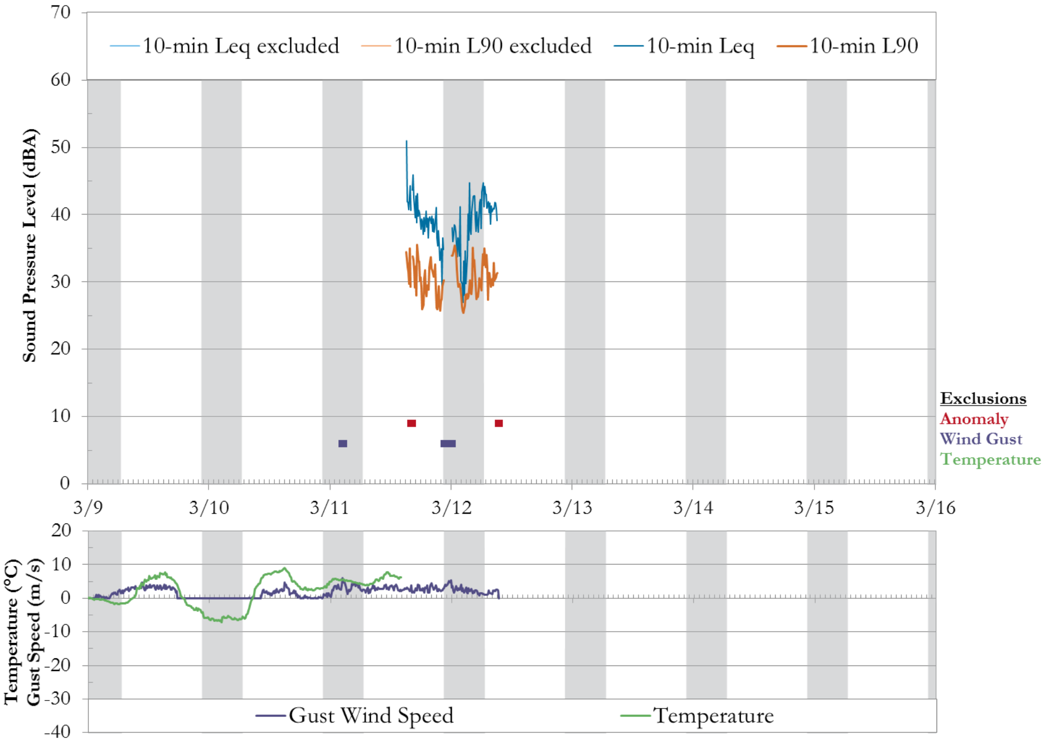

FIGURE 39: HASKINVILLE ROAD MONITOR DATA, MARCH 9 – MARCH 12, 2015

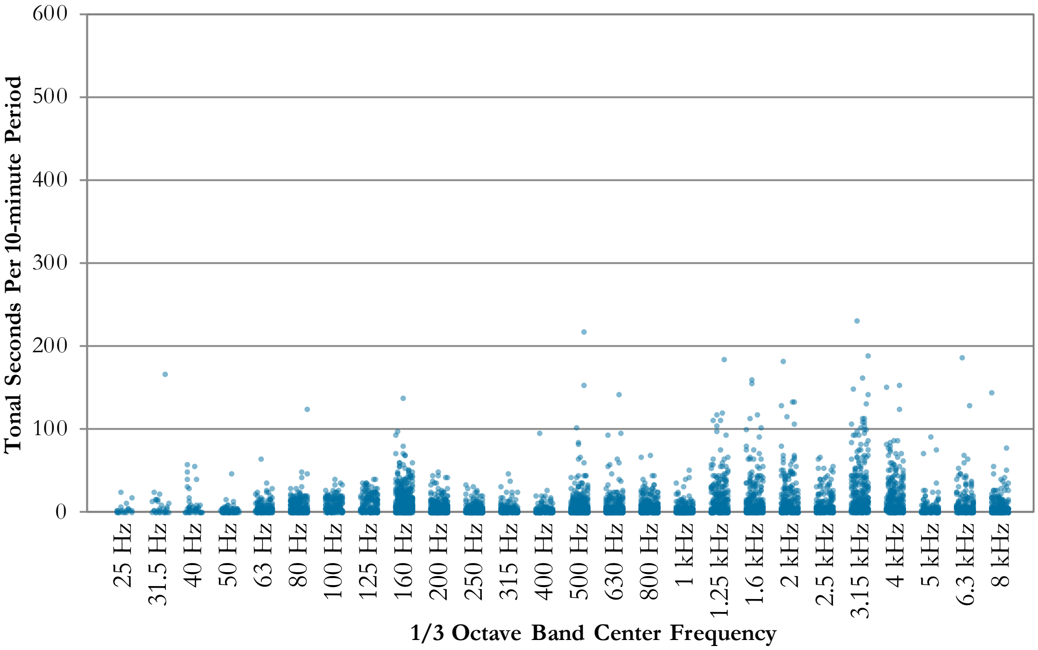

FIGURE 40: HASKINVILLE ROAD WINTER MONITORING PERIOD – TONALITY

SUMMER MONITORING

Summer long-term time history results are shown in Figure 42, Figure 43, and Figure 44. Results show a diurnal pattern at the site that extends slightly beyond the typical daytime hours. This was due to vehicle traffic on State Highway 21 and other anthropogenic sounds, such as building construction and yard work. Biogenic sounds such as birds and insects were also present. Propeller and jet aircraft were present throughout the day and night.

Tonality during the summer monitoring period was common in the higher frequency range from the 2.5 kHz to 8 kHz 1/3 octave bands, as is shown in Figure 45. The cause of this tonality was birds and insects. Less frequent tonality in the 500 Hz 1/3 octave band was due to dogs barking and tonality in the 160 Hz 1/3 octave band is due to machinery operation.

Third octave band sound levels by time of day and season are shown in Figure 60 for the L_{50}, Figure 61 for the L_{90}, and Figure 62 for the L_{eq}. Due to traffic on State Highway 21, there is an increase in sound levels between approximately 400 Hz and 2 kHz, as is visible for the L_{50} and L_{eq} spectra during the daytime. Like other sites, there is a midfrequency "hump" caused by the change in sound absorption due to winter snow cover or wind-induced sound and an increase in high-frequency sound levels due to seasonal biogenic sounds.

FIGURE 41: HASKINVILLE SITE DURING THE SUMMER—LOOKING NORTH

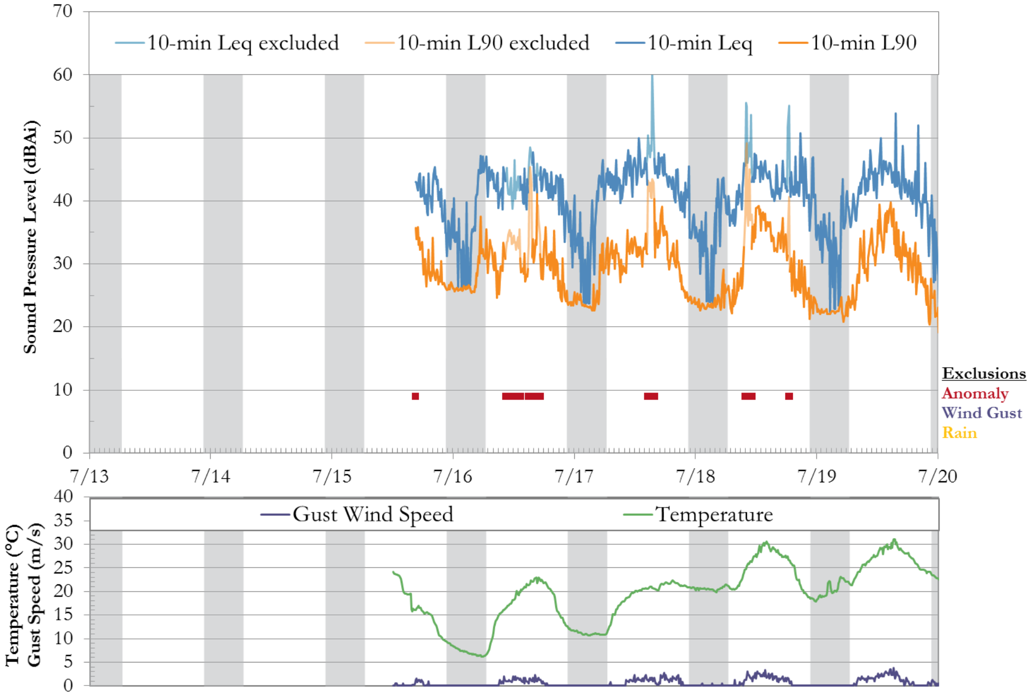

FIGURE 42: HASKINVILLE ROAD MONITOR DATA, JULY 13 – JULY 20, 2015

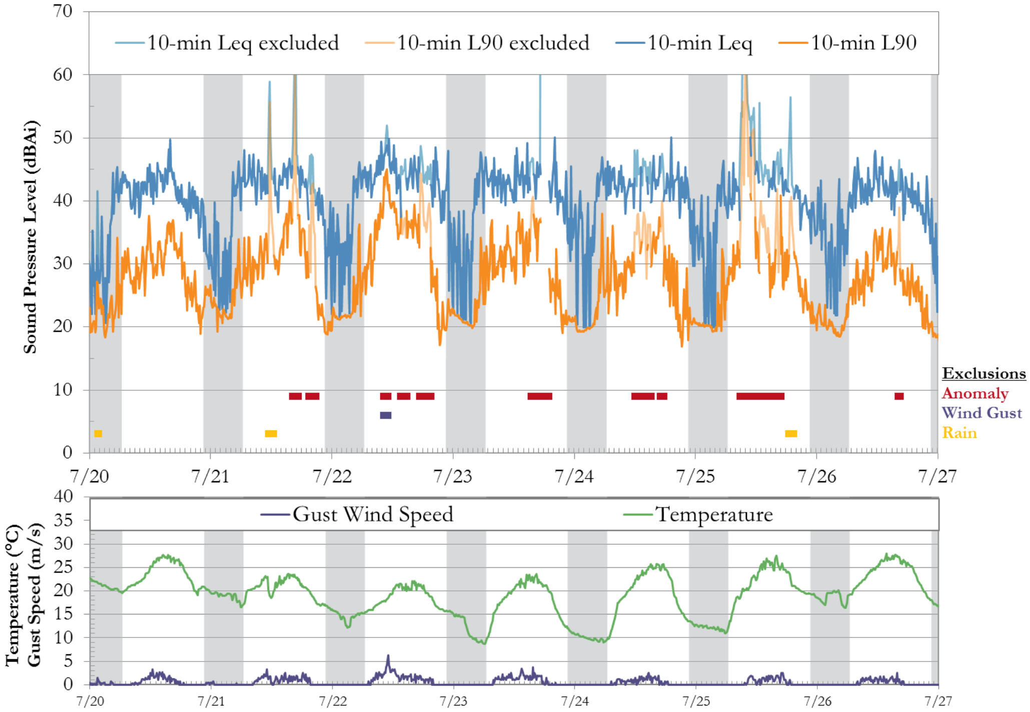

FIGURE 43: HASKINVILLE ROAD MONITOR DATA, JULY 20 – JULY 27, 2015

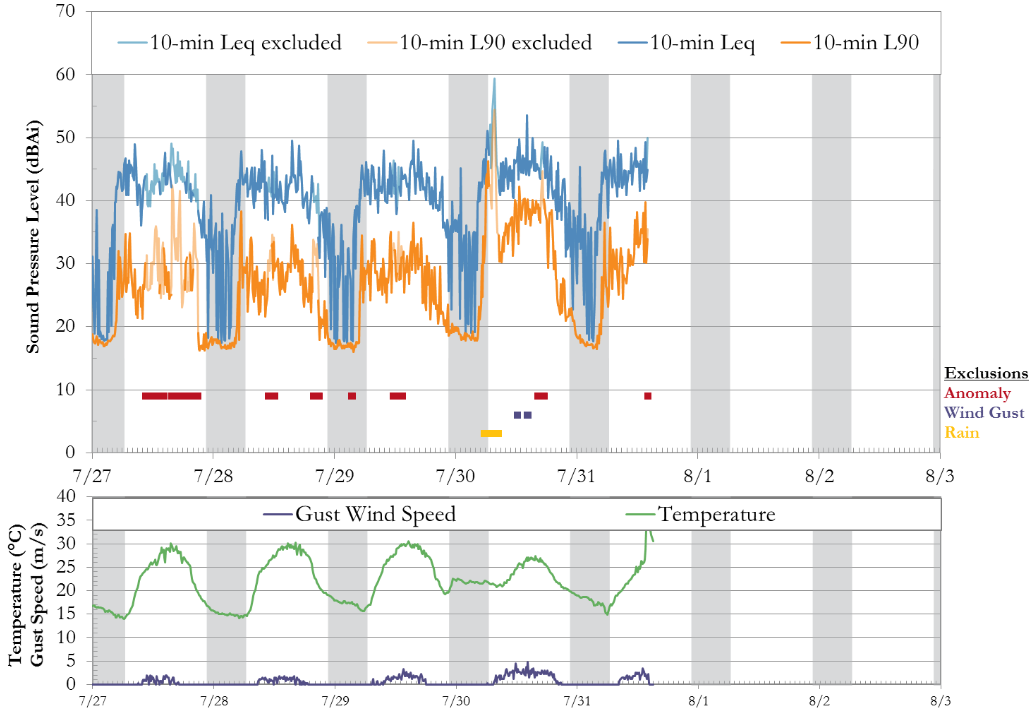

FIGURE 44: HASKINVILLE ROAD MONITOR DATA, JULY 27 – AUGUST 3, 2015

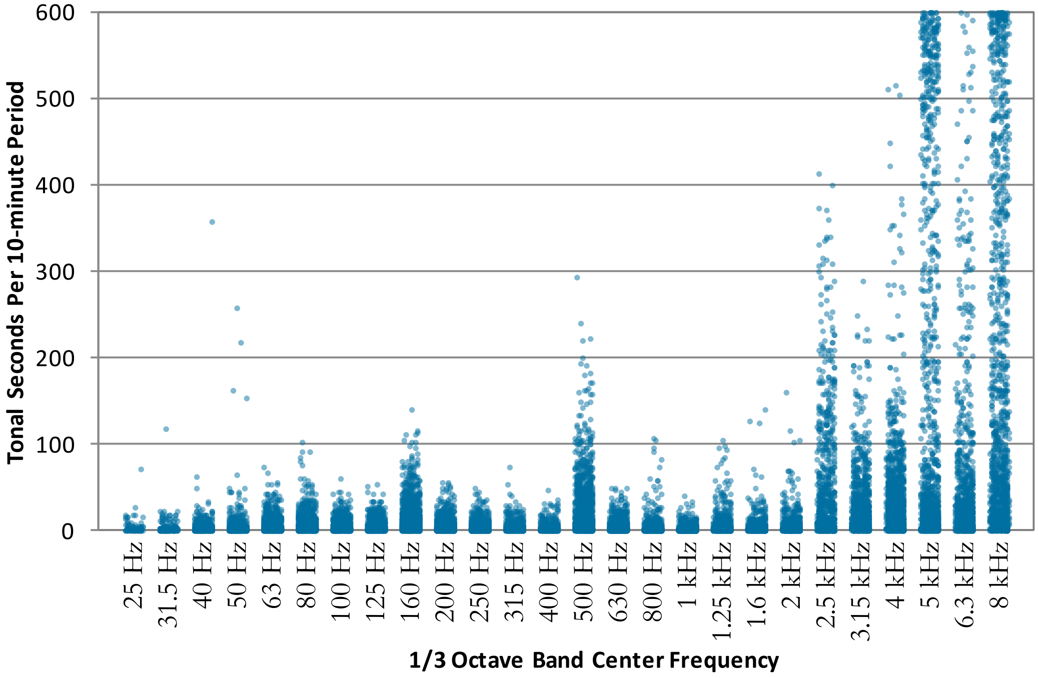

FIGURE 45: HASKINVILLE ROAD SUMMER MONITORING PERIOD – TONALITY

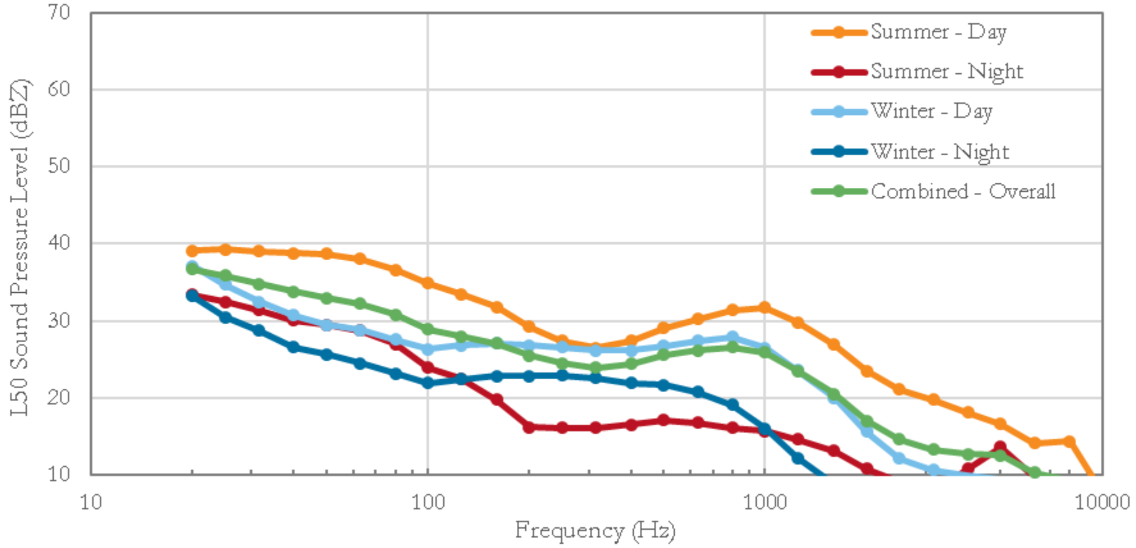

FIGURE 46: HASKINVILLE 1/3 OCTAVE BAND MEDIAN SOUND LEVEL (L50) BY SEASON AND TIME OF DAY

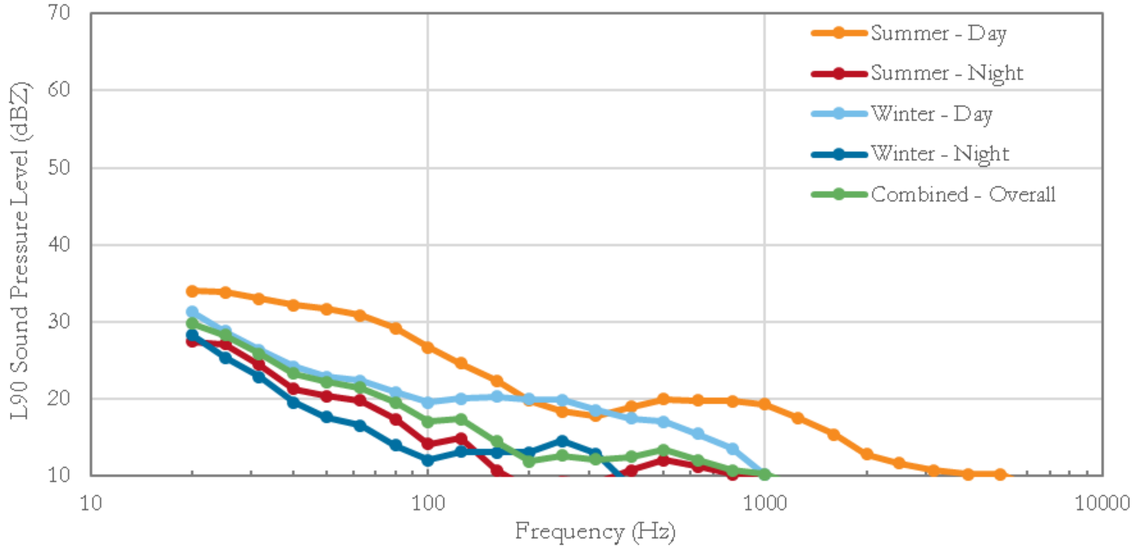

FIGURE 47: HASKINVILLE 1/3 OCTAVE BAND LOWER 10TH PERCENTILE SOUND LEVELS (L90) BY SEASON AND TIME OF DAY

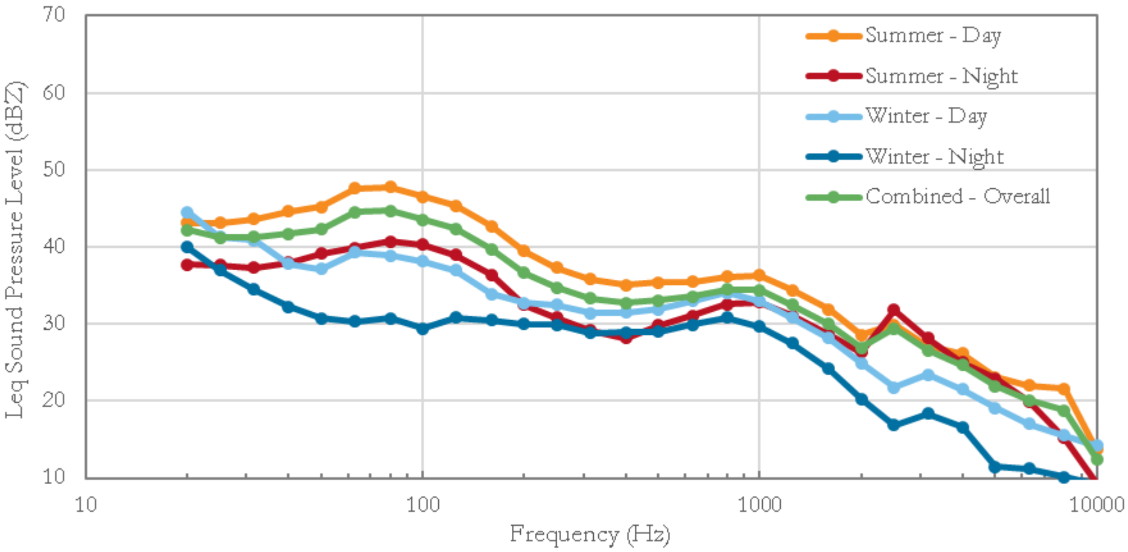

FIGURE 48: HASKINVILLE 1/3 OCTAVE BAND EQUIVALENT AVERAGE SOUND LEVEL (L_{eq}) BY SEASON AND TIME OF DAY

6.5 | MONITOR 4: HENKLE HOLLOW

The Henkle Hollow monitor was located at 3323 Henkle Hollow Road in Cohocton, New York. The monitor was placed toward the top of a hill behind the residence, approximately 73 meters (239 feet) from Henkle Hollow Road and 29 meters (95 feet) from a house. The site is shown on the map in Figure 49. Figure 50 shows a photograph of the winter installation looking northeast and Figure 55 shows a view of the summer monitoring installation, looking directly north.

WINTER MONITORING

The long-term sound level results are plotted as time history graphs in Figure 51, Figure 52, and Figure 53. The monitor was directly above the driveway of the residence that had a significant amount of activity, including cars coming and going (with doors opening and closing), a tractor operating throughout the property, and snowmobiles. Sounds from snowmobiles passing close to the monitor were excluded from processing of statistical levels, but all other engine sources were retained. These frequent transient sources explain the separation between the 10-minute L_{eq} and L_{90} levels at intervals throughout day and night. Although the time history appears to show a diurnal pattern, much of the noise can be attributed to the wind blowing through the trees. The wind was seldom calm at this site.

Figure 54 shows little tonal activity at the site. Tonality in the 1.25 kHz 1/3 octave band was due to birds.

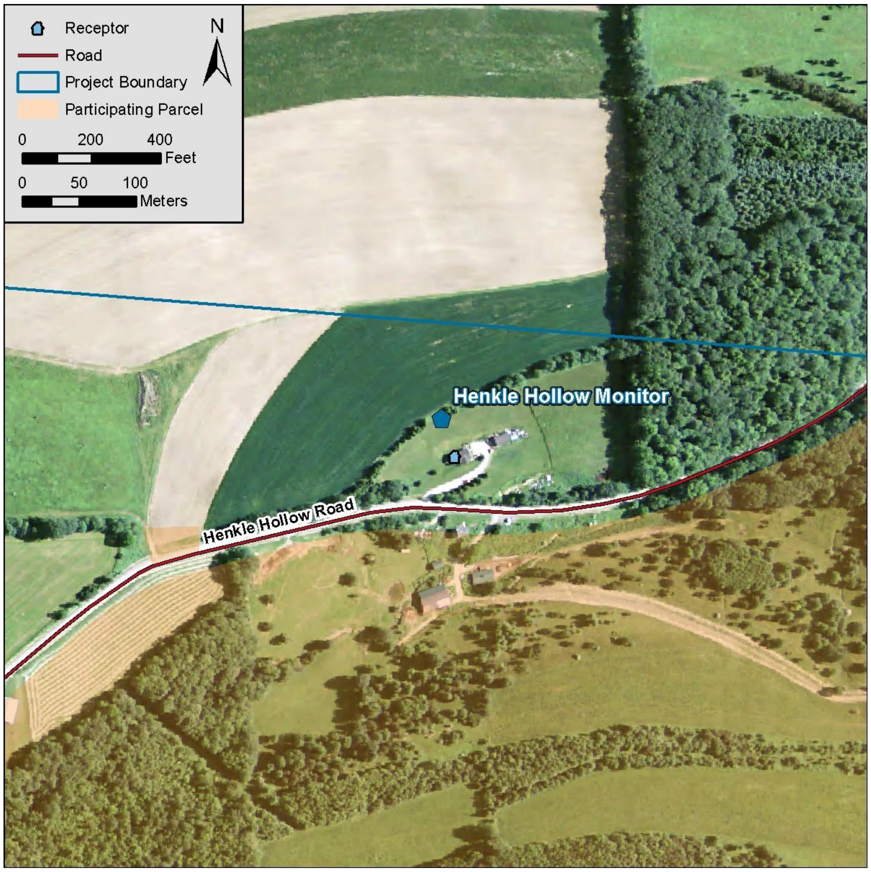

FIGURE 49: LOCATION OF THE HENKLE HOLLOW MONITOR

FIGURE 50: PHOTOGRAPH OF THE HENKLE HOLLOW SITE, LOOKING NORTH

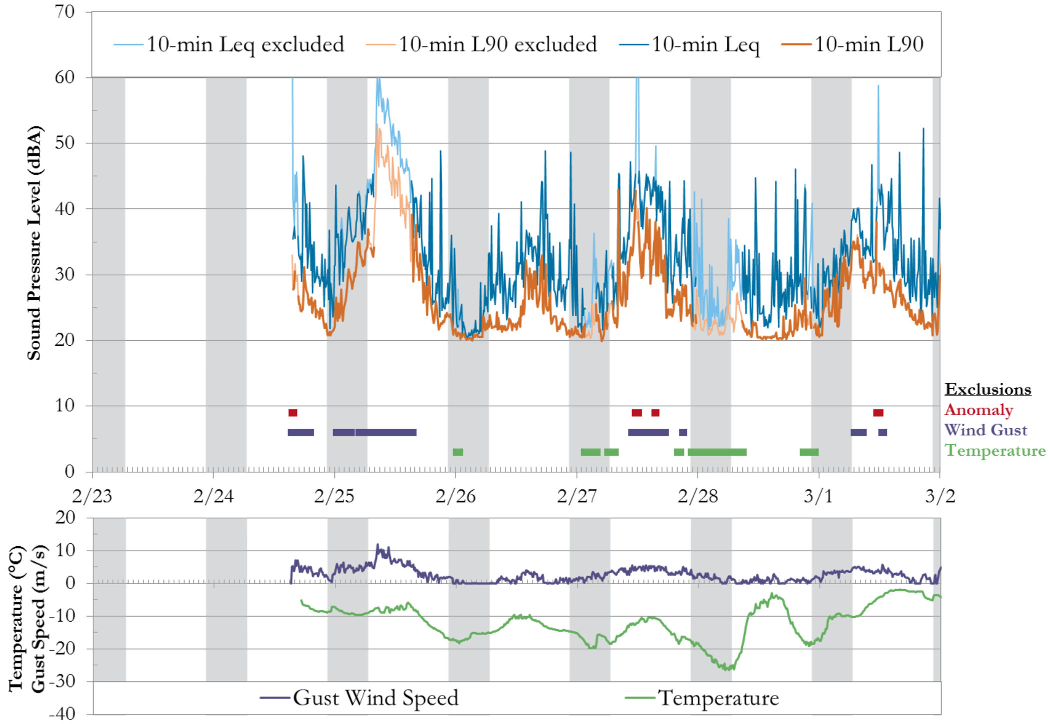

FIGURE 51: HENKLE HOLLOW MONITOR DATA, FEBRUARY 24 – MARCH 1, 2015

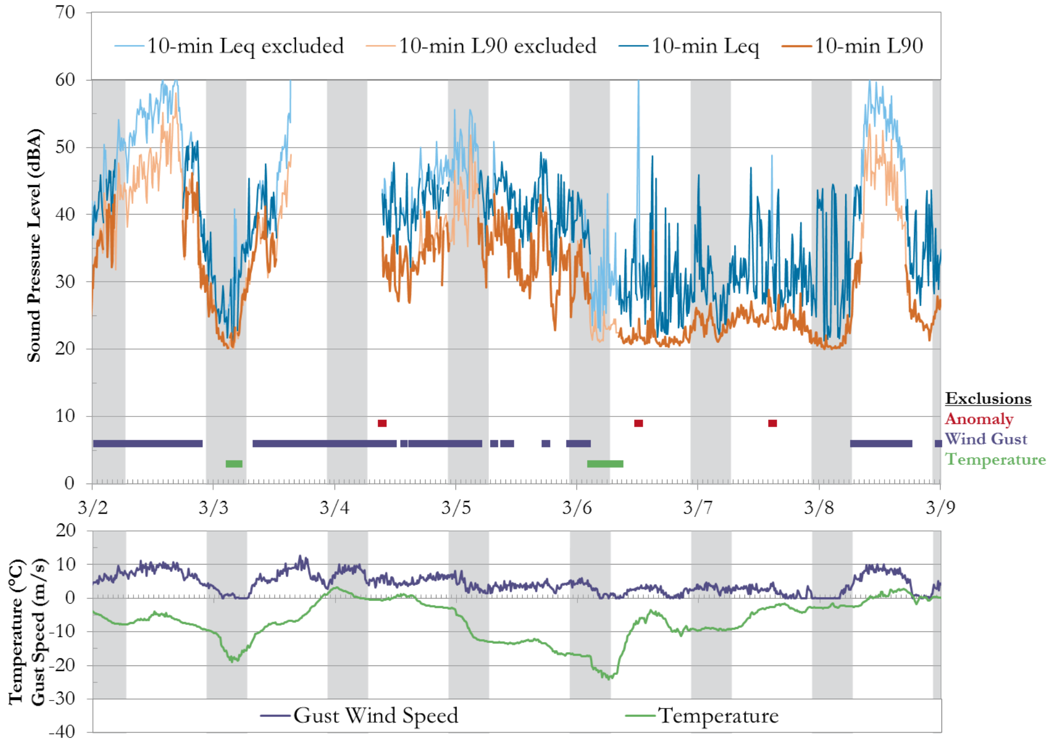

FIGURE 52: HENKLE HOLLOW MONITOR DATA, MARCH 1 – MARCH 8, 2015

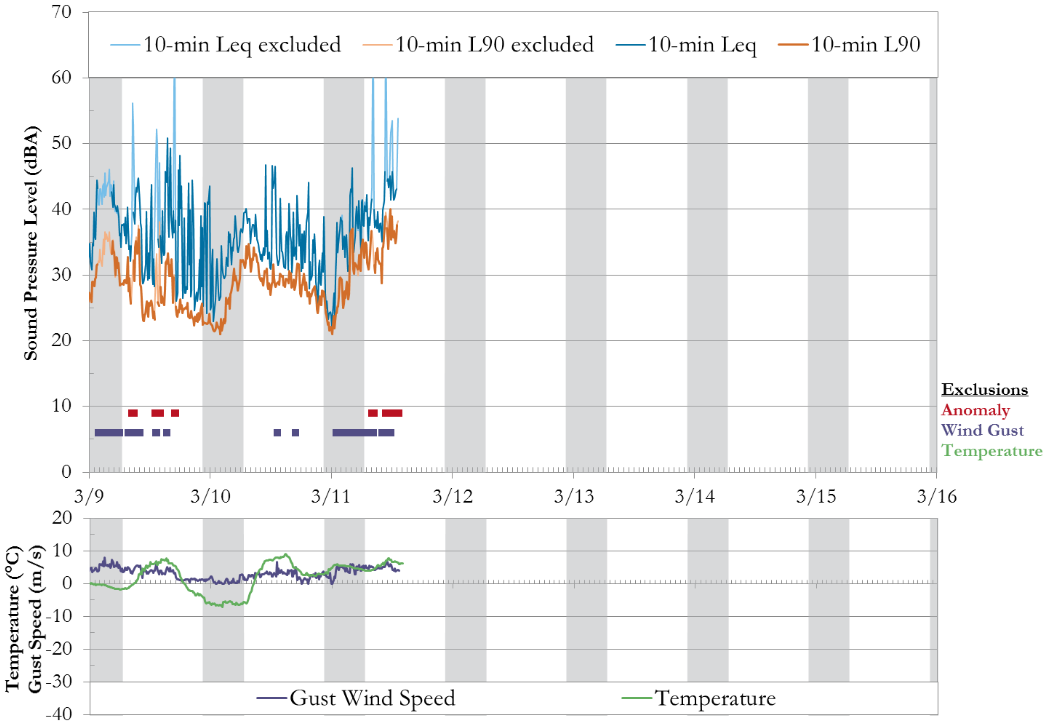

FIGURE 53: HENKLE HOLLOW MONITOR DATA, MARCH 8 – MARCH 11, 2015

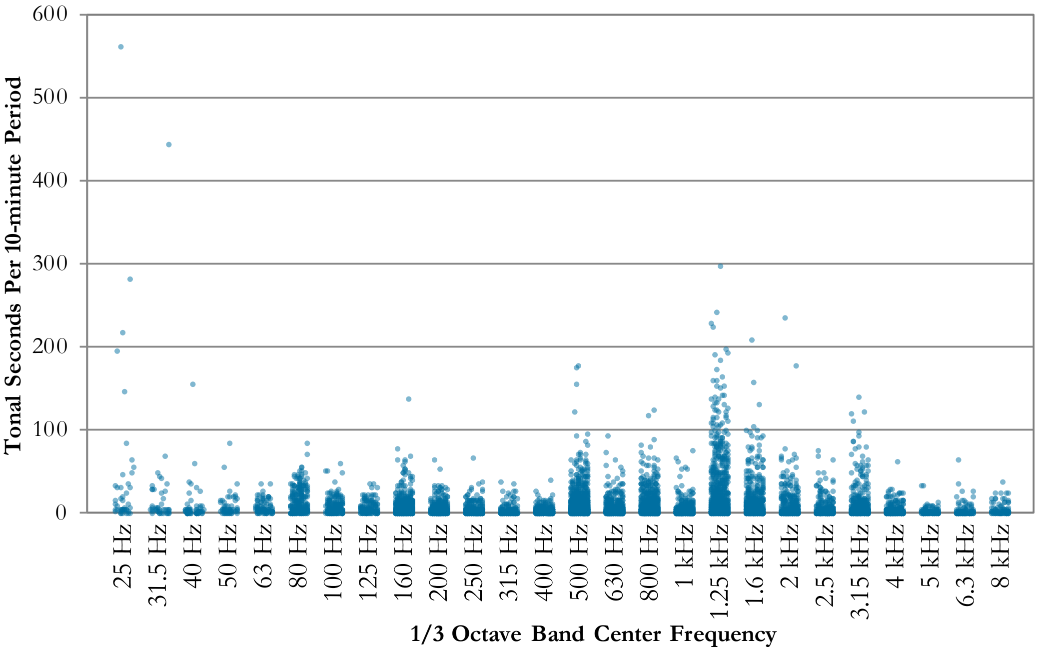

FIGURE 54: HENKLE HOLLOW WINTER MONITORING PERIOD—TONALITY

SUMMER MONITORING

Time history plots are presented in Figure 56, Figure 57, and Figure 58. Similar to winter monitoring, the site did not exhibit purely diurnal patterns. Sources in the summer at Henkle Hollow included wind through the trees, tractor operations, airplane overflights, truck traffic on the interstate, and a window air conditioning unit on the house. Since tractor operations were not seasonal, this source was retained in the data. However, when the tractor operated close to the monitor, and levels were exceptionally high, data were excluded. A window air conditioning unit was installed at the house in line of sight from the monitor. The air conditioning unit affected levels when it was on; this is evident in the sound level data, particularly the L_{90}. Since it was a seasonal source, periods when the unit was on were excluded from data processing. Traffic noise from the interstate can be heard during the quieter times in the morning.

The tonality chart in Figure 59 indicates the major tonal sources were from biogenic sound such as birds and insects, indicated by higher levels of tonal incidence in the 5 kHz, 6.3 kHz, and 8 kHz 1/3 octave bands.

Third octave band sound levels by season and time of day are shown in Figure 60, for the L_{50}, Figure 61 for the L_{90}, and Figure 62 for the L_{eq}. The overall shape of all five spectra is similar for this site, particularly below about 200 Hz. The winter spectra have relatively higher sound levels in the midfrequency range and the summer spectra have relatively higher overall sound levels in the upper frequency range due to biogenic sounds. The midfrequency hump in the winter spectra is nonexistent L_{90} spectra, but present in the L_{50} and L_{eq} spectra. Apparent tones exist in both summer spectra, due to insects or amphibians at 5 kHz and 8 kHz.

FIGURE 55: PHOTOGRAPH OF THE HENKLE HOLLOW SITE, LOOKING NORTH

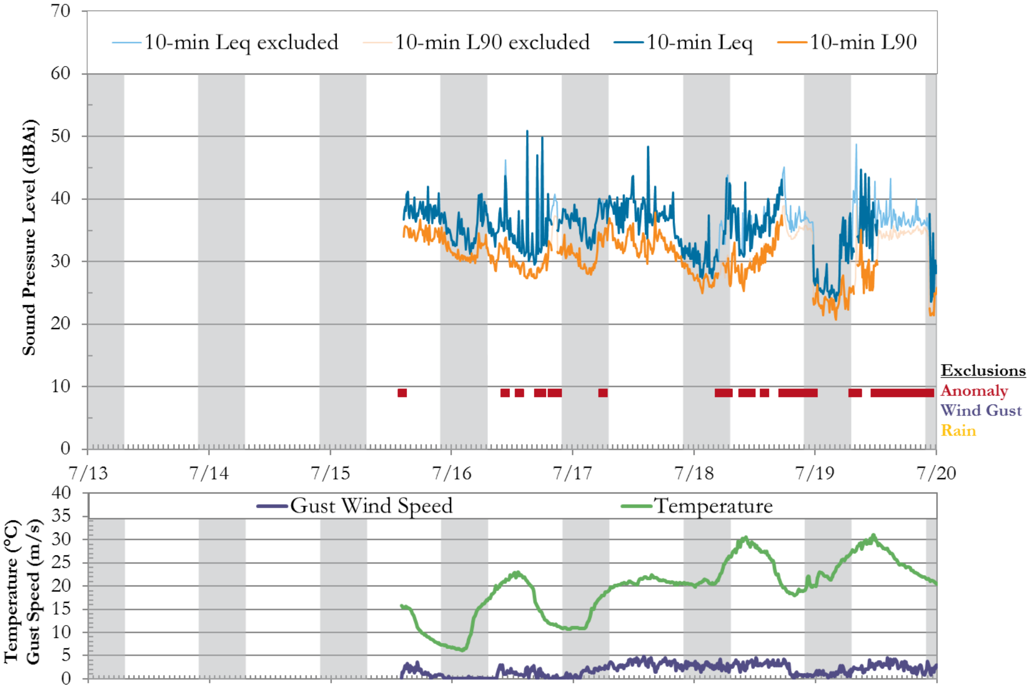

FIGURE 56: HENKLE HOLLOW ROAD MONITOR DATA, JULY 13 – 20, 2015

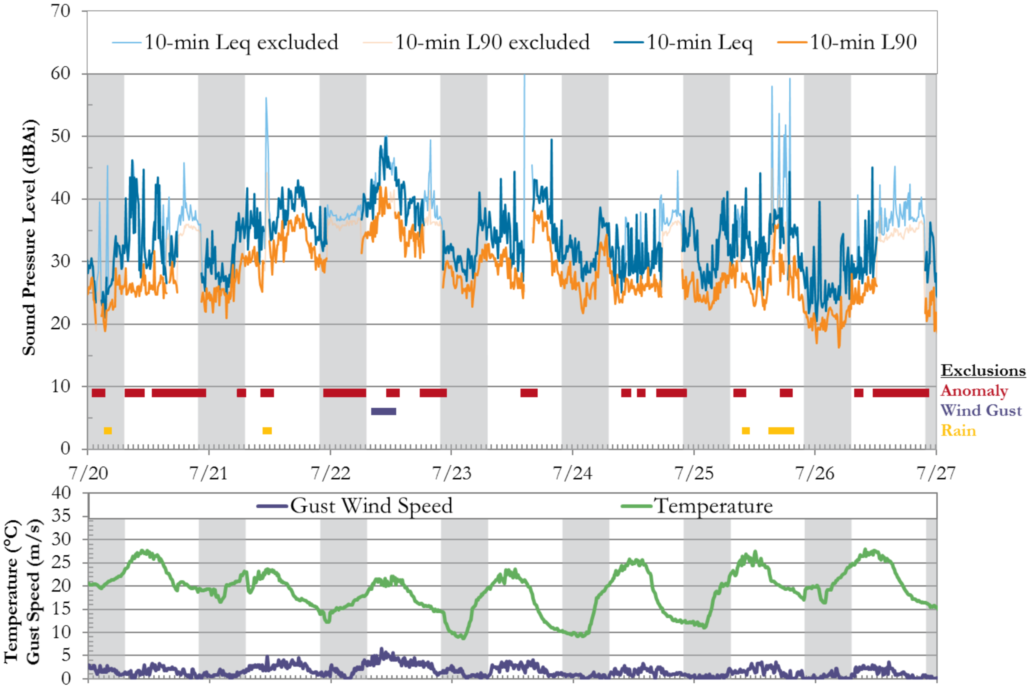

FIGURE 57: HENKLE HOLLOW ROAD MONITOR DATA, JULY 20 – 27, 2015

Figure 60

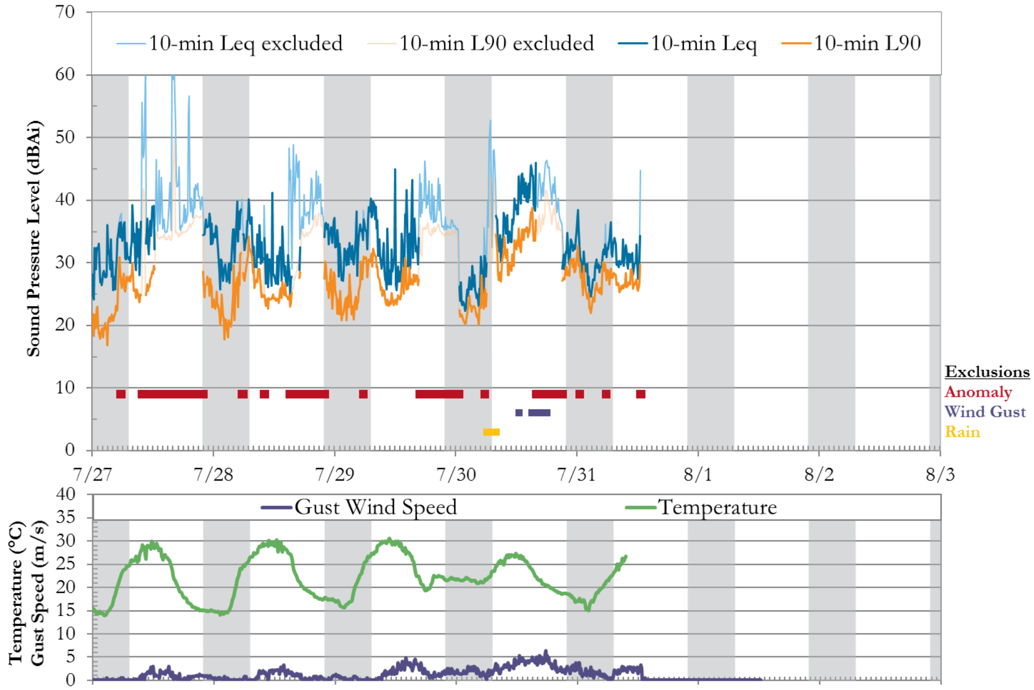

FIGURE 58: HENKLE HOLLOW ROAD MONITOR DATA, JULY 27 – AUGUST 3, 2015

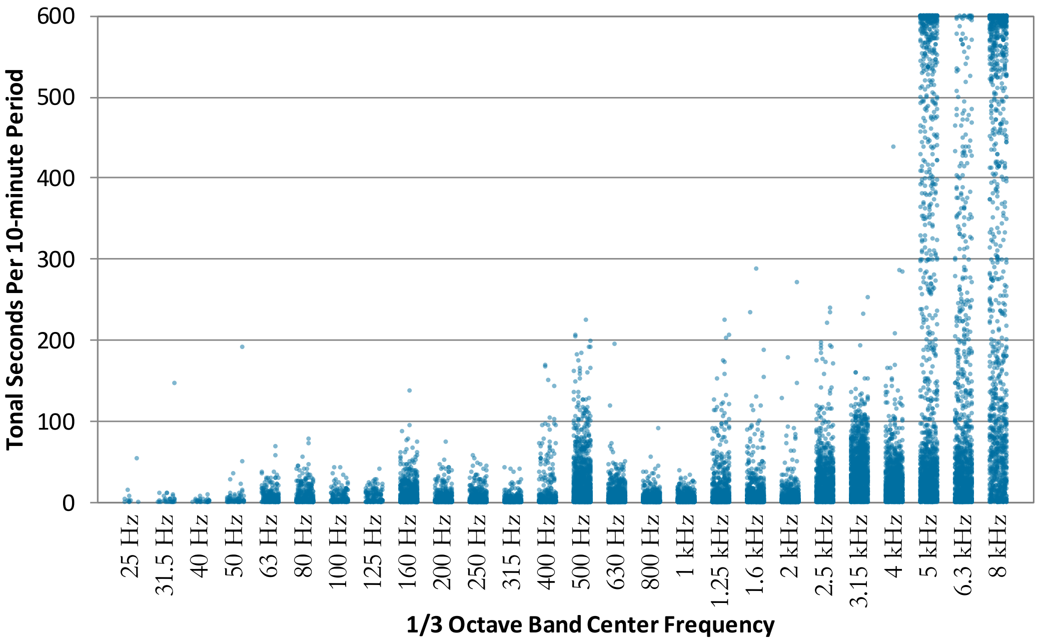

FIGURE 59: HENKLE HOLLOW SUMMER MONITORING PERIOD – TONALITY

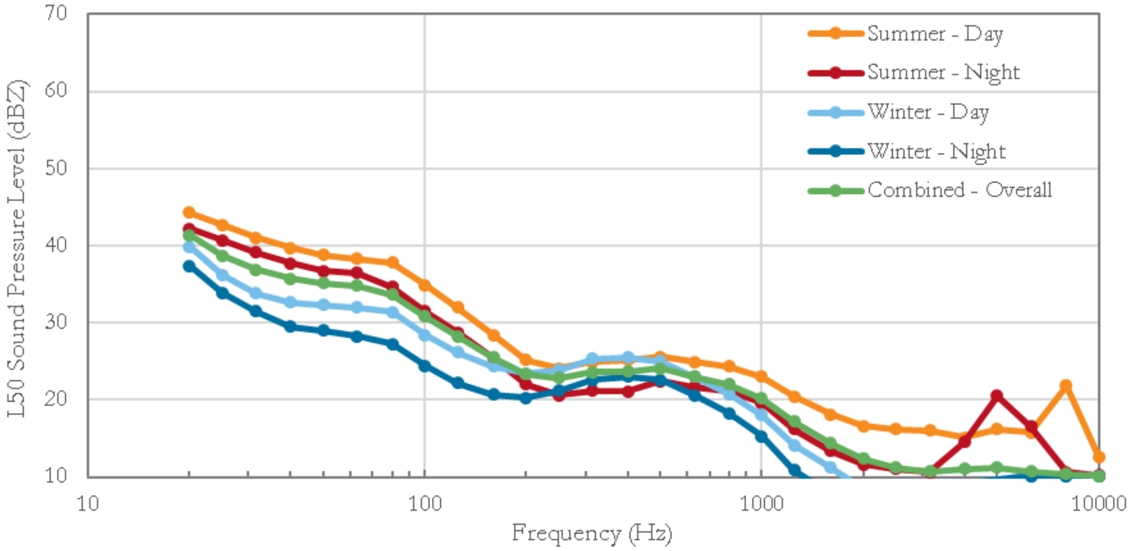

FIGURE 60: HENKLE HOLLOW 1/3 OCTAVE BAND MEDIAN SOUND LEVELS (L_{50}) BY SEASON AND TIME OF DAY

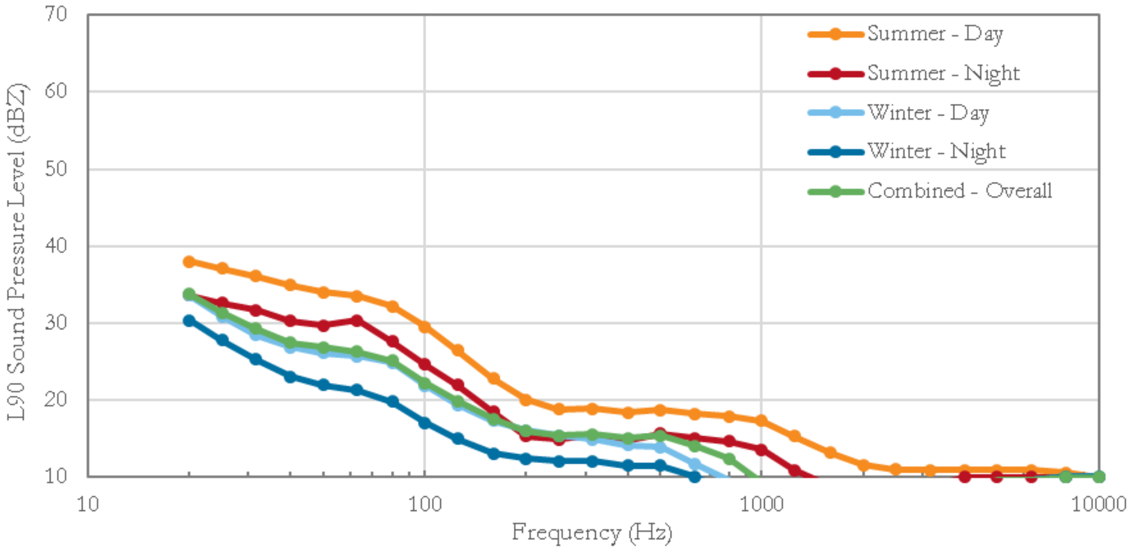

FIGURE 61: HENKLE HOLLOW 1/3 OCTAVE BAND LOWER 10TH PERCENTILE SOUND LEVELS (L_{90}) BY SEASON AND TIME OF DAY

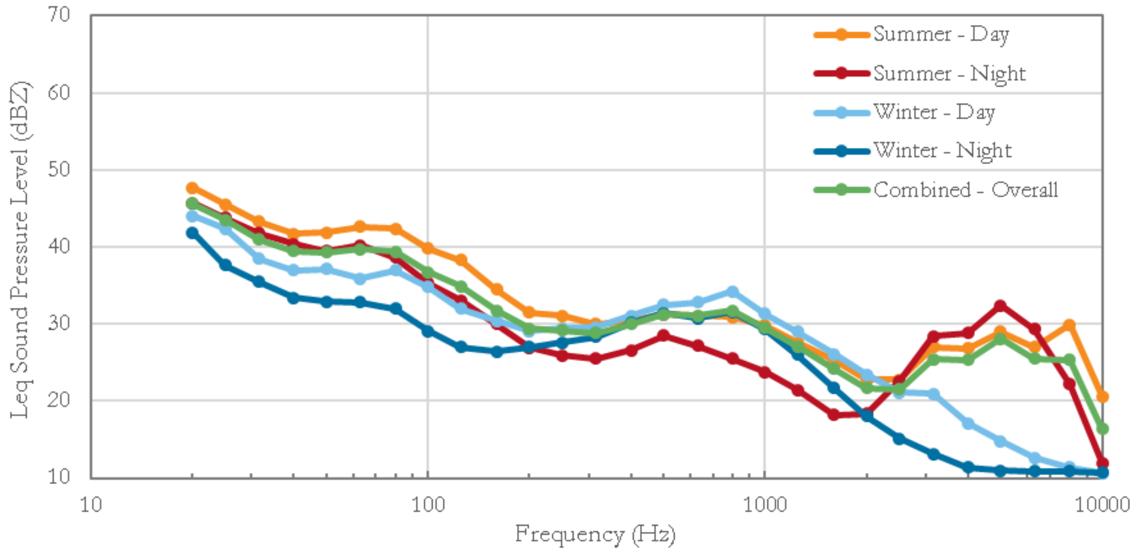

FIGURE 62: HENKLE HOLLOW 1/3 OCTAVE BAND EQUIVALENT AVERAGE SOUND LEVELS (L_{eq}) BY SEASON AND TIME OF DAY

6.6 | MONITOR 5: LOON LAKE

The Loon Lake monitor was located at 9487 SR-21 in Wayland, New York, near the intersection of SR-21 and Chapel Road. The monitor was placed in an isolated clump of cedar trees with a clear view of the surrounding valley, approximately 29 meters (131 feet) from SR-21 and 79 meters (259 feet) from Chapel Road. The only structure on this portion of the property was a lightly used tractor barn. The location of the site is displayed on the map in Figure 63. Figure 64 shows a photograph of the installation looking northeast toward the lake. The monitor installation for summer monitoring is shown in Figure 69.

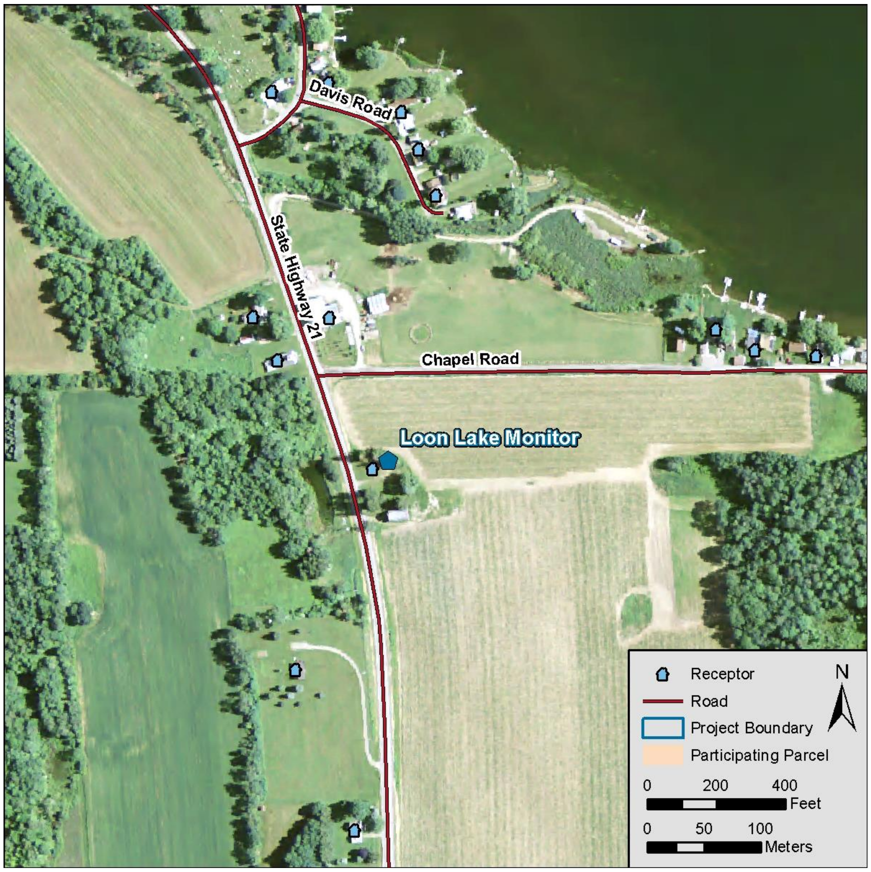

FIGURE 63: LOCATION OF THE LOON LAKE MONITOR

WINTER MONITORING

Both an anemometer and a temperature gauge were included in the installation. The long-term sound level results are plotted as time history graphs in Figure 65, Figure 66, and Figure 67. The largest contributors to sound levels were car, truck, and snowmobile pass bys, transient sound levels that contributed to the large difference between the L_{eq} and L_{90}. An active snowmobile trail approached the monitoring location from the southeast and crossed SR-21 about 100 meters (328 feet) south of the monitoring location. Several snowmobile pass bys were excluded from the data when they veered off the trail and passed close to the monitor. The data show a regular diurnal pattern, indicating the influence of human activity in the area.

The tonality chart in Figure 68 indicates a moderate source of tonality at 1.25 kHz, which is attributable to the nearby snowmobiles.

FIGURE 64: PHOTOGRAPH OF THE LOON LAKE MONITOR, LOOKING NORTH

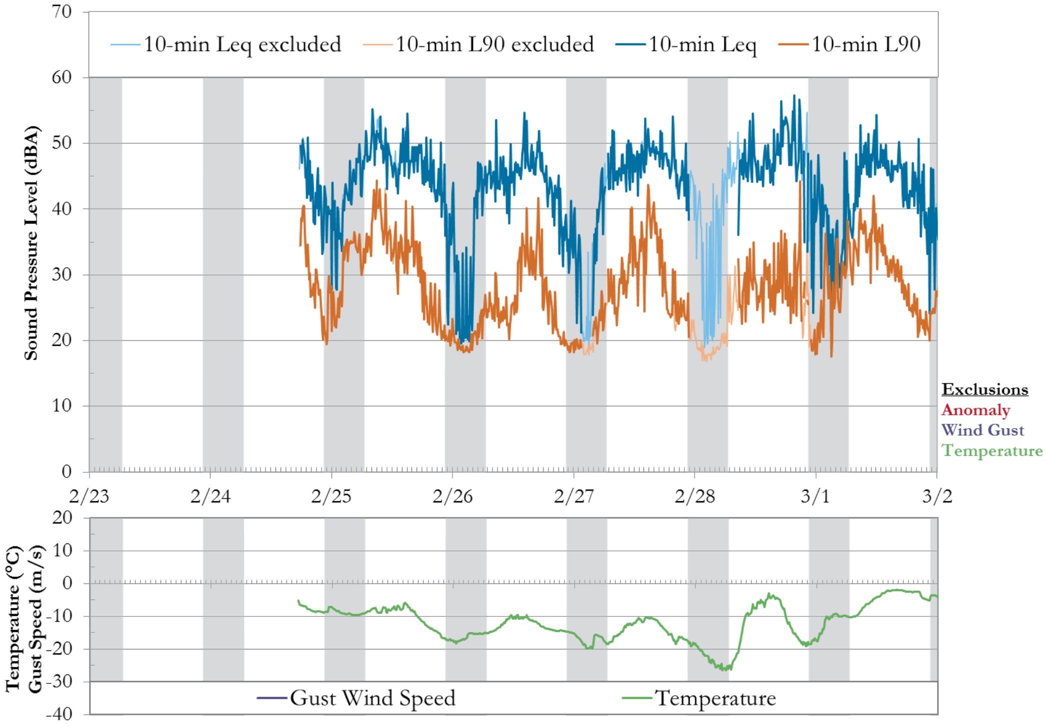

FIGURE 65: LOON LAKE MONITOR DATA, FEBRUARY 24 – MARCH 1, 2015

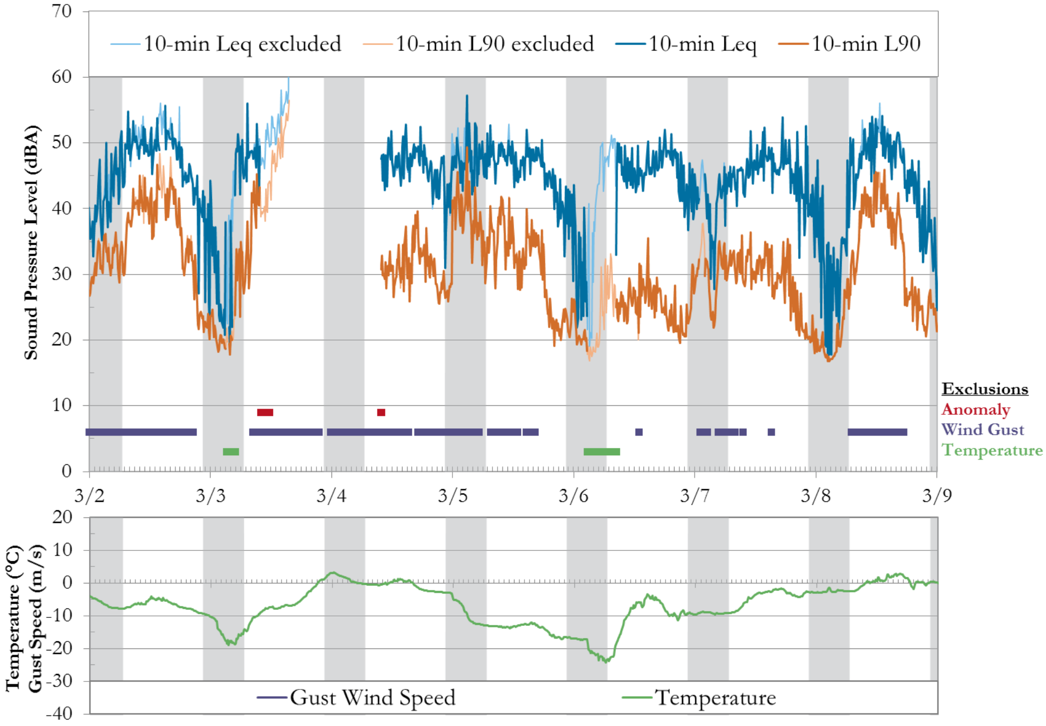

FIGURE 66: LOON LAKE MONITOR DATA, MARCH 1 – MARCH 8, 2015

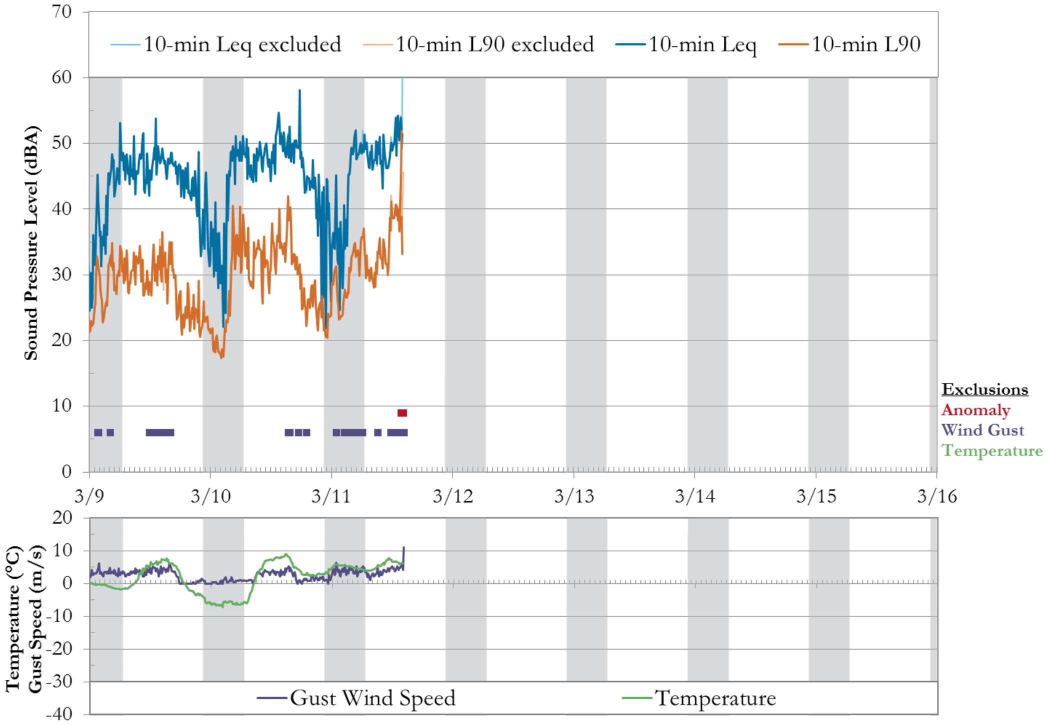

FIGURE 67: LOON LAKE MONITOR DATA, MARCH 8 – MARCH 11, 2015

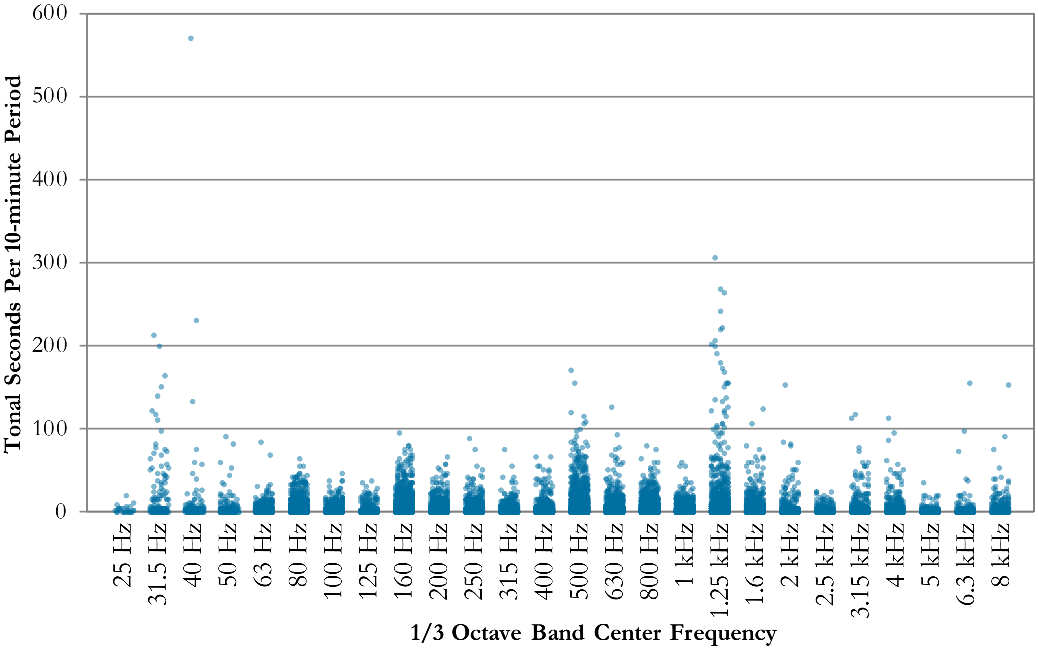

FIGURE 68: LOON LAKE WINTER MONITORING PERIOD – TONALITY

SUMMER MONITORING

Time history data from the summer monitoring period is presented in Figure 70, and Figure 71. Note that the power system for the equipment malfunctioned almost immediately after installation for the second week; sound level data was not acquired for the second half of summer monitoring at this site. The dominant sound source was traffic pass bys on Rt. 21. The increased traffic volumes during the day caused a diurnal pattern. Also, tractor operations in the nearby fields were audible at times and were excluded from the data since they were seasonal in nature. One instance of church bells was excluded from the data as intermittent noise because they were prominent for 30 minutes at the monitoring site; the church was about 120 meters (400 feet) from the monitor. Other events that were excluded from the data were a motorcycle idling nearby for over 10 minutes, thunder, and lawn equipment.

As indicated in Figure 72, steady tonal sources were minimal at this site.

Third octave band spectra by season and time of day are shown in Figure 73 for the L_{50}, Figure 74 for the L_{90}, and Figure 75 for the L_{eq}. Due to the high level of traffic audible at this site (as with the Haskinville site, this monitor is near State Route 21), there is an increase in daytime sound levels between about 400 Hz and 2 kHz for the L_{50} and L_{eq}. An interesting feature of this site is that there is minimal summertime biogenic sound in the higher frequencies, even in the L_{eq}. The midfrequency sound level increase for winter spectra, relative to summer spectra is smaller than at other sites. The low-frequency increase in sound levels, particularly evident during the summer and the L_{eq} spectra during the daytime is due to vehicle engine noise.

FIGURE 69: PHOTOGRAPH OF THE LOON LAKE SITE

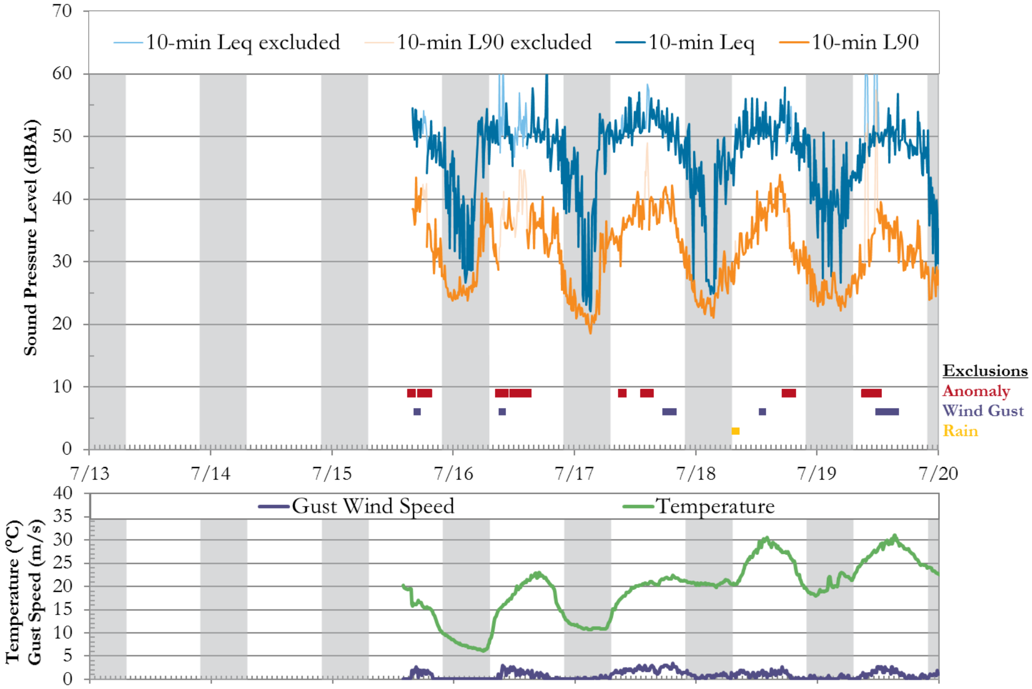

FIGURE 70: LOON LAKE MONITOR DATA, JULY 13 – 20, 2015

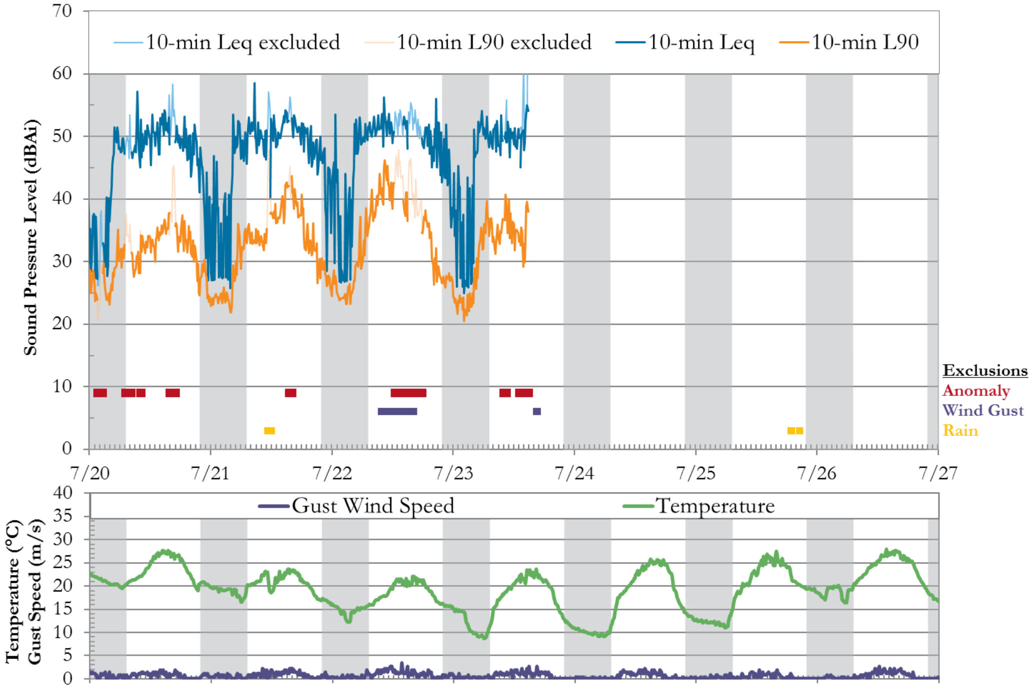

FIGURE 71: LOON LAKE MONITOR DATA, JULY 20 – 27, 2015

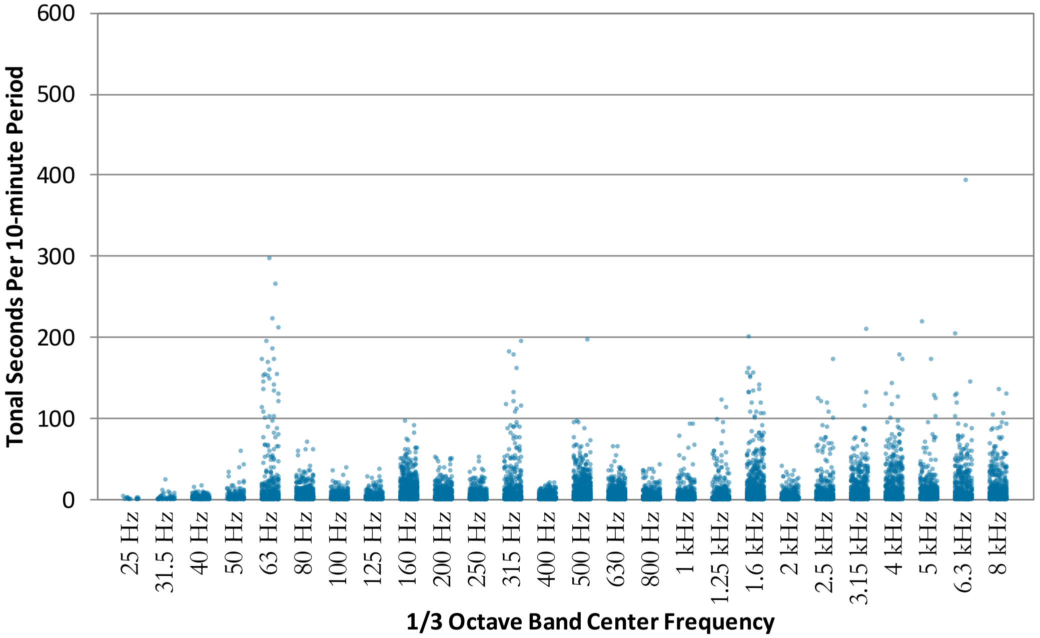

FIGURE 72: LOON LAKE SUMMER MONITORING PERIOD—TONALITY

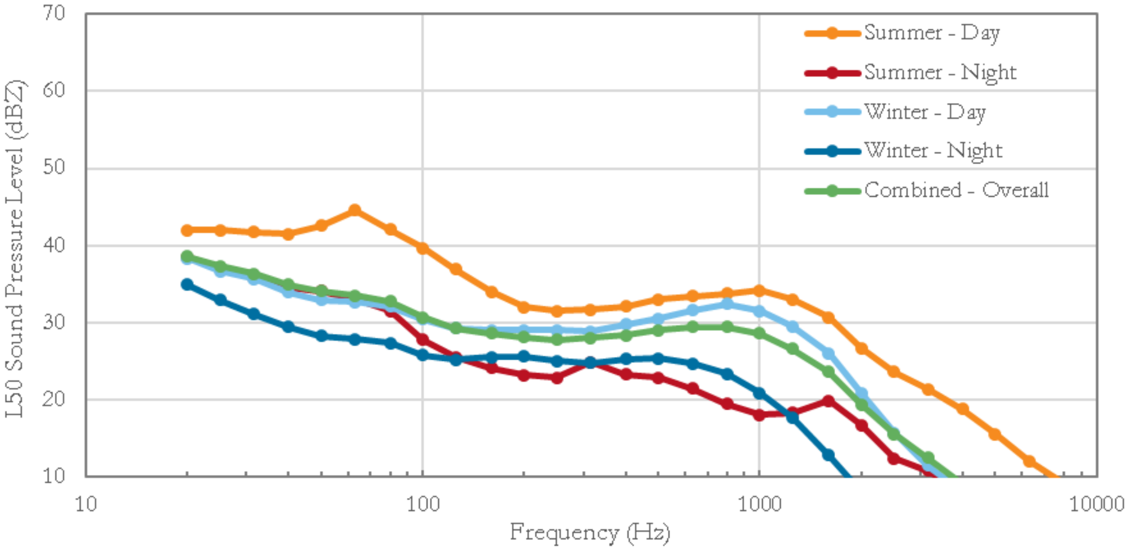

FIGURE 73: LOON LAKE 1/3 OCTAVE BAND MEDIAN SOUND LEVELS (L_{50}) BY SEASON AND TIME OF DAY

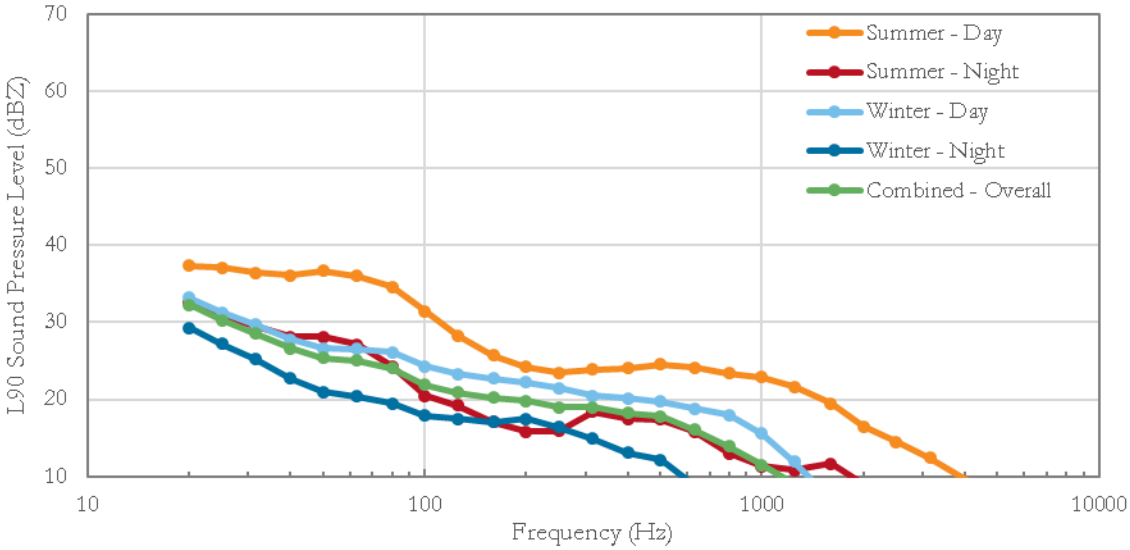

FIGURE 74: LOON LAKE 1/3 OCTAVE BAND LOWER 10TH PERCENTILE SOUND LEVELS (L_{90}) BY SEASON AND TIME OF DAY

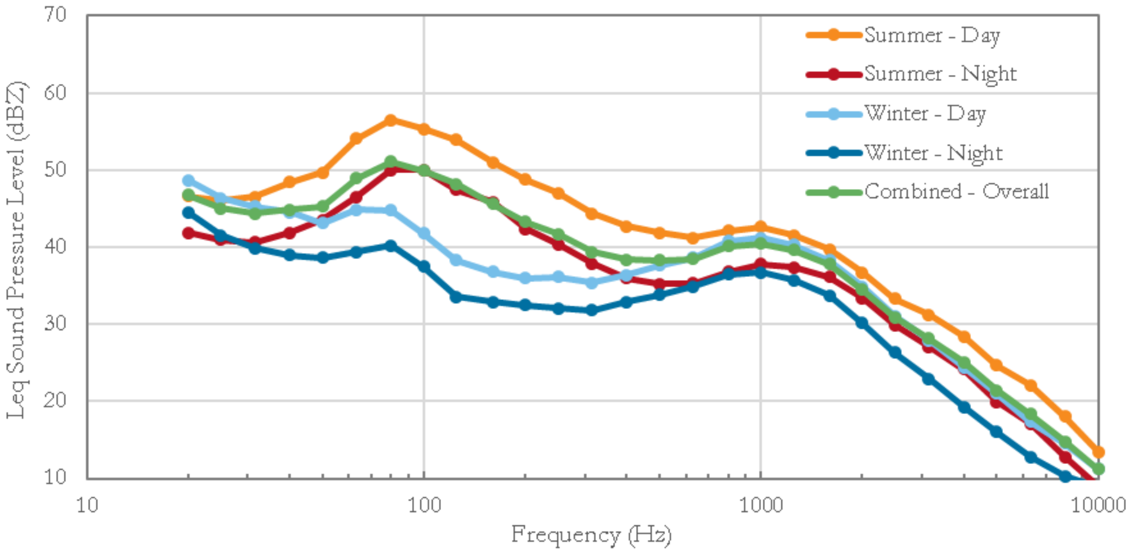

FIGURE 75: LOON LAKE 1/3 OCTAVE BAND EQUIVALENT AVERAGE SOUND LEVELS (L_{eq}) BY SEASON AND TIME OF DAY

6.7 | MONITOR 6: ROSE ROAD

The Rose Road monitor was located near 7731 Rose Road in Hornell, New York. The monitor was placed in the woods approximately 170 meters (558 feet) across a cornfield from Rose Road and 82 meters (266 feet) uphill through the woods from Tuttle Road. The site is located on the map in Figure 76. Figure 77 shows a photograph of the installation looking toward the southeast and the summer monitoring site is pictured in Figure 82.

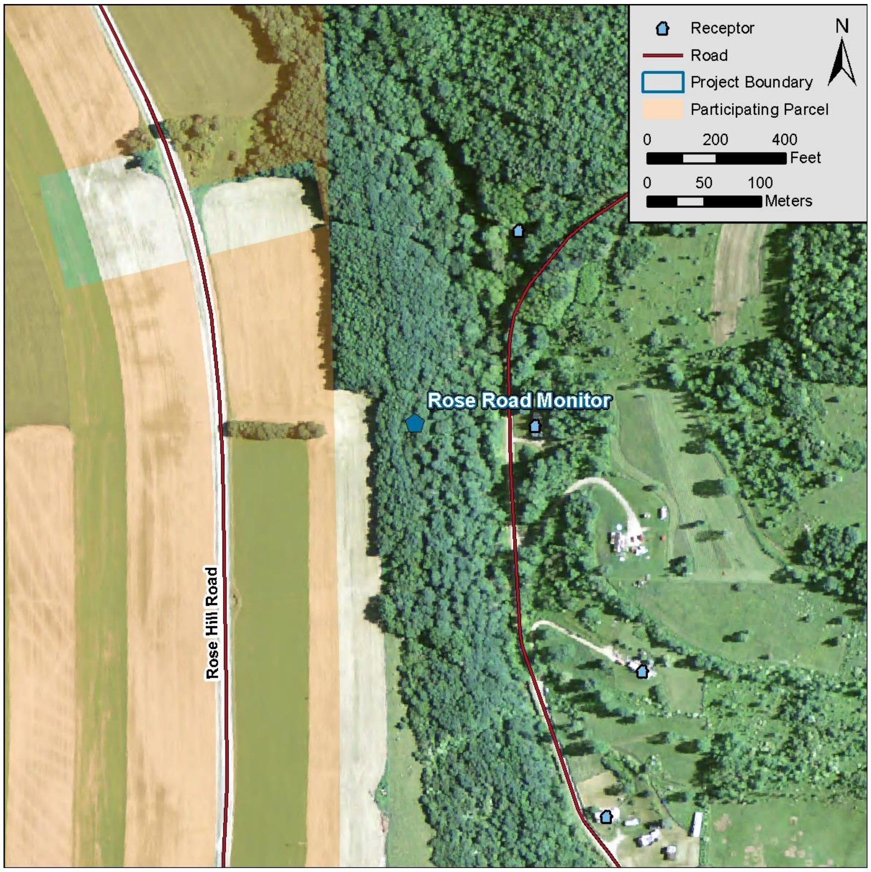

FIGURE 76: LOCATION OF THE ROSE ROAD MONITOR

WINTER MONITORING

The long-term sound level results are plotted as time history graphs in Figure 78, Figure 79, and Figure 80. As there was no activity in the cornfield during the winter season, most of the sound measured at the monitor came from residential sites on Tuttle Road below. The residences below contributed sound in the form of engines, residential construction activities, and a chainsaw. One chainsaw event was excluded from statistical averaging of the data. Other sources of sound at the site were distant snowmobiles, trucks on the interstate, airplane overflights, wind through the trees, and birdsongs. Sound levels at the site were diurnal, as human activities contributed to the daytime levels.

Tonality incidence at this site, shown in Figure 81 is minimal. Higher tonality in the 1.25 kHz 1/3 octave band is due to birds and vehicle backup alarms.

FIGURE 77: PHOTOGRAPH OF THE ROSE ROAD MONITOR

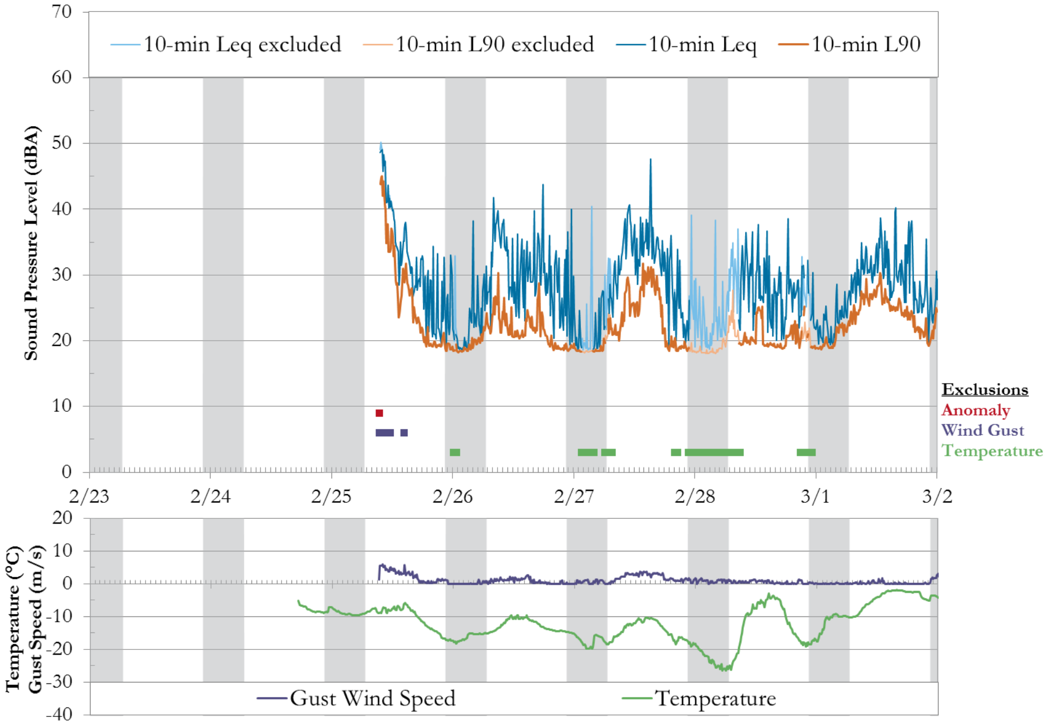

FIGURE 78: ROSE ROAD MONITOR DATA, FEBRUARY 25 – MARCH 1, 2015

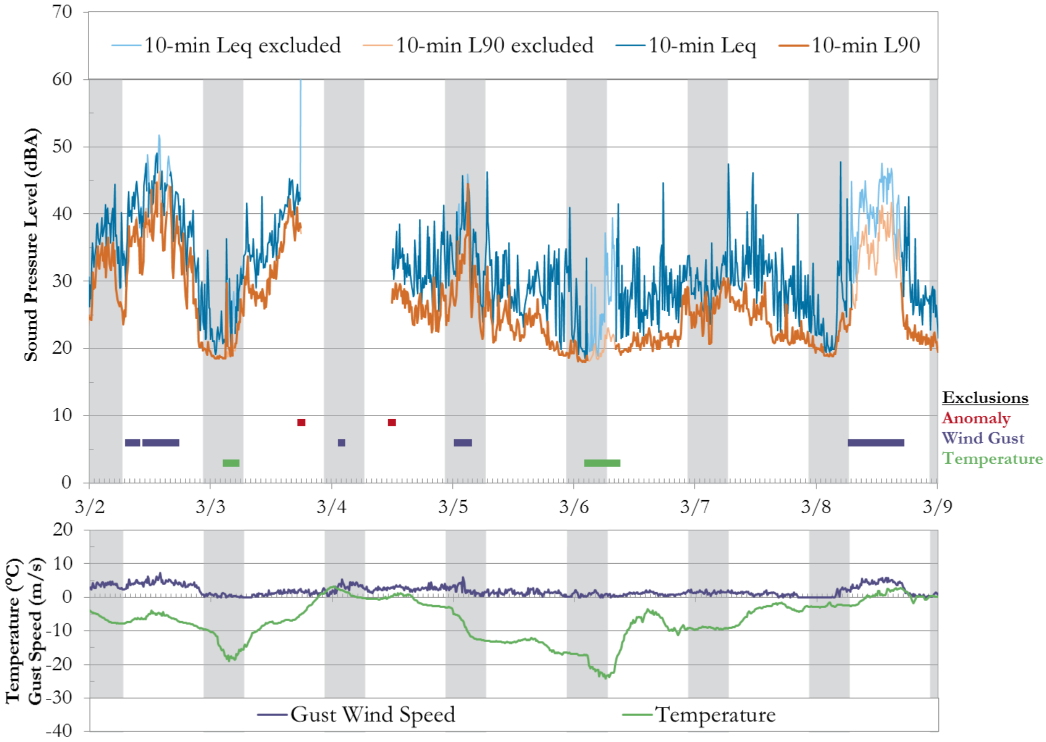

FIGURE 79: ROSE ROAD MONITOR DATA, MARCH 1 – MARCH 8, 2015

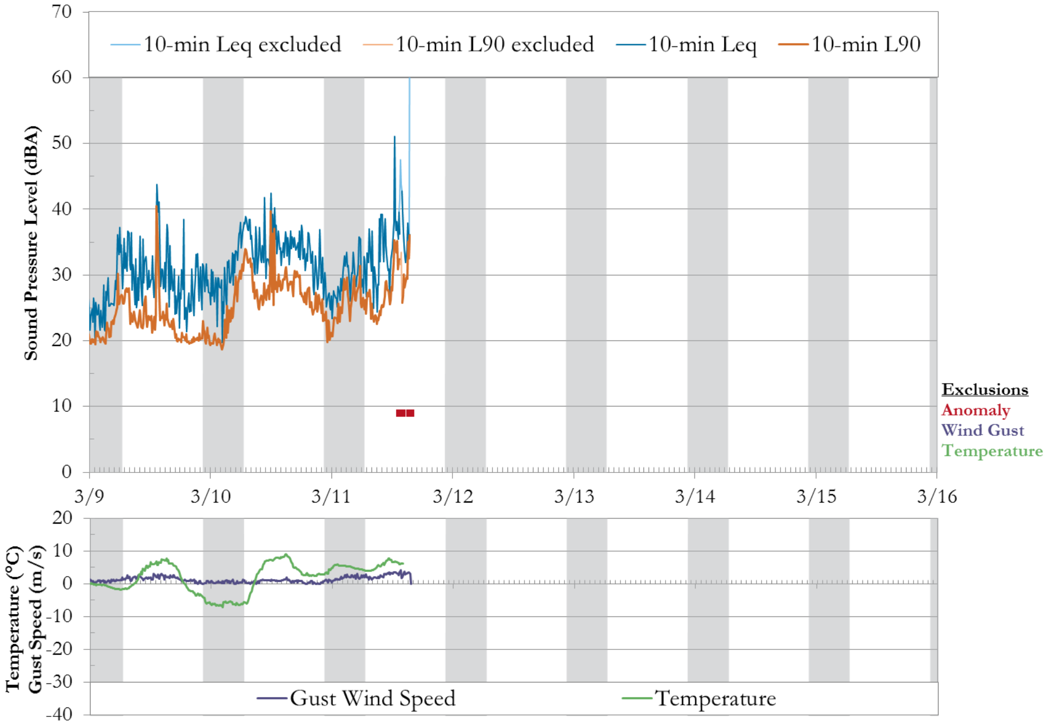

FIGURE 80: ROSE ROAD MONITOR DATA, MARCH 8 – MARCH 11, 2015

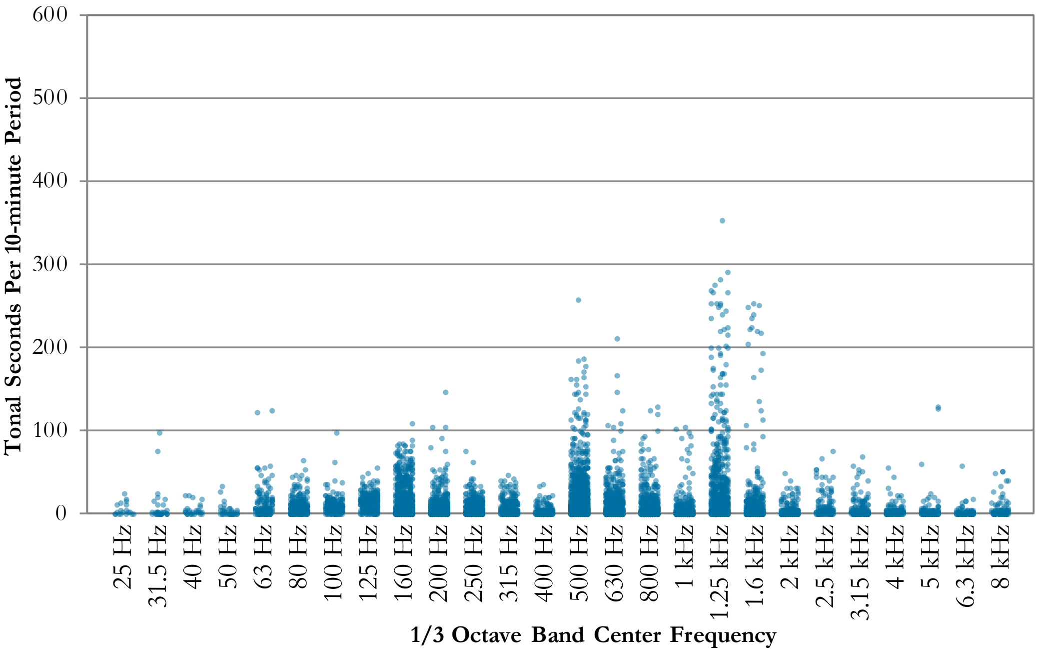

FIGURE 81: ROSE ROAD WINTER MONITORING PERIOD – TONALITY

SUMMER MONITORING

Time history plots from the summer monitoring period are presented in Figure 83, Figure 84, and Figure 85. Although wind speeds measured at the monitor location were low, wind-caused sound from leaf rustle was a prominent source at the monitor. Overall, sound levels at the site loosely adhered to a diurnal pattern but was a bit more crepuscular in nature, with activities starting before dusk and ending after sunset. Operations from the dairy barn were audible at the monitor, including daily tractor work and milk pumps. These events were likewise observed in the winter monitor data, although at lower levels due to the attenuation caused by snow cover on the ground. These operations were retained in the data. The cornfield directly to the west was planted with corn but no field operations took place during the monitoring period. Activities from residents down the hill on Tuttle Road were prominent at the monitor. Loud motorcycle pass bys on Tuttle Road were common. A resident down the hill worked on motorcycles during the day and throughout the night. These activities were retained in the data as being "characteristic of the area."

Tonality for the period, summarized in Figure 86, shows a variety of anthropogenic sources at 500 Hz and below, as well as biogenic sources above 1 kHz (birds and insects). Human generated sound was mostly engine related.

Third octave band spectra are shown in Figure 87 for the $L_{50,}$ Figure 88 for the L_{90}, and Figure 89 for the L_{eq}. As at other sites during the winter, there is a midfrequency hump that is not present during the summer. In the summer, higher frequency sound levels are higher, caused by increases in biogenic sound, as is particularly evident in the L_{eq}. The L_{eq} also shows elevated low-frequency sound levels, particularly during the summer, due to the engine notes from passing vehicles.

FIGURE 82: PHOTOGRAPH OF THE ROSE ROAD SITE

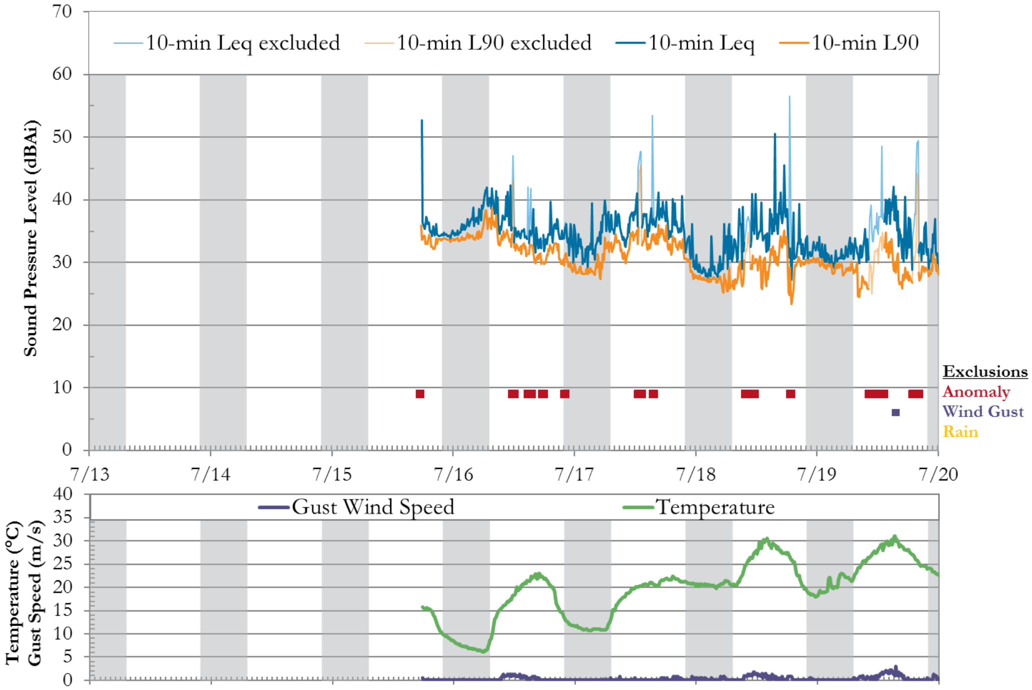

FIGURE 83: ROSE ROAD MONITOR DATA, JULY 13 – 20, 2015

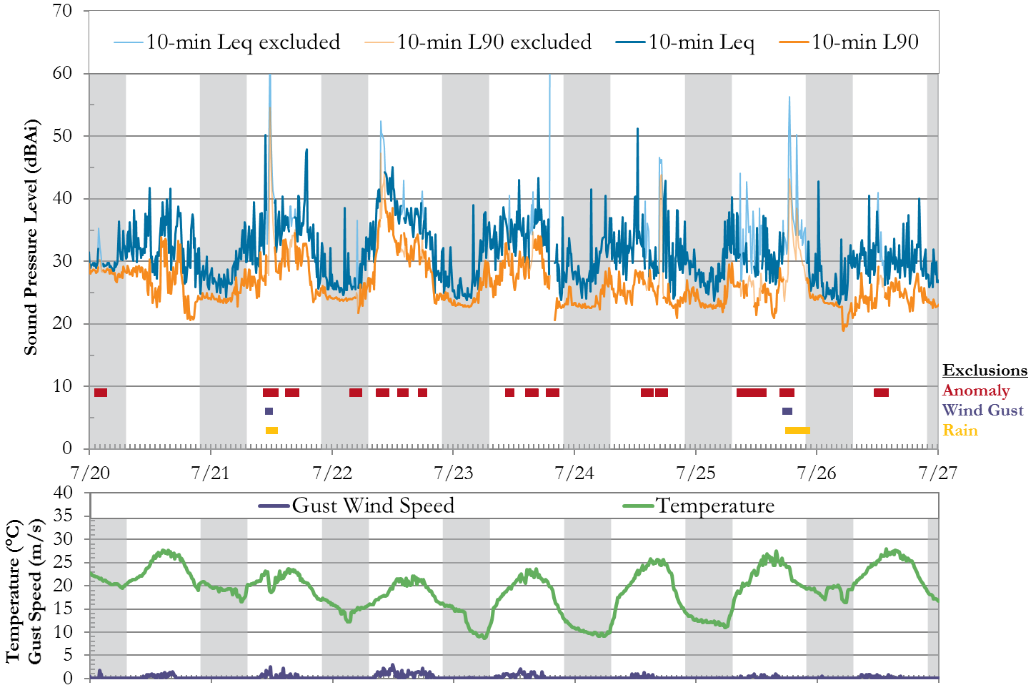

FIGURE 84: ROSE ROAD MONITOR DATA, JULY 20 – 27, 2015

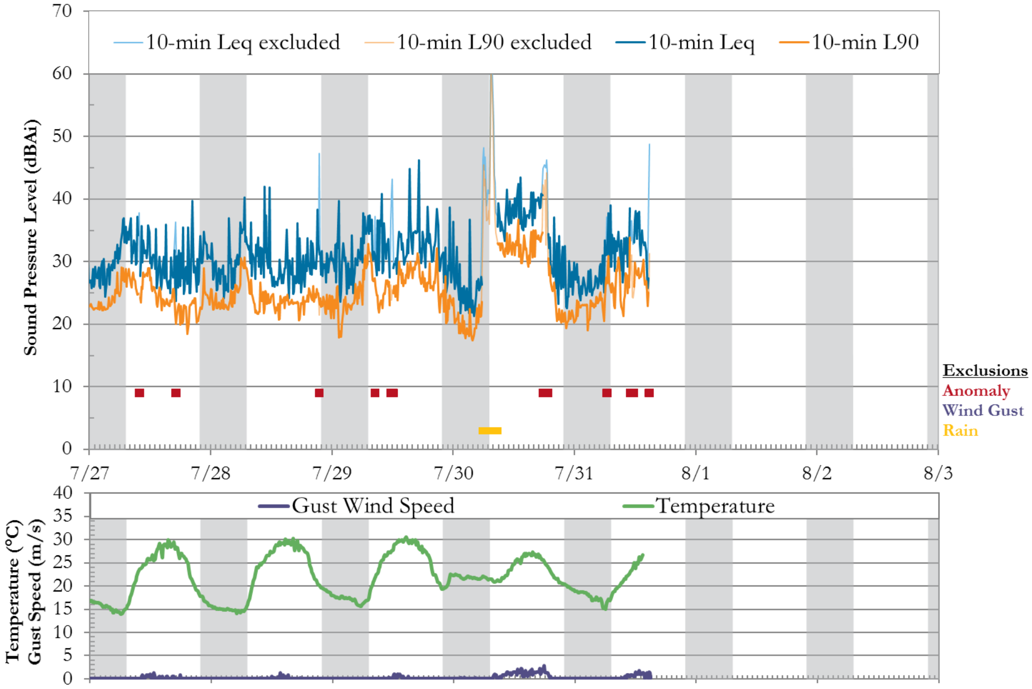

FIGURE 85: ROSE ROAD MONITOR DATA, JULY 27 – AUGUST 3, 2015

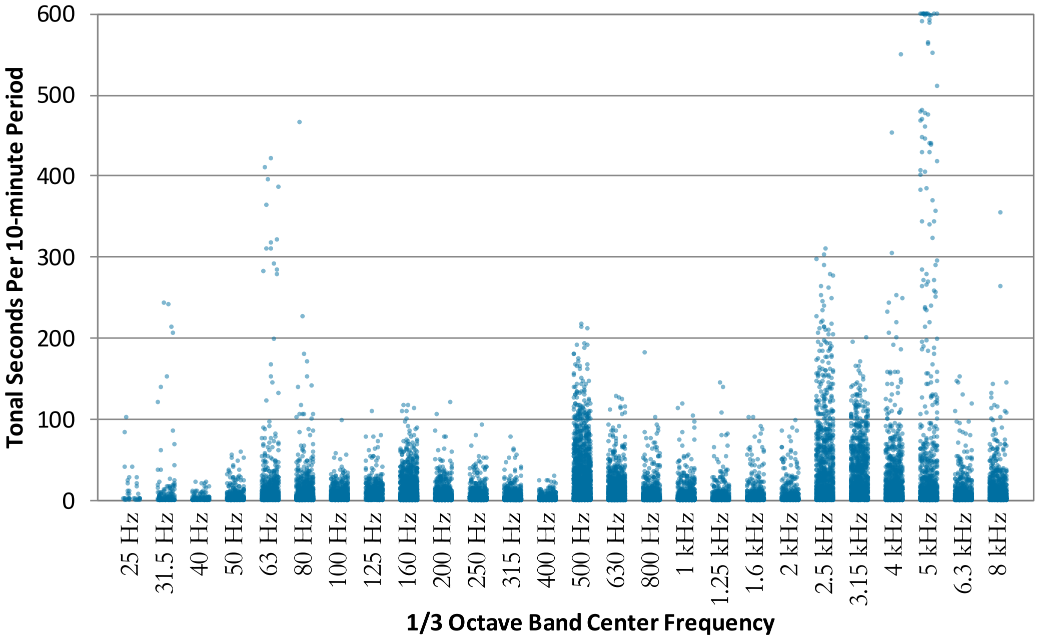

FIGURE 86: ROSE ROAD SUMMER MONITORING PERIOD – TONALITY

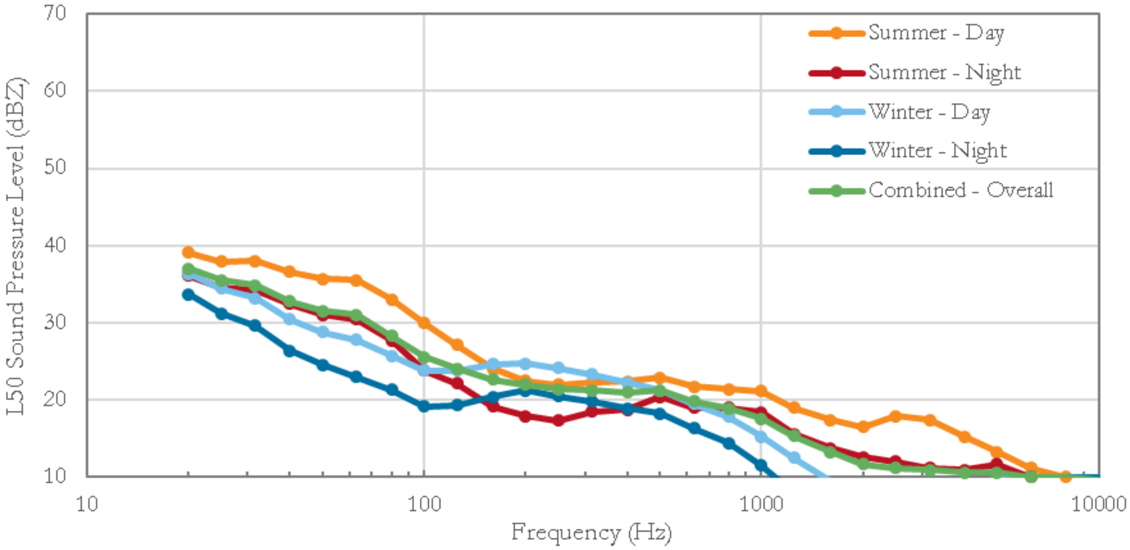

FIGURE 87: ROSE ROAD 1/3 OCTAVE BAND MEDIAN SOUND LEVELS (L_{50}) BY SEASON AND TIME OF DAYFIGURE 88

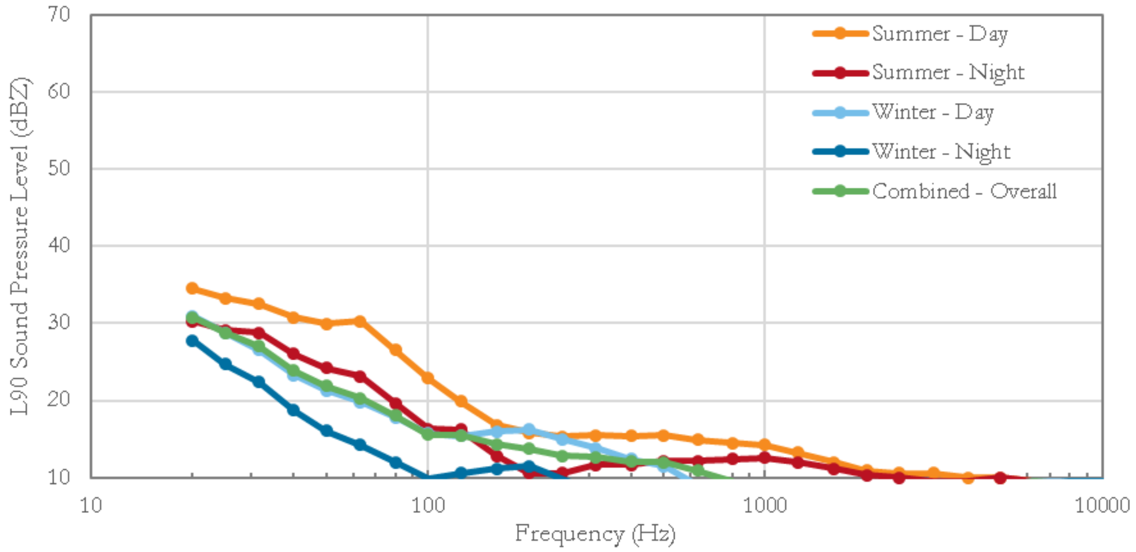

FIGURE 88: ROSE ROAD 1/3 OCTAVE BAND LOWER 10TH PERCENTILE SOUND LEVELS (L_{90}) BY SEASON AND TIME OF DAY

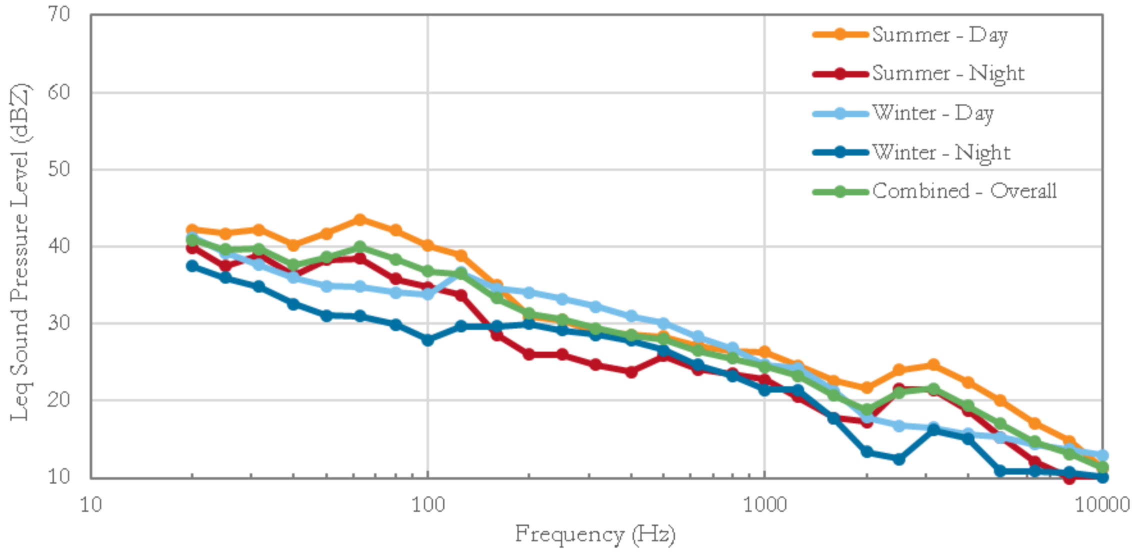

FIGURE 89: ROSE ROAD 1/3 OCTAVE BAND EQUIVALENT AVERAGE SOUND LEVELS (L_{eq}) BY SEASON AND TIME OF DAY

6.8 | MONITOR 7: WALTER KURTZ ROAD

The "Walter Kurtz Road Monitor" monitor was located near 2287 Walter Kurtz Road. The installation was well into the woods, approximately 100 meters (328 feet) from a seasonal road. The site is shown in Figure 90. Figure 91 shows a photograph of the winter installation looking toward the southwest and Figure 96 shows the same view of the summer monitor.

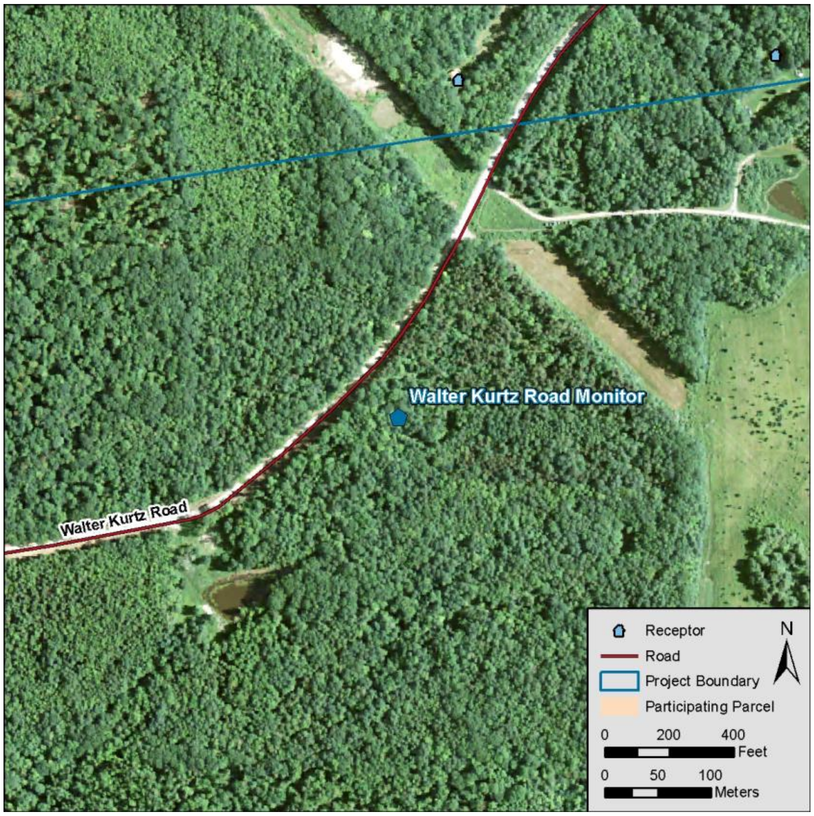

FIGURE 90: LOCATION OF THE WALTER KURTZ ROAD MONITOR

WINTER MONITORING

The long-term sound level results are plotted as time history graphs in Figure 92, Figure 93, and Figure 94. As this portion of Walter Kurtz Road is seasonal (it is not plowed), there was little traffic-related noise at the site. However, there sound from snowmobile traffic on the road appeared several times in the data. Other than the infrequent snowmobiles, the dominant sounds at the site were wind blowing through the trees, birdsong, and aircraft flyovers. Sound levels were seen to increase slightly at dawn and dusk with bird activity. On one occasion, a raven landed close to the monitor and called for several minutes. Due to the uncharacteristically high sound levels this created, this period was excluded from the calculated statistical levels. The Walter Kurtz Road site was the quietest site monitored, with equal daytime and nighttime levels, a result of separation from human activity.

Figure 95 shows tonality incidence at the site. There were no consistent sources of tonal sound.

FIGURE 91: PHOTOGRAPH OF THE WALTER KURTZ ROAD MONITOR, LOOKING SOUTHEAST

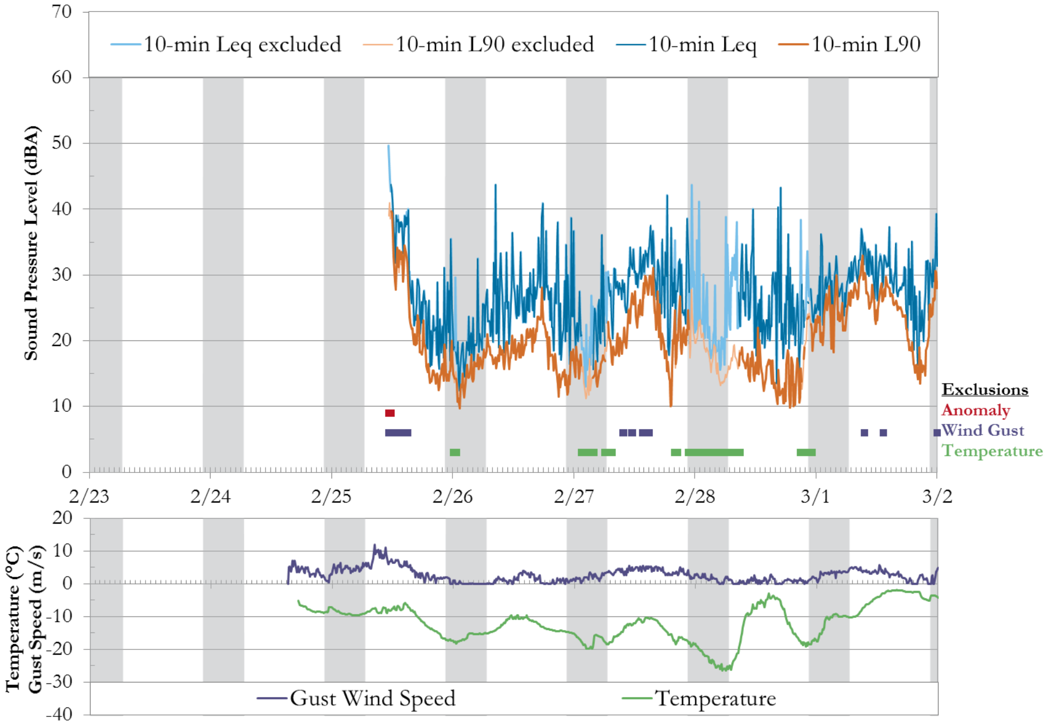

FIGURE 92: WALTER KURTZ ROAD MONITOR DATA, FEBRUARY 25 – MARCH 1, 2015

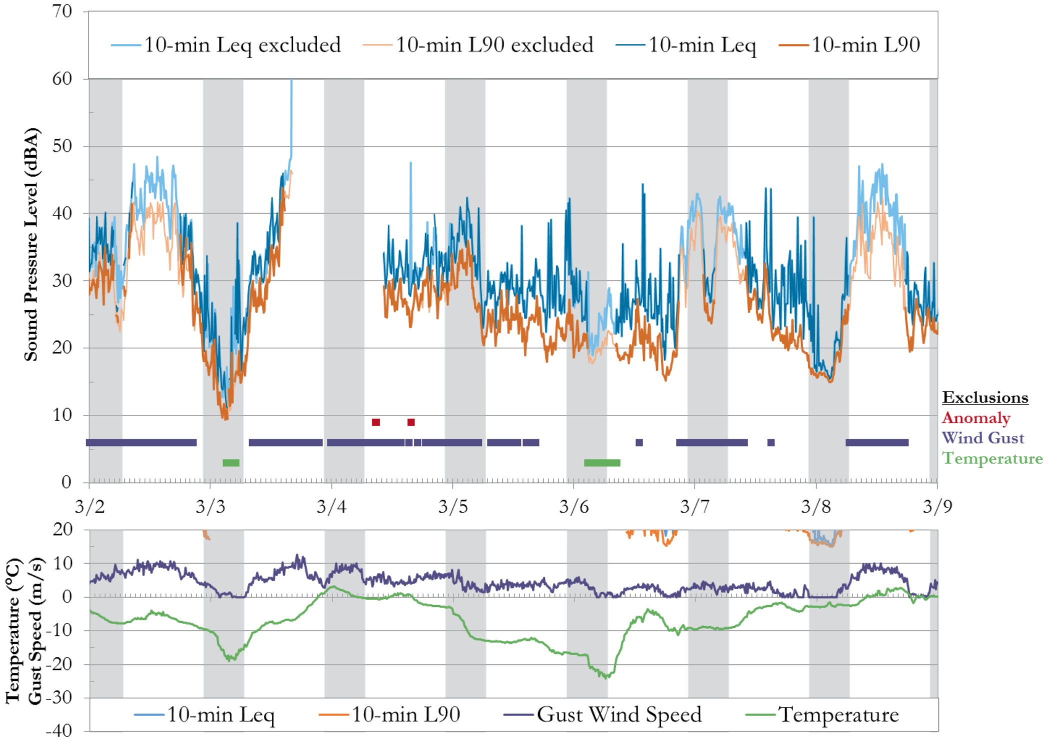

FIGURE 93: WALTER KURTZ ROAD MONITOR DATA, MARCH 1 – MARCH 8, 2015

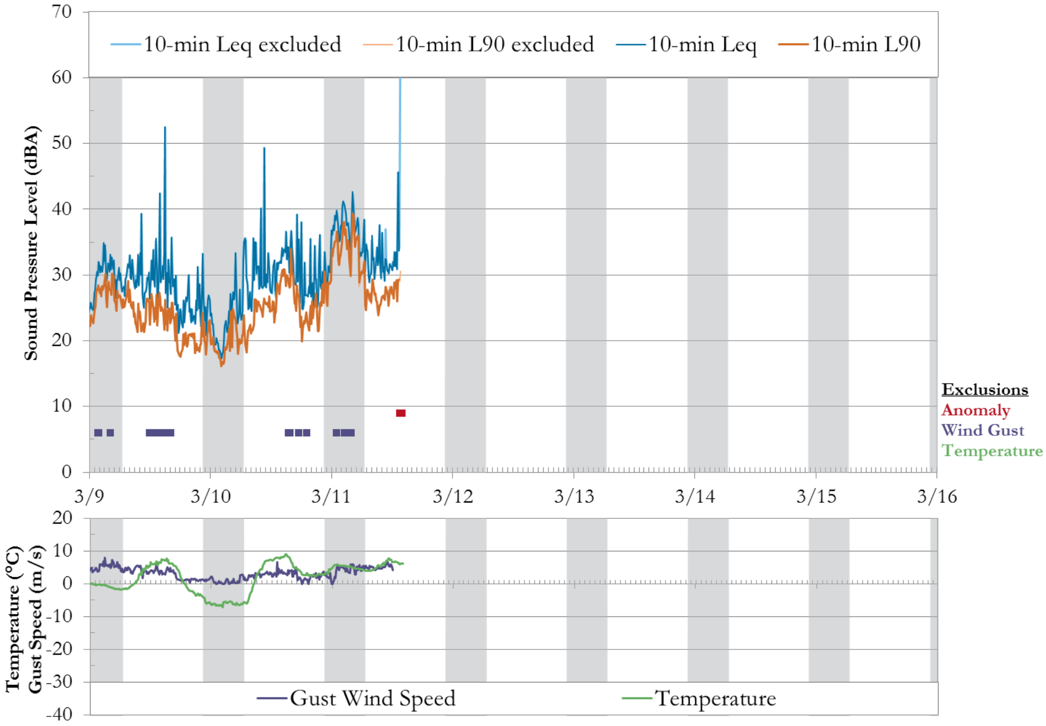

FIGURE 94: WALTER KURTZ ROAD MONITOR DATA, MARCH 8 – MARCH 11, 2015

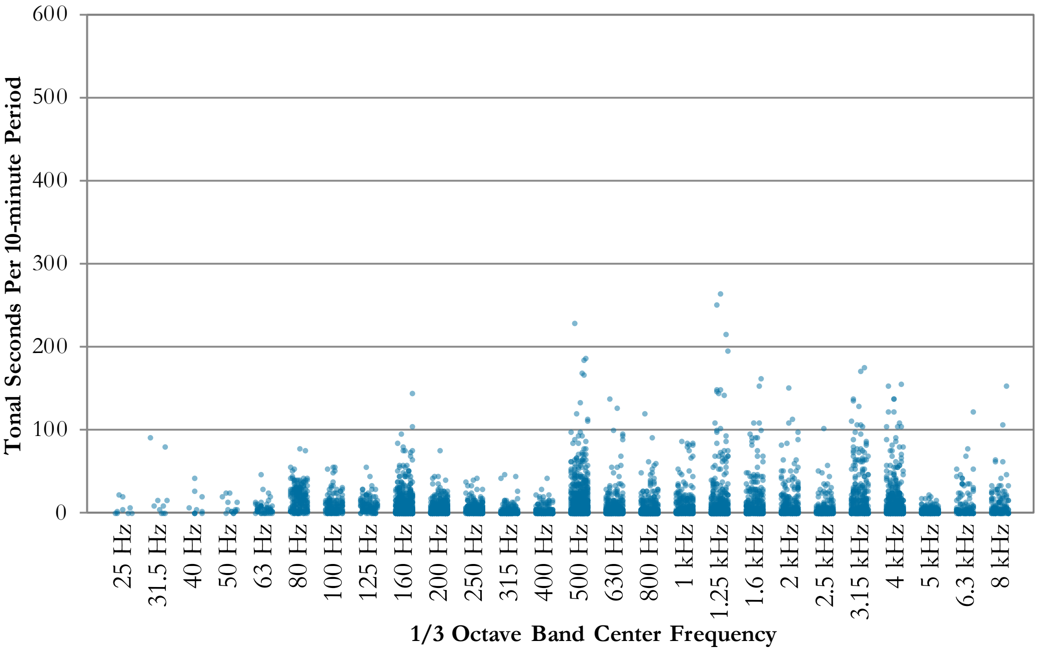

FIGURE 95: WALTER KURTZ ROAD WINTER MONITORING PERIOD – TONALITY

SUMMER MONITORING

The time history plots for this monitoring period are shown in Figure 97, Figure 98, and Figure 99. The seasonal road was well travelled in the summer, mostly by larger vehicles, such as work trucks and hauling trucks. Motorcycle and ATV pass bys were also common. These pass bys were retained in the data, but any work that occurred near the monitor, such as utility operations or logging activities, were excluded. Wind blowing through the leaves in the trees remained the dominant source of sound at this monitor and aircraft overflights were consistent throughout the monitoring period.

The majority of tonal activity at this site was from biogenic sources such as birds and insects, as is shown in the 2.5 kHz to 8 kHz 1/3 octave bands in in Figure 100.

Spectral sound levels, by season and time of day are shown Figure 101 for the L_{50}, Figure 102 for the L_{90}, and Figure 103 for the L_{eq}. Similar to other sites there is increased high-frequency biogenic sound during the summer particularly evident in the L_{eq}, and a midfrequency sound level increase during the winter that is particularly evident in the L_{50}. Also at this site, the difference between the daytime and nighttime low-frequency spectra is greater during the summer than during the winter. This may be due to vehicle traffic on the seasonal road.

FIGURE 96: PHOTOGRAPH OF THE WALTER KURTZ ROAD SITE, LOOKING SOUTHEAST

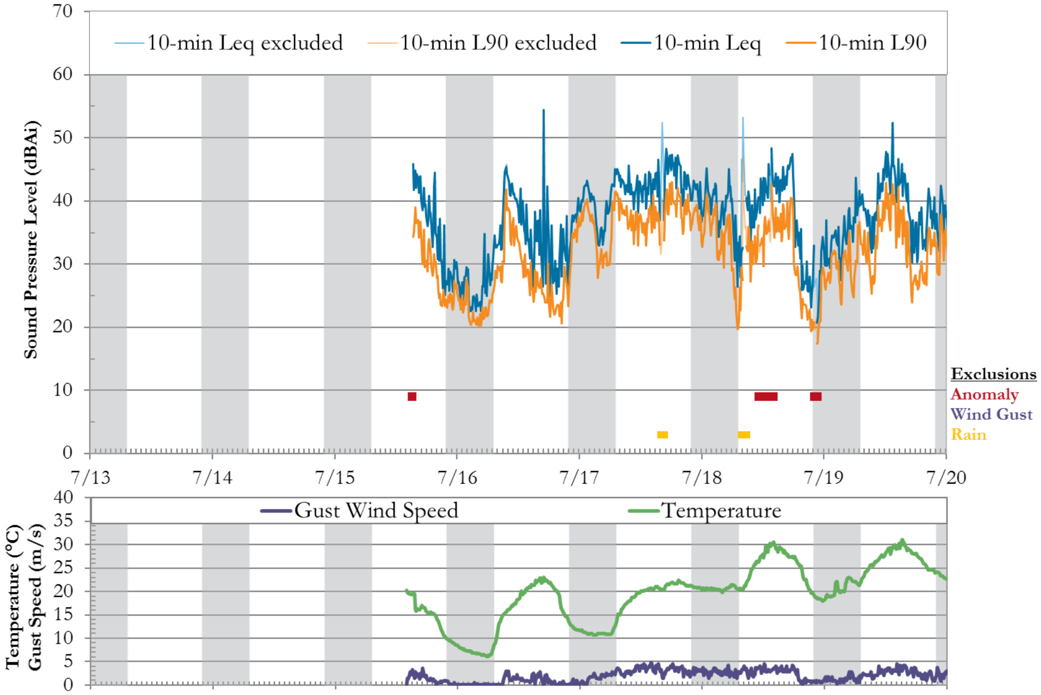

FIGURE 97: WALTER KURTZ ROAD MONITOR DATA, JULY 13 – 20, 2015

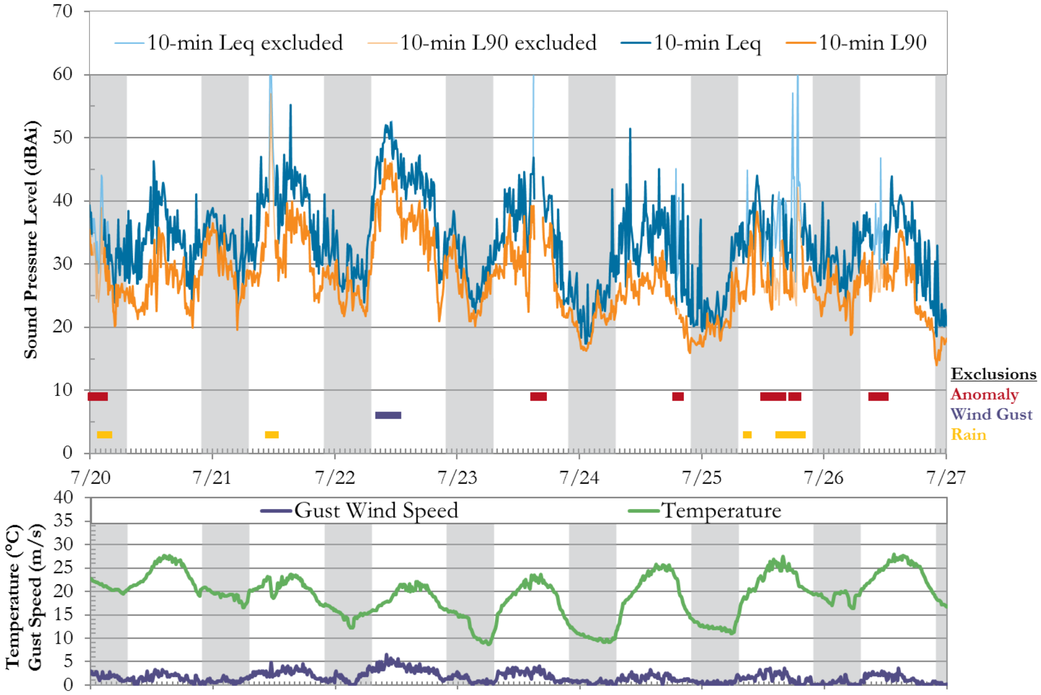

FIGURE 98: WALTER KURTZ ROAD MONITOR DATA, JULY 20 – 27, 2015

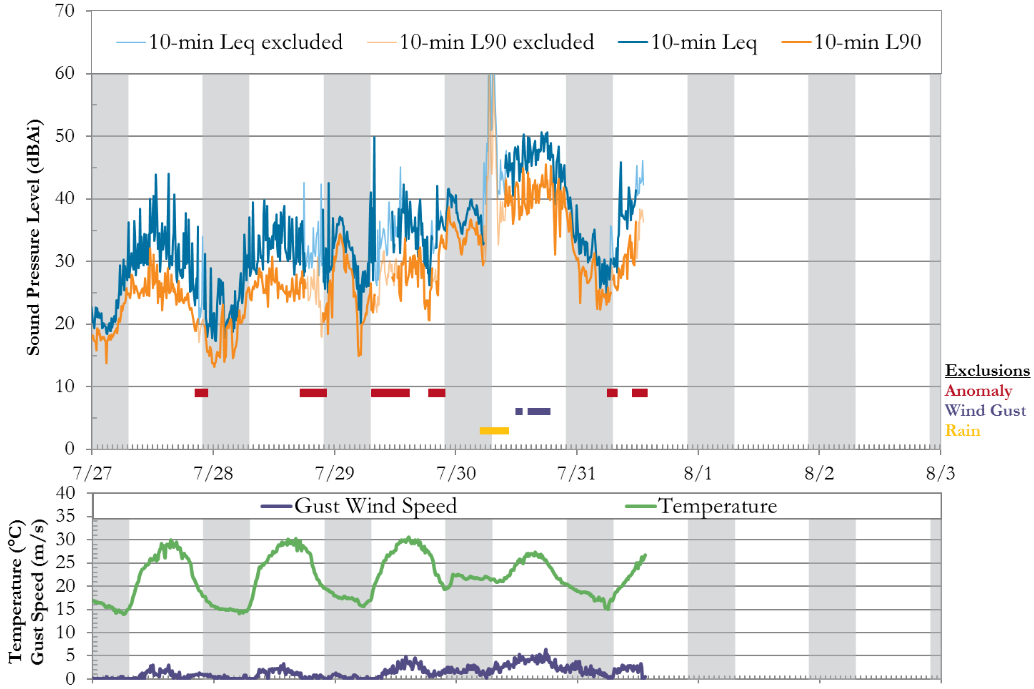

FIGURE 99: WALTER KURTZ ROAD MONITOR DATA, JULY 27 – AUGUST 3, 2015

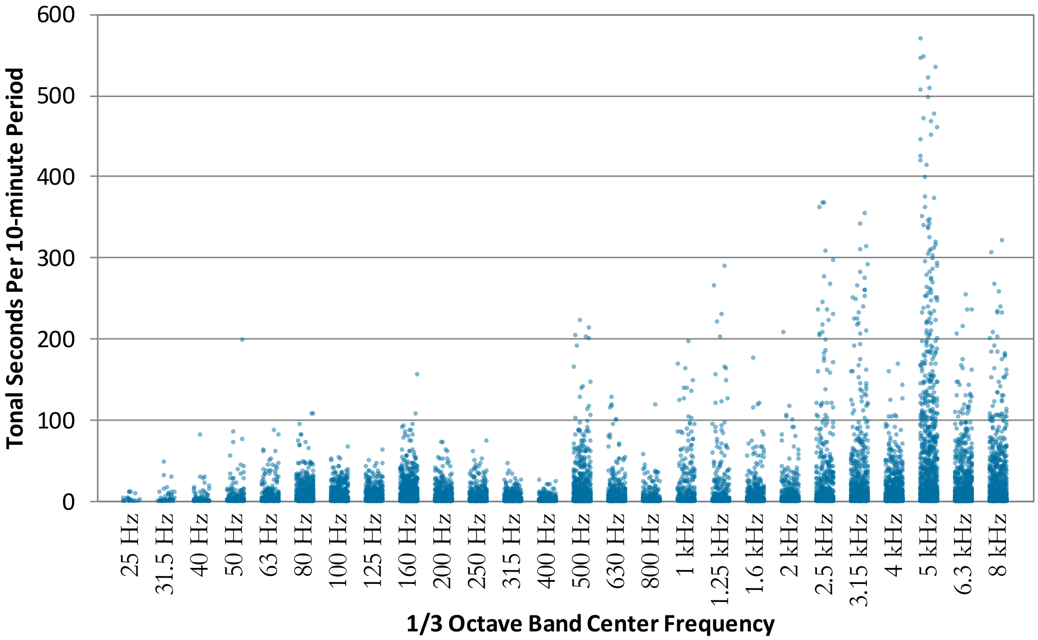

FIGURE 100: WALTER KURTZ ROAD SUMMER MONITORING PERIOD – TONALITY

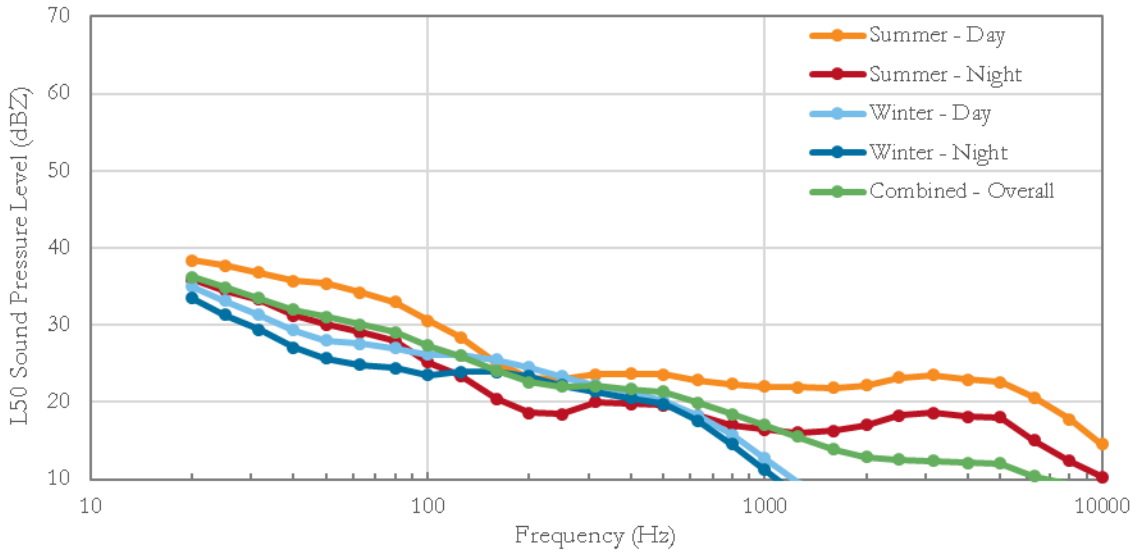

FIGURE 101: WALTER KURTZ ROAD 1/3 OCTAVE BAND MEDIAN SOUND LEVELS (L_{50}) BY SEASON AND TIME OF DAY

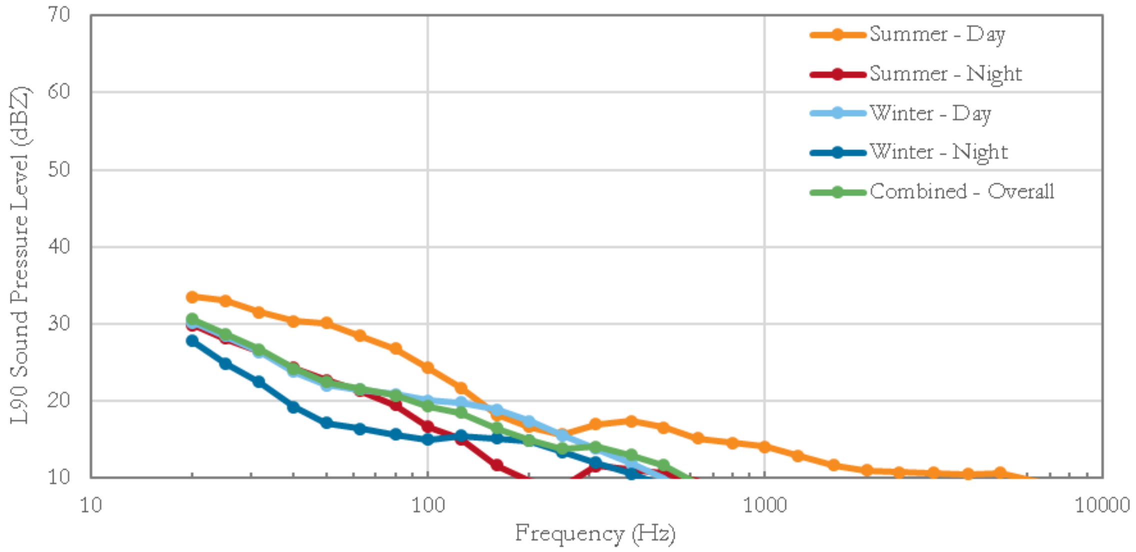

FIGURE 102: WALTER KURTZ ROAD 1/3 OCTAVE BAND LOWER 10TH PERCENTILE SOUND LEVELS (L_{90}) BY SEASON AND TIME OF DAY

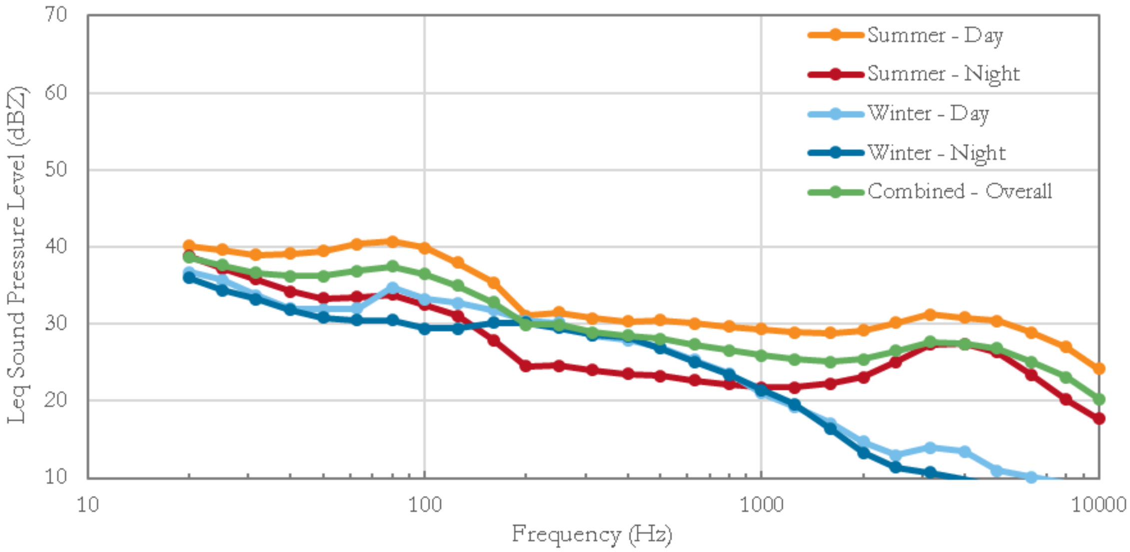

FIGURE 103: WALTER KURTZ ROAD 1/3 OCTAVE BAND EQUIVALENT AVERAGE SOUND LEVEL (L_{eq}) BY SEASON AND TIME OF DAY

7.0 MONITORING RESULTS (ARTICLE 10/STIPULATION 19[B])

7.1 | SOUND PRESSURE LEVELS

The sound levels over the entire monitoring period are summarized for all seven sites for the winter, summer, and combined monitoring periods in Table 11, showing ANS-weighted results and Table 12, showing A-weighted results. Results described in the paragraphs below only concern the ANS-weighted results.

During the winter, the equivalent continuous levels (L_{eq}) at night are less than daytime levels at six of the seven sites, which is typical. At the exception, the Dye/Rex Road monitor, the daytime and nighttime levels are similar, due to the lack of anthropogenic sounds. Where there is a larger difference between the L_{eq} and L_{90}, the soundscape is likely to include transient or intermittent sounds, such as aircraft overflights or passing automobiles, that weight the L_{eq}. This occurred at most of the sites. The winter nighttime equivalent continuous level (L_{eq}) averaged over all seven sites is 39 dBA.

During the summer, sound levels are typically higher than the winter. This is primarily caused by addition of foliage in the summer, along with water flow, and yard/farm equipment. The main exception is Rose Road, where anthropogenic sound sources were decreased during the summer, leading to lower overall sound levels. The Brasted Road monitoring location has higher sound levels during the winter at night, due to equipment operation at the nearby dairy operation. During the summer, there is a relatively wide spread between the L_{90} and L_{10} sound levels at all locations, indicating dominance by transient and intermittent sounds. Whether this difference increased or decreased from summer to winter, depends on the location. The summer nighttime L_{eq} over all seven sites was 39 dBA. Recall that the tonal sound from insects, birds, and other biogenic sounds were removed from these data through ANS weighting, so these sources do not substantively contribute to the summer/winter difference.

Overall, most sites exhibit highly variable sound levels, with intermittent sounds dominating the L_{eq}. No cases exist where there is a single, constant source dominating the soundscape. The overall nighttime L_{eq} was 39 dBA averaged over all seven sites.

7.2 | METEOROLOGY

Temperatures during the winter monitoring period ranged from a low of -28° C (-17° F) to a high of 9° C (49° F). During the summer monitoring period temperatures ranged from a low of 6° C (42° F) to a high of 34° C (94° F). Winds varied widely among the four ground anemometer sites and throughout the monitoring periods, ranging from calm to a maximum 1-minute average of 9 m/s (20 mph) at Henkle Hollow during the winter. This site also recorded the strongest winter gust at 13 m/s (28 mph). The summer was overall less windy, with a maximum 1-minute average wind speed of 4 m/s (8 mph) at Henkle Hollow and the maximum wind gust speed of 8 m/s (19 mph) at Rose Road. Maximum measured wind and gust speeds from all sites are shown in Table 13 and Table 14. The Henkle Hollow site was in an exposed location along the slope of a hill, while Loon Lake in an open, flat valley without much cover provided by the forest or geographical features. The Haskinville Road and Rose Road sites were both in areas that were more protected from the wind by surrounding structures, trees, and topography. The Walter Kurtz Road site was on higher ground, but in a more heavily forested area.

Precipitation in the form of snow fell during the monitoring period on February 26 and 27, 2015, as well as March 1, 2, 3, 5, 7, and 8, 2015. None of the precipitation events were significant; this minimal amount of snowfall did not affect the measurements or the data. During the summer, rain fell on July 15, 18, 21, 25, and 30. Data during these periods were removed.

TABLE 11: PRECONSTRUCTION MONITORING SUMMARY – "SMART" ANS-WEIGHTED

Winter	Location	Sound Level (dBA)											
		Overall				Day				Night			
		Leq	L90	L50	L10	Leq	L90	L50	L10	Leq	L90	L50	L10
	Brasted Road	44	19	29	41	45	22	31	42	44	17	26	39
	Loon Lake	47	24	36	50	48	27	39	52	43	21	31	46
	Dye/Rex Road	35	19	27	36	35	20	27	35	35	17	25	38
	Haskinville Road	39	22	33	43	40	25	35	44	37	20	28	40
	Rose Road Road	35	20	27	38	36	21	28	39	32	19	25	35
	Henkle Hollow Road	39	22	29	41	39	23	30	42	37	22	28	39
	Walter Kurtz Road	32	18	26	34	32	19	26	33	32	17	25	36
Summer	Location	Sound Level (dBA)											
		Overall				Day				Night			
		Leq	L90	L50	L10	Leq	L90	L50	L10	Leq	L90	L50	L10
	Brasted Road	47	19	27	43	49	23	32	47	37	16	22	31
	Loon Lake	50	26	38	53	51	33	42	54	46	24	30	47
	Dye/Rex Road	38	23	29	40	40	25	31	42	32	21	27	35
	Haskinville Road	42	21	35	46	44	28	39	47	39	19	26	43
	Rose Road Road	35	24	30	37	36	25	31	38	32	23	28	34
	Henkle Hollow Road	36	25	31	39	38	26	33	40	33	23	29	36
	Walter Kurtz Road	40	23	32	43	41	25	34	45	35	20	29	39
Combined	Location	Sound Level (dBA)											
		Overall				Day				Night			
		Leq	L90	L50	L10	Leq	L90	L50	L10	Leq	L90	L50	L10
	Brasted Road	46	19	28	42	47	22	31	45	41	17	24	35
	Loon Lake	48	25	37	51	49	29	40	53	45	22	30	46
	Dye/Rex Road	37	21	28	38	38	22	29	39	34	20	27	36
	Haskinville Road	42	21	34	45	43	27	37	46	39	19	26	42
	Rose Road Road	35	22	29	37	36	23	30	38	32	20	27	35
	Henkle Hollow Road	38	23	30	40	39	24	32	41	35	22	29	37
	Walter Kurtz Road	38	20	29	41	39	22	30	42	34	19	27	38

TABLE 12: PRECONSTRUCTION MONITORING SUMMARY—A-WEIGHTED

	Location	Sound Level (dBA)											
		Overall				Day				Night			
		Leq	L90	L50	L10	Leq	L90	L50	L10	Leq	L90	L50	L10
Winter	Brasted Road	44	20	30	41	45	23	32	42	44	17	26	39
	Loon Lake	47	24	36	51	48	27	39	52	43	21	31	46
	Dye/Rex Road	35	19	27	36	35	20	27	35	35	17	25	38
	Haskinville Road	39	22	33	43	40	25	35	44	37	20	28	40
	Rose Road Road	35	20	27	38	36	21	28	39	33	19	25	35
	Henkle Hollow Road	39	22	30	41	39	23	30	42	37	22	28	39
	Walter Kurtz Road	32	18	26	34	33	19	26	34	32	17	25	36
Summer	Location	Sound Level (dBA)											
		Overall				Day				Night			
		Leq	L90	L50	L10	Leq	L90	L50	L10	Leq	L90	L50	L10
	Brasted Road	47	23	33	44	49	28	35	48	39	21	28	38
	Loon Lake	50	27	38	53	51	33	42	54	46	25	30	47
	Dye/Rex Road	38	23	30	40	40	25	32	42	33	22	27	35
	Haskinville Road	43	24	36	47	44	30	40	47	41	22	28	45
	Rose Road Road	35	24	31	38	37	26	32	39	33	24	29	36
	Henkle Hollow Road	39	29	35	41	40	31	36	42	39	27	32	40
	Walter Kurtz Road	40	23	33	43	42	26	35	45	36	21	30	40
Combined	Location	Sound Level (dBA)											
		Overall				Day				Night			
		Leq	L90	L50	L10	Leq	L90	L50	L10	Leq	L90	L50	L10
	Brasted Road	46	22	31	43	48	25	34	45	42	19	27	39
	Loon Lake	48	25	37	51	49	29	40	53	45	22	31	46
	Dye/Rex Road	37	21	29	39	39	22	30	40	34	20	27	36
	Haskinville Road	42	23	35	46	43	28	38	46	40	21	28	43
	Rose Road Road	35	22	29	38	36	23	30	39	33	21	27	36
	Henkle Hollow Road	39	24	33	41	40	25	34	42	38	23	31	40
	Walter Kurtz Road	38	20	30	41	39	22	31	43	35	19	28	39

TABLE 13: PRECONSTRUCTION WINTER MONITORING – WIND SPEED SUMMARY

Monitoring Location	Average Wind Speed		Maximum 1-minute Wind Speed		Maximum Wind Gust Speed	
	m/s	mph	m/s	mph	m/s	mph
Haskinville Road	0.4	1	4	9	9	21
Rose Road	0.4	1	4	10	7	16
Loon Lake	1.0	2	7	16	11	25
Henkle Hollow	1.4	3	9	20	13	28

TABLE 14: PRECONSTRUCTION SUMMER MONITORING – WIND SPEED SUMMARY

Monitoring Location	Average Wind Speed		Maximum 1-minute Wind Speed		Maximum Gust Speed	
	m/s	mph	m/s	mph	m/s	mph
Haskinville Road	0.1	0	2	5	6	14
Rose Road	0.0	0	3	6	8	19
Loon Lake	0.3	1	3	8	7	15
Henkle Hollow	0.4	1	4	8	7	15
Walter Kurtz Road	0.0	0	1	2	6	12

7.3 | COMPARISON OF SOUND LEVELS TO WIND SPEED

The 10-meter wind speed is the wind speed as it was measured at the Project's Sand Hill meteorological tower at 40 and 60 meter heights, and extrapolated down to a 10-meter height, is shown in relation to measured L_{eq} or L_{90} at each monitoring site in Figures 104 to 131.

In the first two figures for each monitoring location show a purple area that indicates the 80th percentile sound level, with the middle grey line indicating the median sound level. Wind speeds below 3 m/s, below the typical wind turbine cut-in speed, were omitted.

The second two figures for each monitoring site show the hub-height wind speed compared to the 10-minute sound level (L_{eq} and L_{90} respectively) for each individual 10-minute period. These periods are split into daytime (red dots) and nighttime (blue dots) sets. A linear correlation is shown for each of these data sets, with the equation for the best-fit line and coefficient of determination (R^2) to indicate the quality of relationship between 10-meter wind speed and monitored sound levels.

BRASTED ROAD

The middle 80th percentile of 10-minute sound levels is shown in comparison with 10-meter wind speeds, for the L_{eq} in Figure 104 and for the L_{90} in Figure 105. Due to the influence of transient sounds such as dog barks, car pass bys, and agricultural equipment at this monitor, there is a relatively large spread in L_{eq}s for a given wind speed. The L_{90}s show less of a spread. For example, at 3 m/s the difference between bottom and top 10th percentile of periods is about 35 dBA for the L_{eq}, but less than 20 dB for the L_{90}.

In Figure 106 the daytime and nighttime data show relatively low coefficients of determination between the L_{eq} and 10-meter wind speed. This is due to traffic along local roads, along with transient and biogenic sounds that occurred during all times of day, such as farm equipment, dogs barking and airplane overflights, resulting in similar amounts of transient sounds for the day and night. Figure 107 indicates that the coefficient of determination decreases for daytime periods and increases for nighttime periods when 10-

meter winds speeds are compared to the L90. This may be due to influence of agricultural sound sources such as pumps becoming more dominant in the day relative to sound from wind gusts, while the L90 successfully remove highly transient sounds, such as dog barks at night.

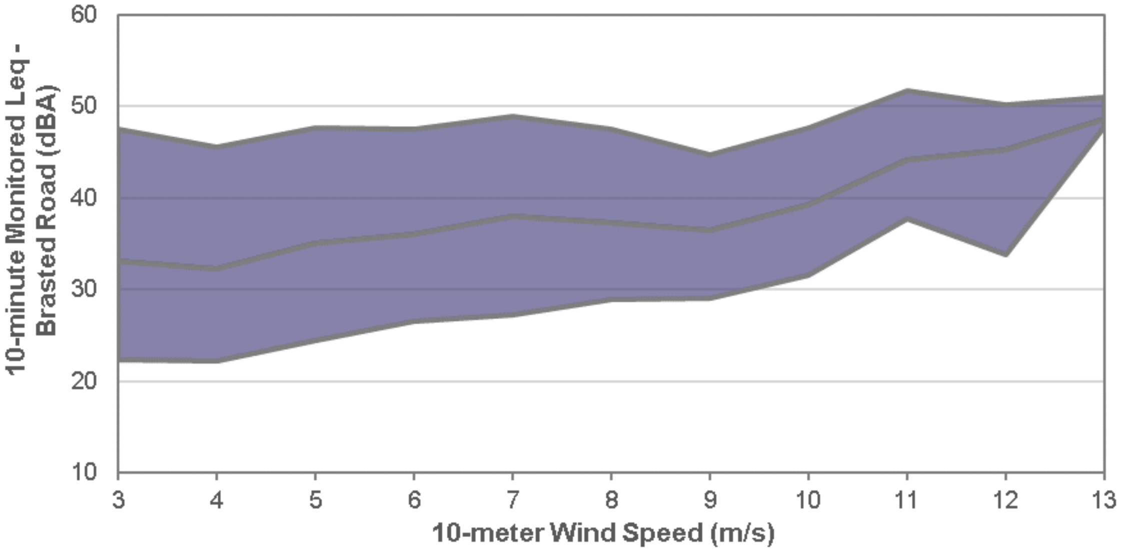

FIGURE 104: MEASURED 10-MINUTE L_{eq} AT BRASTED ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

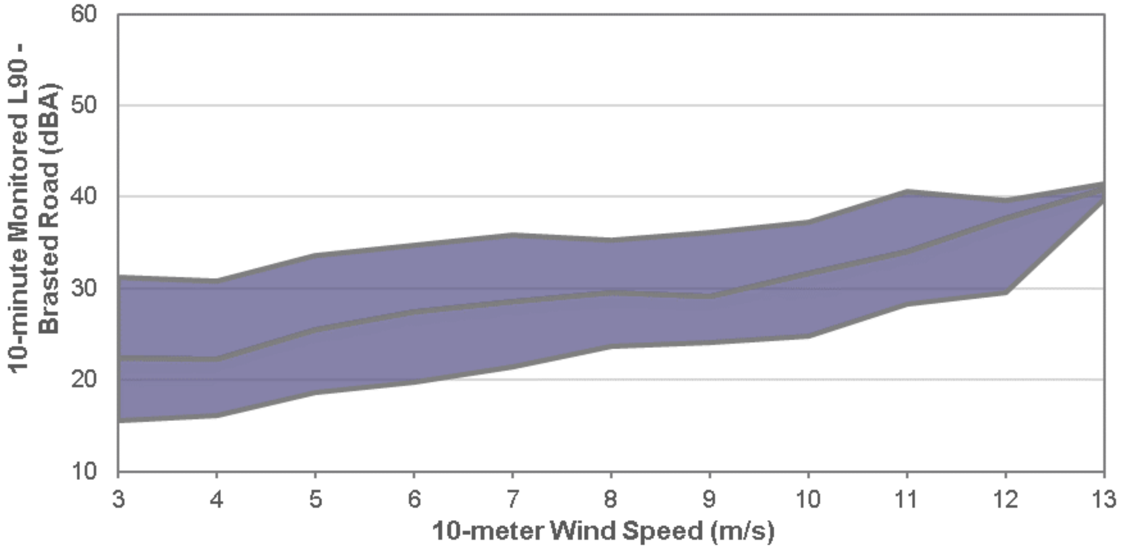

FIGURE 105: MEASURED 10-MINUTE L_{90} AT THE BRASTED ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

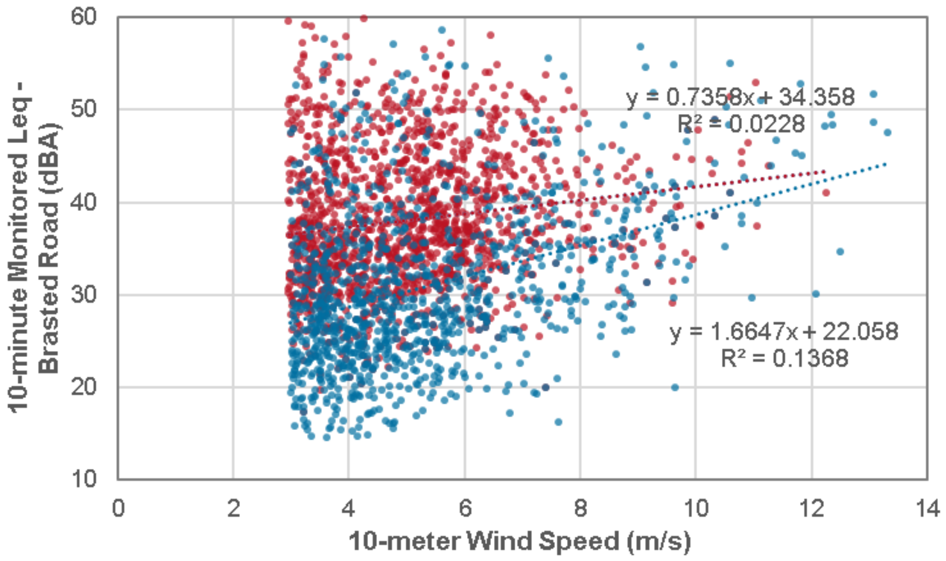

FIGURE 106: MEASURED 10-MINUTE L_{eq} AS MEASURED AT THE BRASTED ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

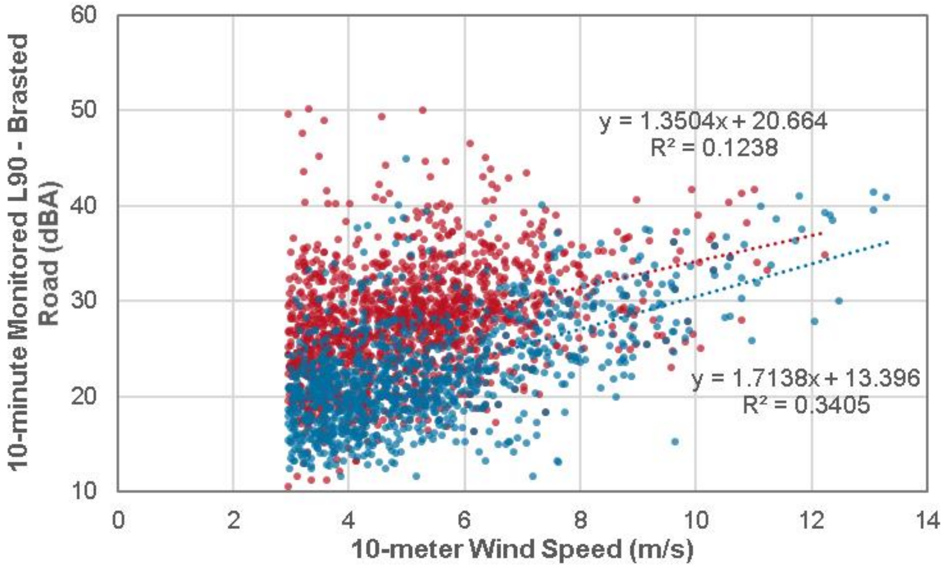

FIGURE 107: MEASURED 10-MINUTE L_{90} AS MEASURED AT THE BRASTED ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

DYE/REX ROAD

The middle 80th percentile of 10-minute sound levels is shown in Figure 108 for the L_{eq} and Figure 109 for the L_{90} at Dye/Rex Road. While the L_{eq} does show a larger spread in sound levels than the L_{90}, the difference is not as large as at some other sites. This site is relatively isolated with only occasional car pass bys and aircraft overflights for biogenic sounds.

Daytime and nighttime periods show similar coefficients of determination in Figure 110 Figure 111, with L_{90} sound levels showing higher correlations than the $L_{eq.}$ Due to a relative lack of anthropogenic sound sources nearby, this location exhibits some of the best correlation with wind speed.

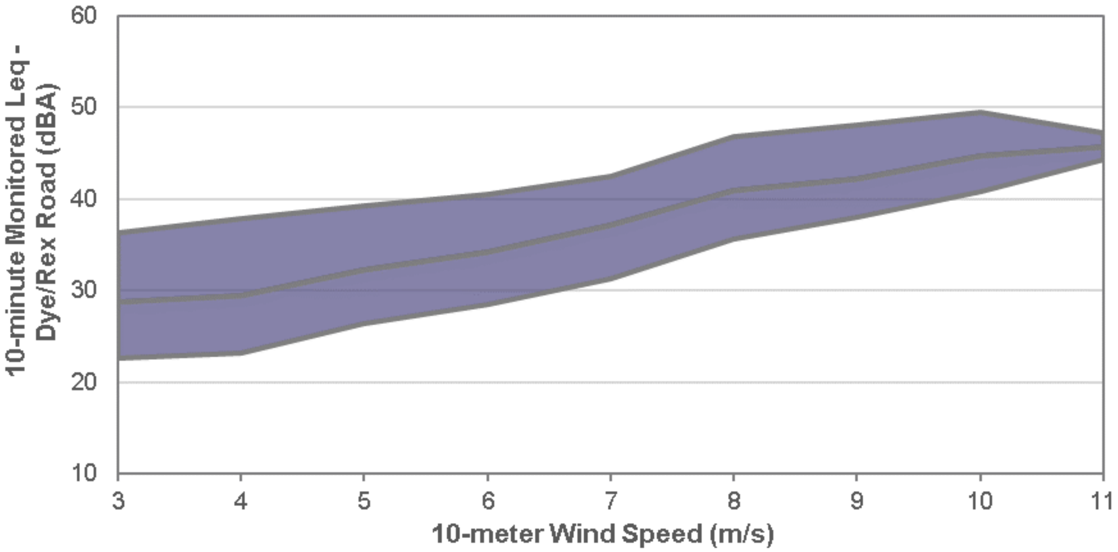

FIGURE 108: MEASURED 10-MINUTE L_{eq} AT DYE/REX ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

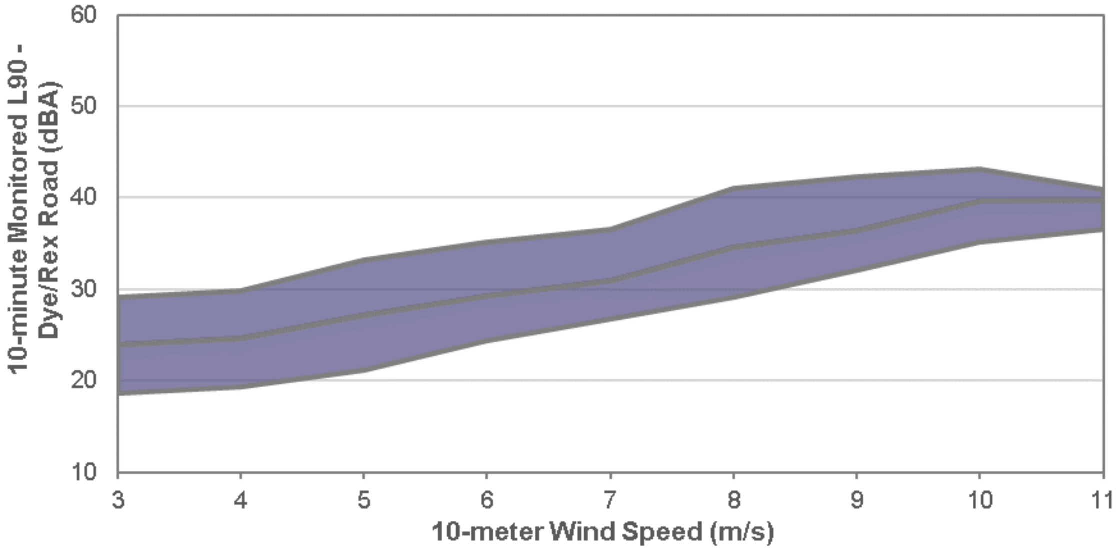

FIGURE 109: MEASURED 10-MINUTE L_{90} AT THE DYE/REX ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

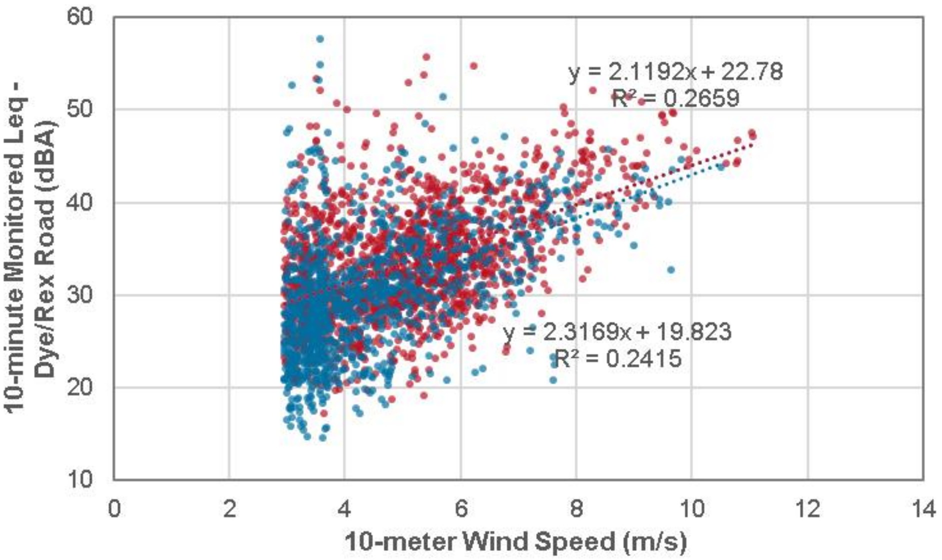

FIGURE 110: MEASURED 10-MINUTE L_{eq} AS MEASURED AT THE DYE/REX ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

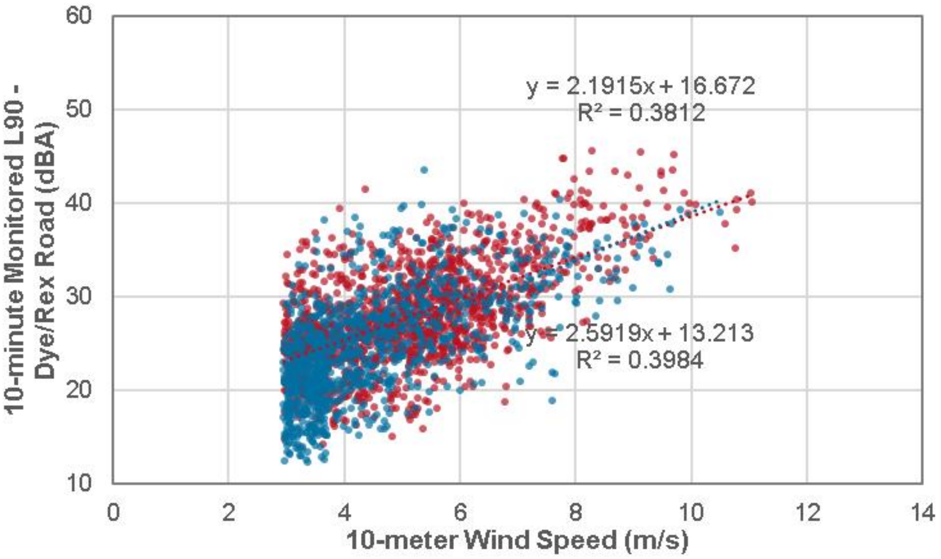

FIGURE 111: MEASURED 10-MINUTE L_{90} AS MEASURED AT THE DYE/REX ROAD MONITOR COMPARED WITH THE 10-MINUTE WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

HASKINVILLE ROAD

Comparison of the middle 80th percentile of 10-minute sound levels monitored at the Haskinville Road monitor and 10-meter wind speed are shown for the L_{eq} in Figure 112 and L_{90} in Figure 113. Due to high influence of car pass bys on NY Route 21, there is little correlation between L_{eq} and wind speed. There is a better correlation for the L_{90}, but it is still less than at other locations.

Correlations shown in Figure 114 and Figure 115 bear this out. With the L_{eq}, the coefficient of determination is relatively poor (below 0.4 for both day and night) and the slope of the line relatively flat. With the L_{90}, the coefficient of determination is a higher (0.2), but the slope of the line is still relatively flatter than other sites. For example, at Dye/Rex Road, the slope indicates a sound level increase of approximately 2 dB for every 1 m/s increase in wind speed. For Haskinville, this decreases to between 1.2 and 1.3 dB per m/s. The only sites with similar or lesser slopes are Loon Lake and Henkle Hollow.

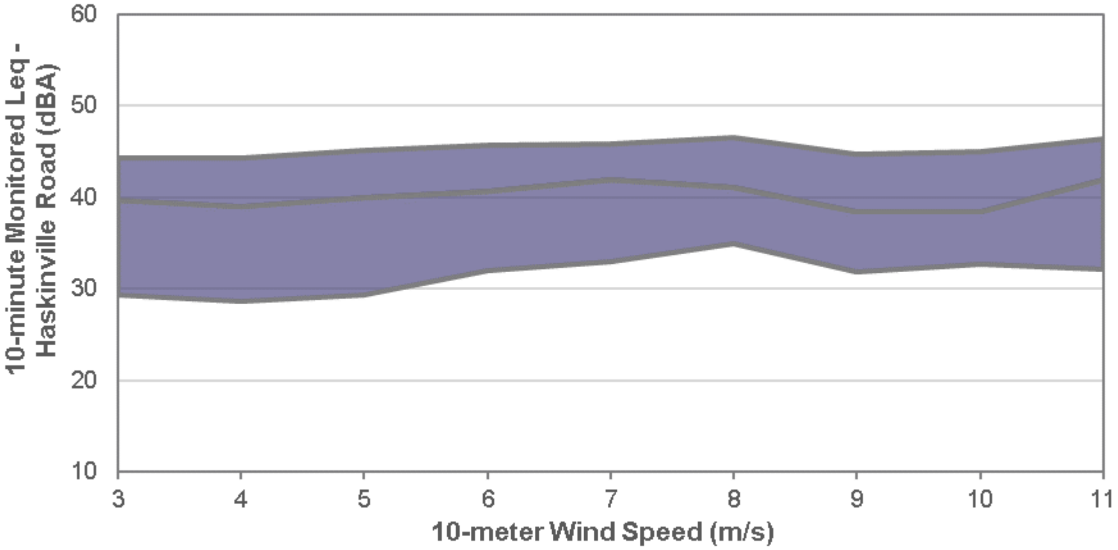

FIGURE 112: MEASURED 10-MINUTE L_{eq} AT HASKINVILLE ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

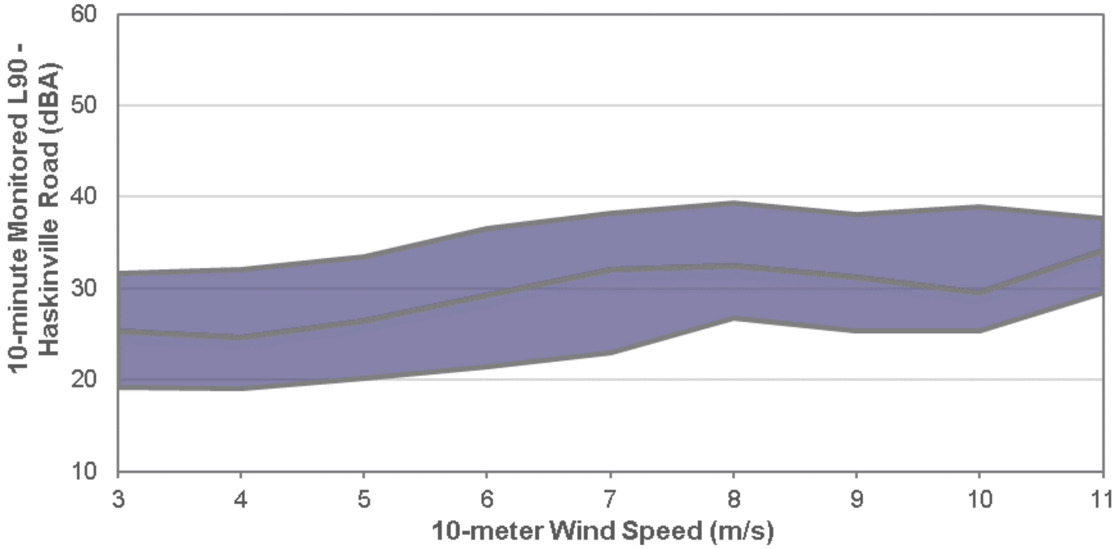

FIGURE 113: MEASURED 10-MINUTE L_{90} AT THE HASKINVILLE ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

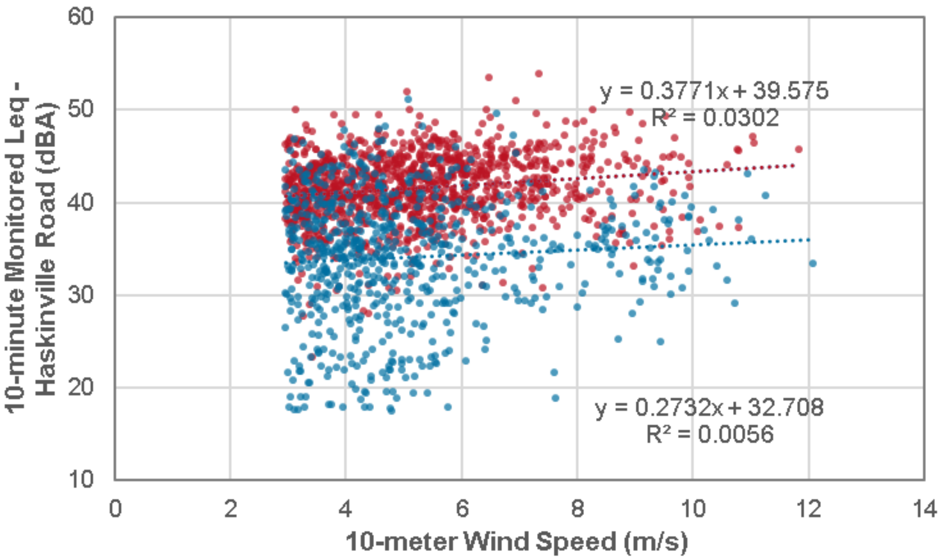

FIGURE 114: MEASURED 10-MINUTE L_{eq} AS MEASURED AT THE HASKINVILLE ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

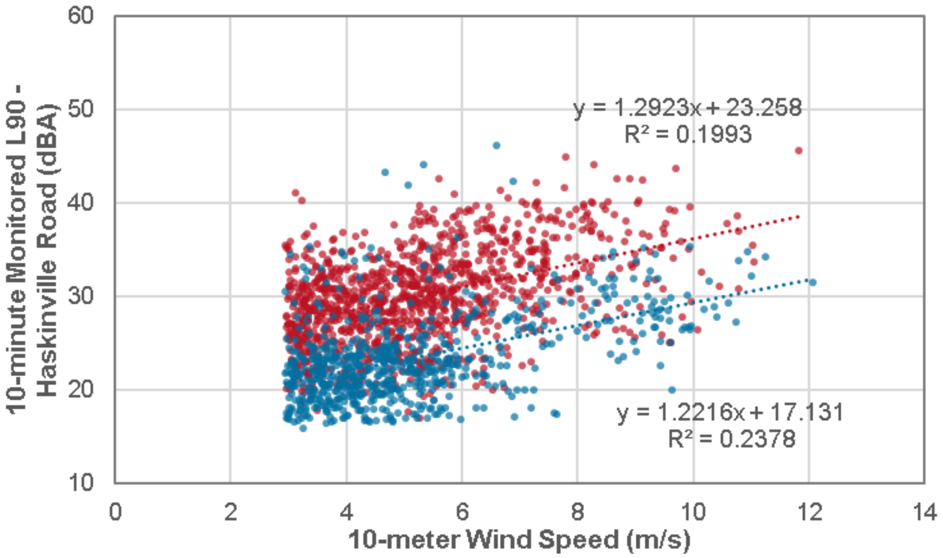

FIGURE 115: MEASURED 10-MINUTE L_{90} AS MEASURED AT THE HASKINVILLE ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

HENKLE HOLLOW

Henkle Hollow shows a modest relationship between the middle 80th percentile of both the L_{eq} and L_{90} metrics and wind speed, as is shown in Figure 116 and Figure 117. This is probably due to the relatively exposed position of this monitor, near the top of a small ridge. This steady relationship does not result in a steep slope between wind speed and sound level or a high coefficient of determination, as is shown in Figure 118 and Figure 119. This is the result of the combination of distant traffic on Interstate 390, a variety of biogenic sounds, a variety of anthropogenic sounds, and traffic on Henkle Hollow Road.

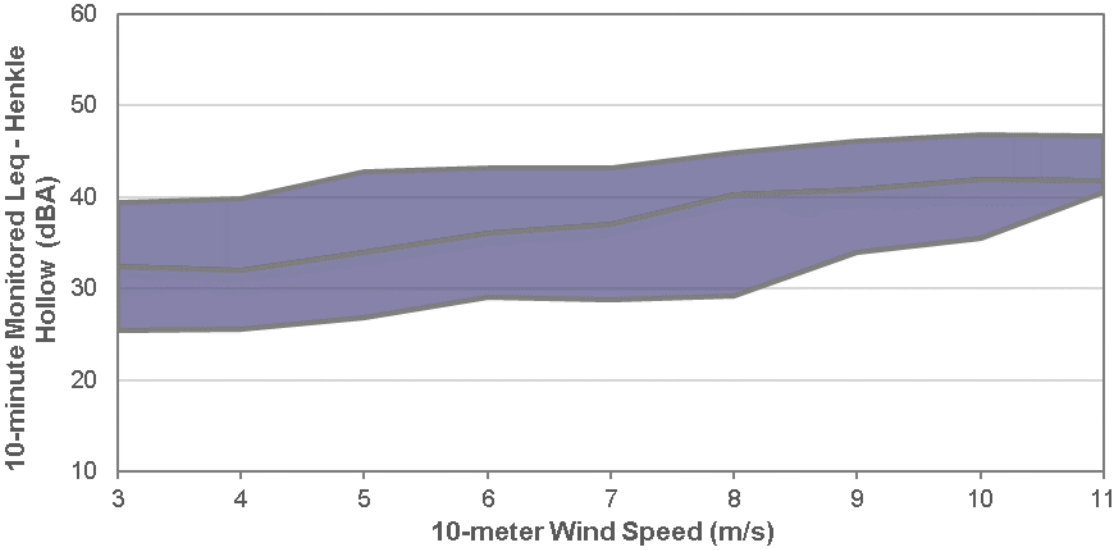

FIGURE 116: MEASURED 10-MINUTE L_{eq} AT HENKLE HOLLOW MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

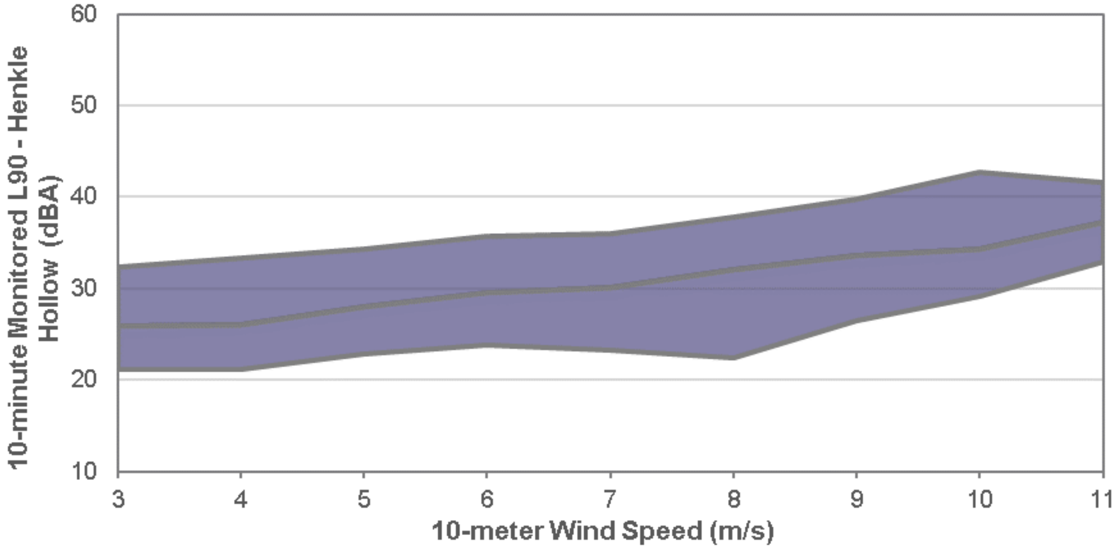

FIGURE 117: MEASURED 10-MINUTE L_{90} AT THE HENKLE HOLLOW ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

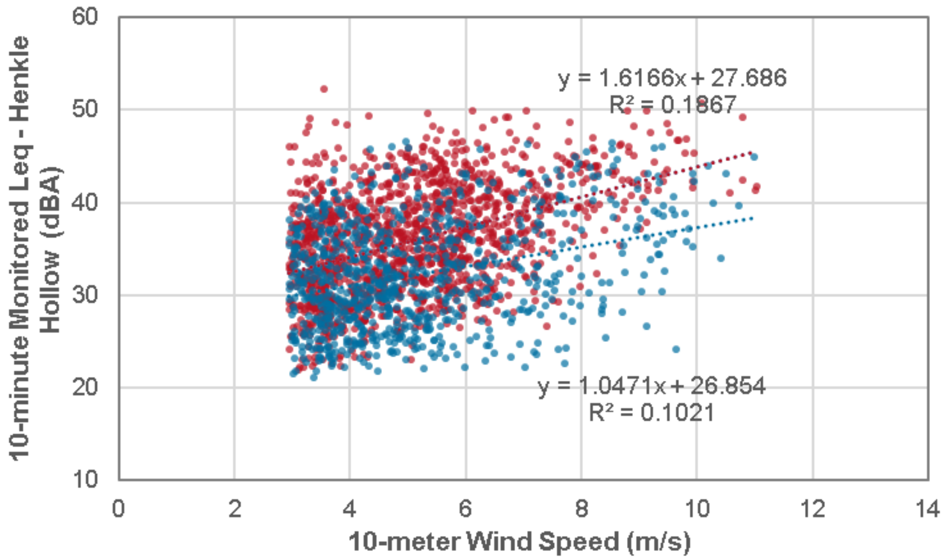

FIGURE 118: MEASURED 10-MINUTE L_{eq} AS MEASURED AT THE HENKLE HOLLOW MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

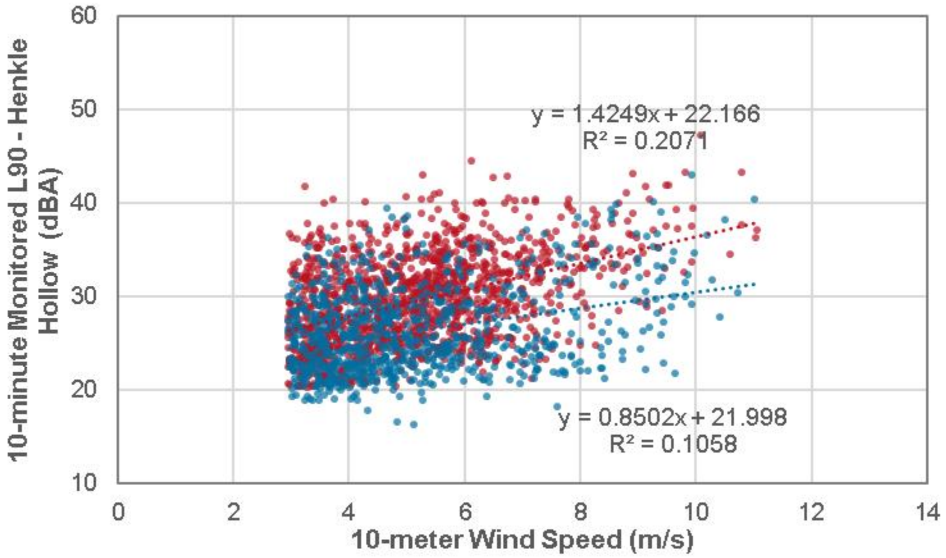

FIGURE 119: MEASURED 10-MINUTE L_{90} AS MEASURED AT THE HENKLE HOLLOW MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

LOON LAKE

Like other higher road traffic monitoring locations, there is a relatively low correlation between the L_{eq} and 10-meter wind speed at the met tower, as is shown in Figure 120. However, the lower 10th percentile of periods (bottom of the purple area), more clearly increases with wind speed. The relationship improves for the L_{90}, although at lower wind speeds, the sound level spread is quite large (Figure 121). The spread tightens to less than 5 dB when 10-meter winds speeds are above 12 m/s.

Looking at the regression results in Figure 122 and Figure 123, correlations and slopes for the relationship between the L_{eq} and L_{90} are relatively poor (ranging from 0.01 to 0.26).

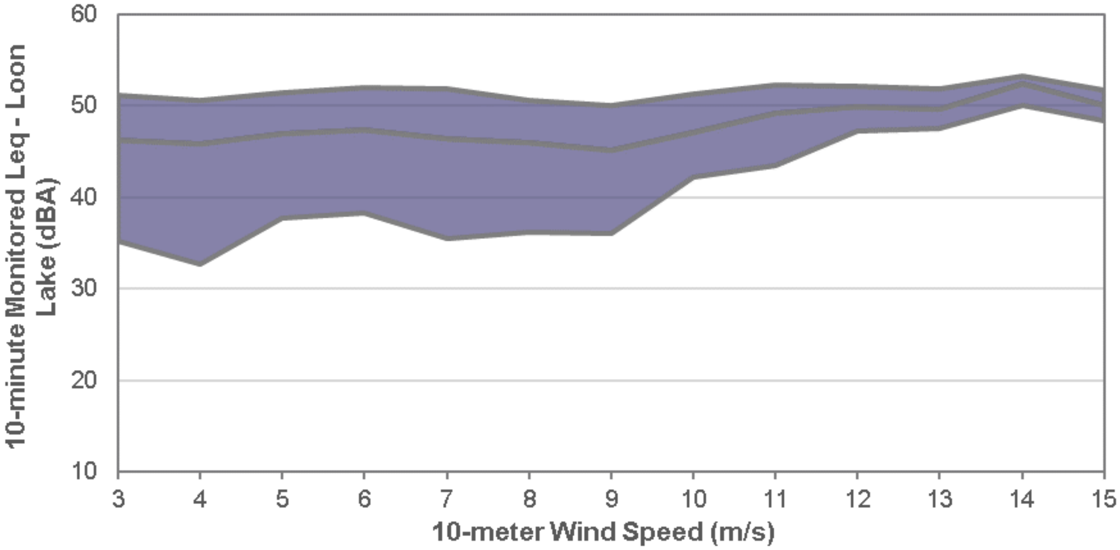

FIGURE 120: MEASURED 10-MINUTE L_{eq} AT LOON LAKE MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

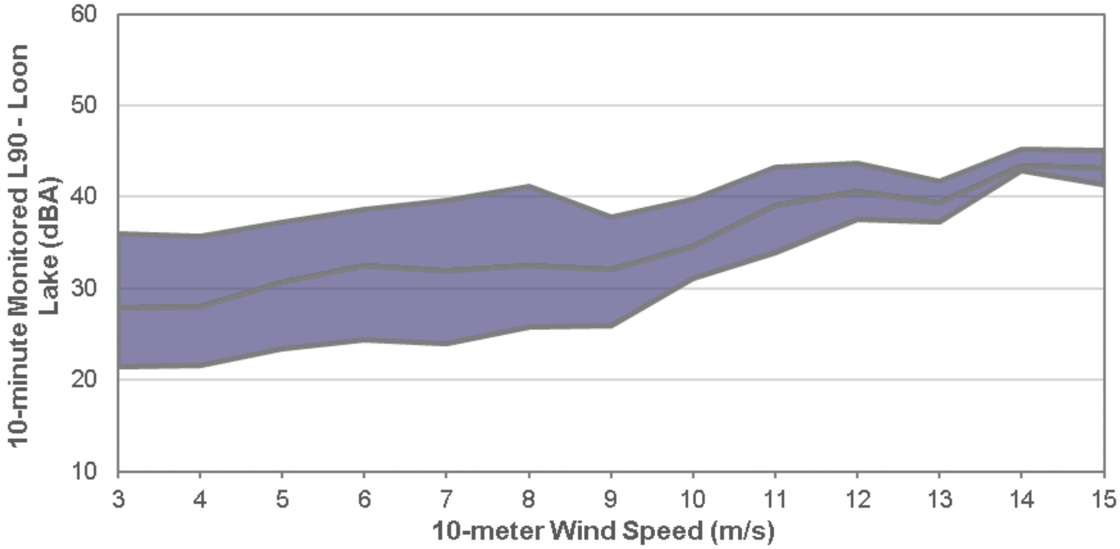

FIGURE 121: MEASURED 10-MINUTE L_{90} AT THE LOON LAKE MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

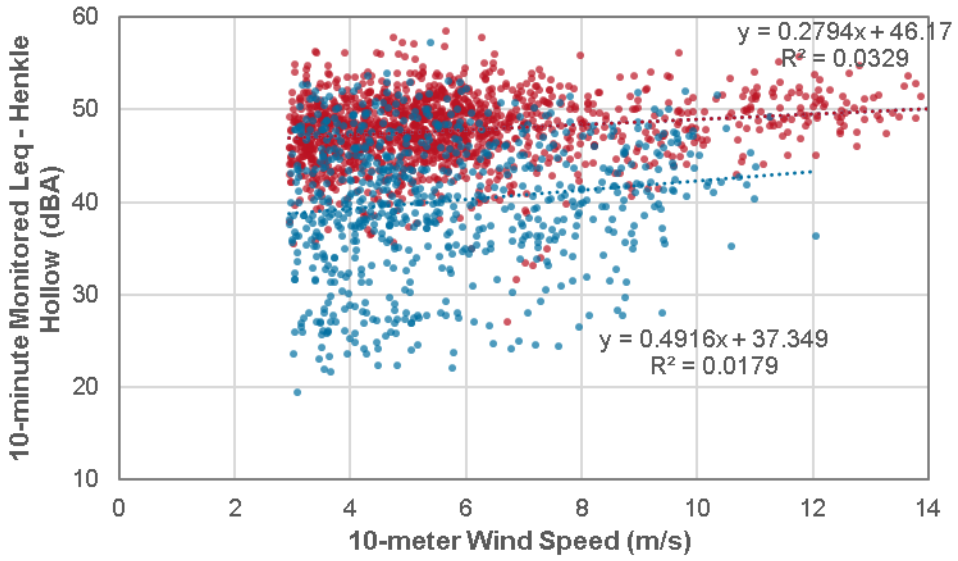

FIGURE 122: MEASURED 10-MINUTE L_{eq} AS MEASURED AT THE LOON LAKE MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

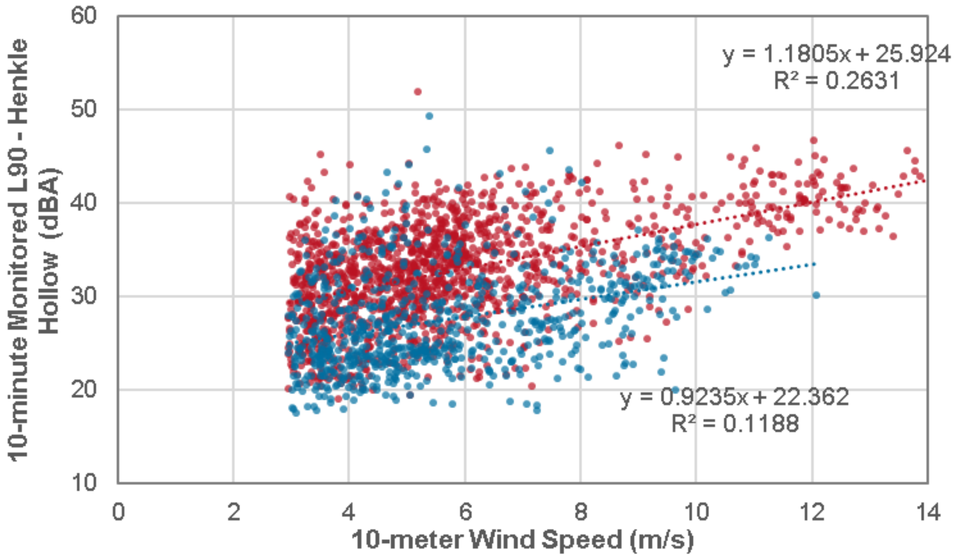

FIGURE 123: MEASURED 10-MINUTE L_{90} AS MEASURED AT THE LOON LAKE MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

ROSE ROAD

Figure 124 and Figure 125 show the middle 80th percentile of 10-minute L_{eq} and L_{90} sound levels, respectively, as a function of 10-meter wind speed at Rose Road. The correlations for each, shown for the L_{eq} in Figure 126 and for the L_{90} in Figure 127, have coefficients of determination and slope slopes are higher in the daytime. This could be due to a relative prominence of airplane overflights during the nighttime hours, particularly in the winter, that add background noise.

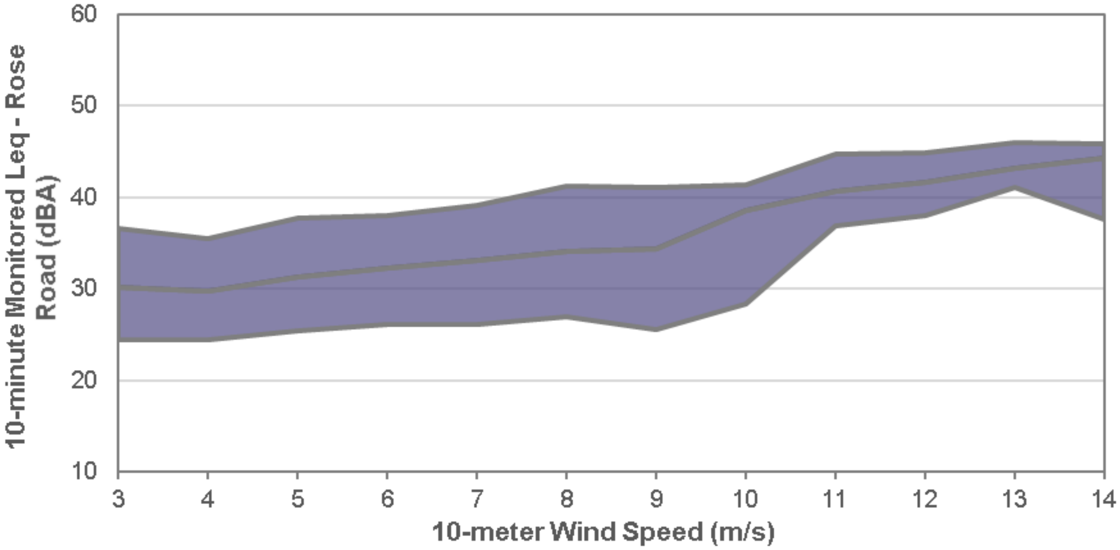

FIGURE 124: MEASURED 10-MINUTE L_{eq} AT ROSE ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

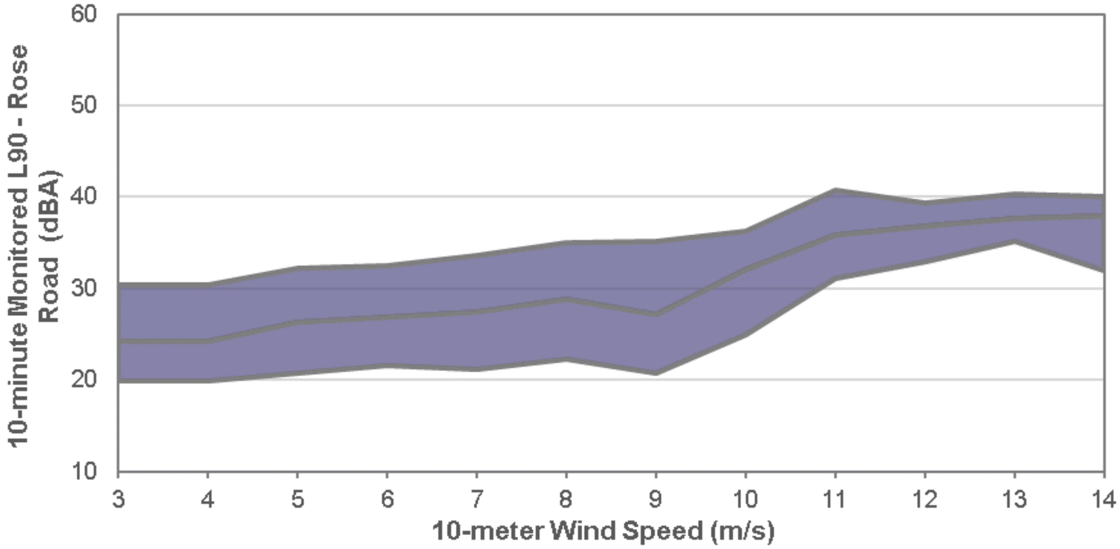

FIGURE 125: MEASURED 10-MINUTE L_{90} AT ROSE ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

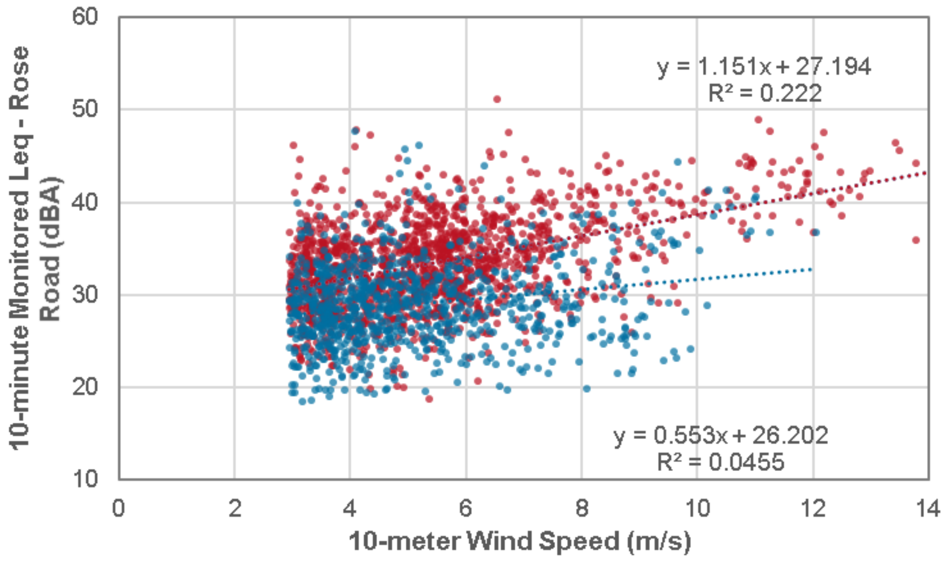

FIGURE 126: MEASURED 10-MINUTE L_{eq} AS MEASURED AT THE ROSE ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

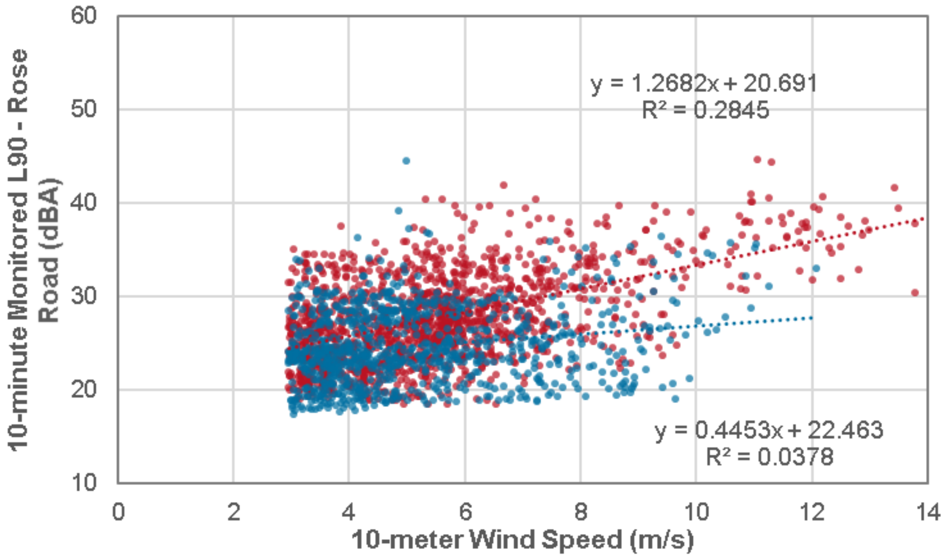

FIGURE 127: MEASURED 10-MINUTE L_{90} AS MEASURED AT THE ROSE ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

WALTER KURTZ

The 10-meter wind speed is shown in relation to measured L_{eq} and L_{90} in Figure 128 and Figure 129, respectively, for the Walter Kurtz site. Both L_{90} and L_{eq} increase with increasing wind speeds. Both metrics show a relatively high spread in sound levels at each wind speed, relative to other monitoring locations.

Figure 130 and Figure 131 show the hub-height wind speed compared to the 10-minute sound level (L_{eq} and L_{90} respectively) for each individual 10-minute period. The L_{eq} shows a lower coefficient of determination than the L_{90}. For both the L_{eq} and L_{90} datasets, there is a higher coefficient of determination during the day than at night. This may be due to airplane overflights during the night.

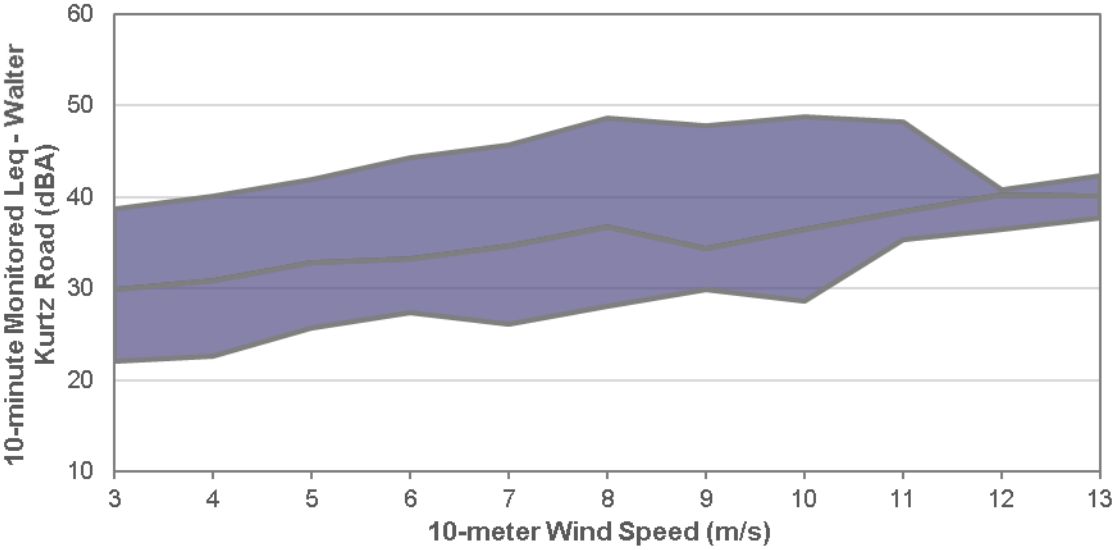

FIGURE 128: MEASURED 10-MINUTE L_{eq} AT THE WALTER KURTZ ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

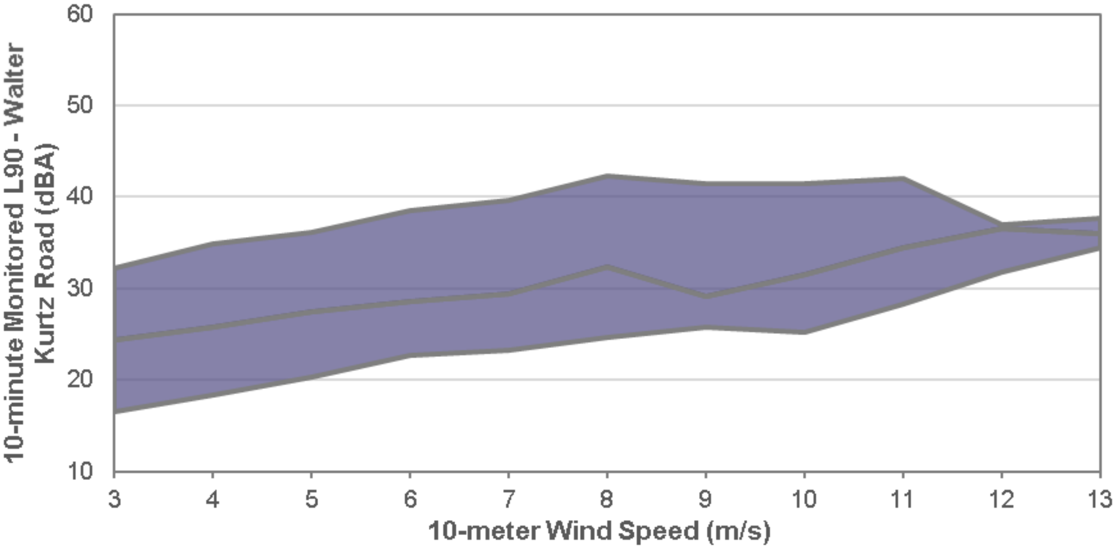

FIGURE 129: MEASURED 10-MINUTE L_{90} AT THE WALTER KURTZ ROAD MONITOR COMPARED WITH THE 90-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

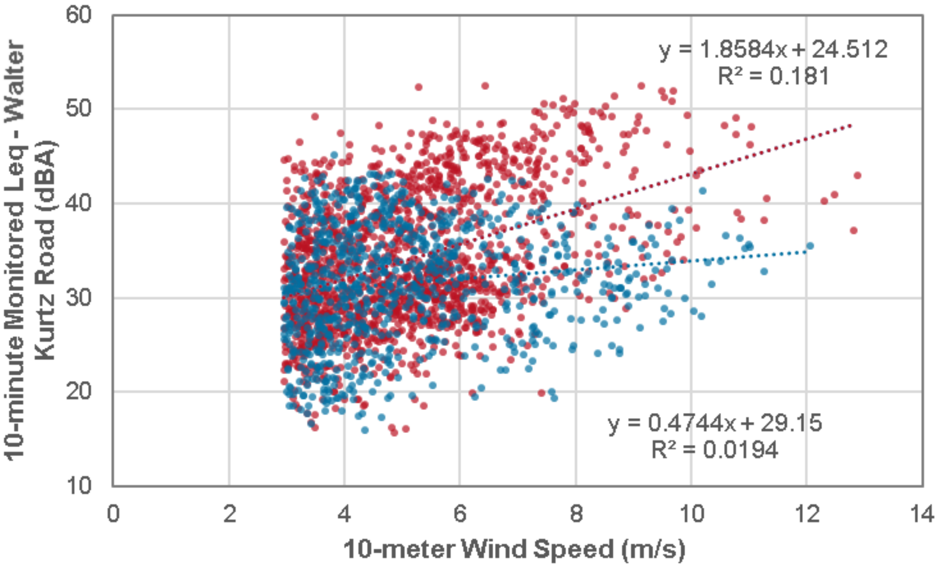

FIGURE 130: MEASURED 10-MINUTE L_{eq} AS MEASURED AT THE WALTER KURTZ ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

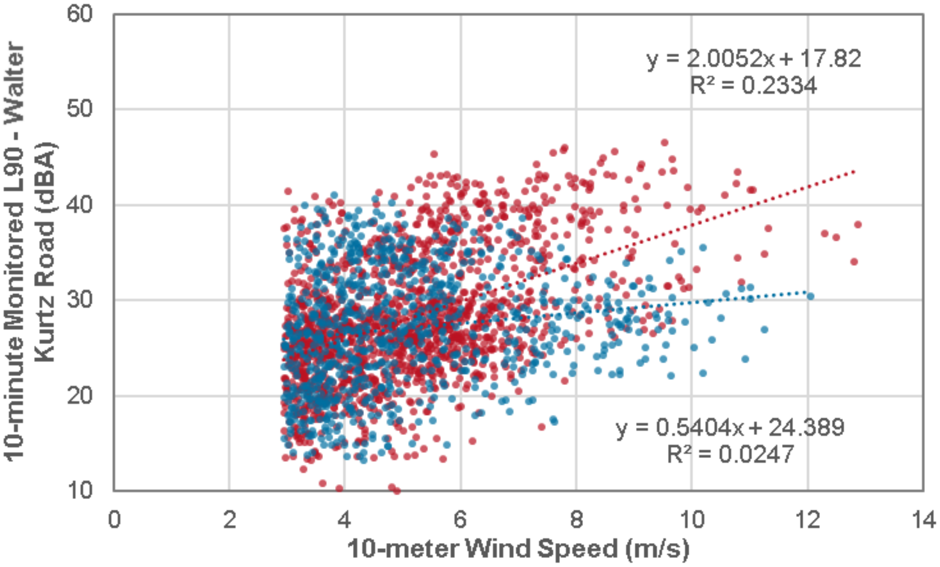

FIGURE 131: MEASURED 10-MINUTE L_{90} AS MEASURED AT THE WALTER KURTZ ROAD MONITOR COMPARED WITH THE 10-METER WIND SPEED AS ESTIMATED FROM PROJECT MET TOWER

7.4 | TEMPORAL ACCURACY

Temporal accuracy of the monitoring data was analyzed according to ANSI S12.9 Part 2. The standard analyzes the representativeness of the measurement data for a measurement location. This is accomplished through calculating the day-night average sound level (L_{dn}) for each day within the monitoring period and then determining the 95th percentile confidence interval for the data series. These confidence intervals are categorized into three classes. Class "A" is for precision measurements, with Class "B" and Class "C" being less precise. Normality of the dataset is then calculated using a Kolmogorov-Smirnov test. The Stipulations for the project specify that the analysis would also be conducted for the L_{eq} and L_{90} sound level metrics. While the confidence intervals and normality tests are general statistics and can be used for sets of data with disparate uses, the "classes" are specific to sound levels and L_{dn} datasets used by the authors of ANSI S12.9 Part 2.

Analysis results are shown in Table 15 for L_{eq} data and Table 16 for L_{90} data. All except one site meets the "A" status required for precision measurements for both sound level metrics, and all sites fit the criteria for normality. The site that did not meet criteria "A" precision is the Walter Kurtz site. The Walter Kurtz site is more isolated, with minimal influence from anthropogenic sound sources such as cars or agricultural equipment. As a result, the daily sound levels are more variable.

Remote sites in the project area (Brasted Road, Rex/Dye Road, and Walter Kurtz Road) tend to have higher standard deviations than those near major roads (Haskinville Road or Loon Lake). This is due to dominance of the soundscape by road traffic. At rural sites, there is less likely to be a consistent sound sources that dominates the soundscape, providing a consistent day-to-day sound level. Instead, the sound level is driven by inconsistent sound sources such as dogs, farming activity, birds/insects, and weather.

TABLE 15: MONITORING DATA TEMPORAL ACCURACY (ANSI 12.9 PART 2) – BASED ON DAILY L_{EQ} SOUND LEVELS

	Brasted Road	Rex/Dye Road	Haskinville Road	Henkle Hollow	Loon Lake	Rose Road	Walter Kurtz Road
Number of Samples	33	32	29	33	25	31	32
Upper Confidence Interval (dB)	1.6	1.5	0.7	1.2	1.0	1.0	2.1
Lower Confidence Interval (dB)	1.4	1.4	0.7	1.1	1.0	0.9	1.8
Measurement Class	A	A	A	A	A	A	B
Normality	Yes	Yes	Yes	Yes	Yes	Yes	Yes

TABLE 16: MONITORING DATA TEMPORAL ACCURACY (ANSI 12.9 PART 2) - BASED ON DAILY L_{90} SOUND LEVELS

	Brasted Road	Rex/Dye Road	Haskinville Road	Henkle Hollow	Loon Lake	Rose Road	Walter Kurtz Road
Number of Samples	33	32	29	33	25	31	32
Upper Confidence Interval (dB)	1.5	1.6	1.5	1.6	1.4	1.7	2.7
Lower Confidence Interval (dB)	1.4	1.4	1.3	1.4	1.3	1.5	2.2
Measurement Class	A	A	A	A	A	A	B
Normality	Yes	Yes	Yes	Yes	Yes	Yes	Yes

7.5 | MONITORING RESULTS SUMMARY

RSG conducted preconstruction background sound level monitoring in Steuben County, New York for the Baron Winds wind power project. Monitoring was performed in compliance with rules of the New York State Board on Electric Generation Siting and the Environment ("Siting Board") under 16 NYCRR § 1011.19. Monitoring was performed over two distinct periods, lasting at least 14 days each. The first period ran from February 24 to

March 12, 2015, to measure sound levels at the site during the winter. The second period ran from July 15 to July 31, 2015 to capture sound levels at the site during the summer.

Measured sound levels were widely distributed, depending on the proximity to human activity and industry. Anthropogenic (human-caused) sounds were prominent in daytime sound levels at six of the seven monitoring locations. The seventh monitoring location was located on a seasonal road in a sparsely populated and wooded area, where biogenic and meteorological sources dominated the overall sound levels, although occasional aircraft, vehicle pass bys, and other human activities were observed.

Overall equivalent average sound levels ranged from 36 to 49 dBA during the day and 33 to 45 dBA during the night. These equivalent averages include periods that were ANS-weighted to account for seasonal biogenic sound. The ANS-weighting was used when tonal, high-frequency sound was present, but not other periods. The overall L_{90} sound levels, which are sound levels exceeded 90 percent of the time, ranged from 20 to 25 dBA during the day and 19 to 23 dBA during the night. The overall L_{10} sound levels, which are sound levels exceeded 10 percent of the time, ranged from 39 dBA to 53 dBA during the day and 36 to 46 dBA during the night.

8.0 WIND TURBINE NOISE – SPECIAL CONSIDERATIONS

8.1 | SOURCES OF SOUND GENERATION BY WIND TURBINES

Wind turbines generate two principal types of noise: aerodynamic noise, produced from the flow of air around the blades, and mechanical noise, produced from mechanical and electrical components within the nacelle.

Aerodynamic noise is the primary source of noise associated with wind turbines. These acoustic emissions can be either tonal or broad band. Tonal noise occurs at discrete frequencies, whereas broadband noise is distributed with little peaking across the frequency spectrum.

While unusual, tonal noise can also originate from unstable air flows over holes, slits, or blunt trailing edges on blades. Most modern wind turbines have upwind rotors designed to prevent blade impulsive noise. Therefore, the majority of audible aerodynamic noise from wind turbines is broadband at the middle frequencies, roughly between 200 Hz and 1,000 Hz.

Wind turbines emit aerodynamic broadband noise as the spinning blades interact with atmospheric turbulence and as air flows along their surfaces. This produces a characteristic “whooshing” sound through several mechanisms (Figure 132):

- Inflow turbulence noise occurs when the rotor blades encounter atmospheric turbulence as they pass through the air. Uneven pressure on a rotor blade causes variations in the local angle of attack, which affects the lift and drag forces, causing aerodynamic loading fluctuations. This generates noise that varies across a wide range of frequencies but is most significant at frequencies below 500 Hz.
- Trailing edge noise is produced as boundary-layer turbulence as the air passes into the wake, or trailing edge, of the blade. This noise is distributed across a wide frequency range but is most notable at high frequencies between 700 Hz and 2 kHz.
- Tip vortex noise occurs when tip turbulence interacts with the surface of the blade tip. While this is audible near the turbine, it tends to be a small component of the overall noise further away.
- Stall or separation noise occurs due to the interaction of turbulence with the blade surface.

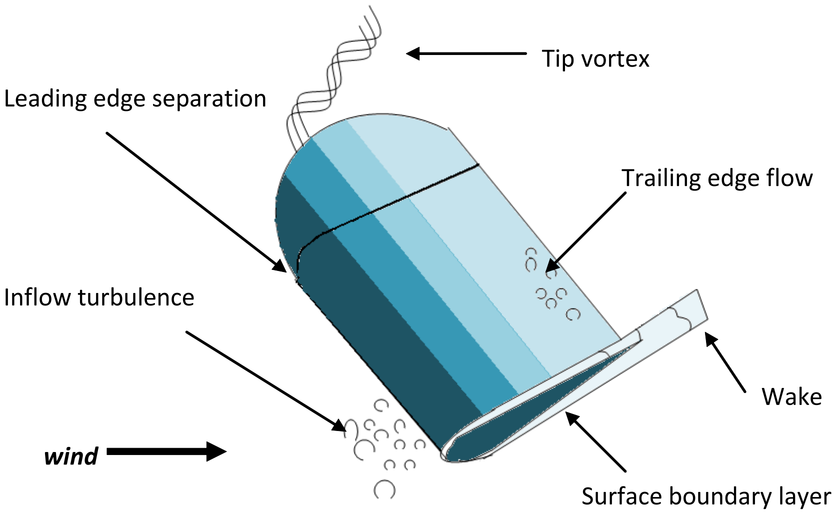

FIGURE 132: AIRFLOW AROUND A ROTOR BLADE

Mechanical sound from machinery inside the nacelle tends to be tonal in nature but can also have a broadband component. Potential sources of mechanical noise include the gearbox, generator, yaw drives, cooling fans, and auxiliary equipment. These components are housed within the nacelle, whose surfaces, if untreated, radiate the resulting noise. However modern wind turbines have nacelles that are designed to reduce internal noise, and rarely is the mechanical noise a significant portion of the total noise from a wind turbine.

8.2 | AMPLITUDE MODULATION

Amplitude modulation (AM) is a fluctuation in sound level that occurs at the blade passage frequency. No consistent definition exists for how much of a sound level fluctuation is necessary for blade swish to be considered AM, however sound level fluctuations in A-weighted sound level can range up to 10 dB. Fluctuations in individual 1/3 octave bands are typically more and can exceed 15 dB. Fluctuations in individual 1/3 octave bands can sometimes synchronize and desynchronize over periods, leading to increases and decreases in magnitude of the A-weighted fluctuations. Similarly, in wind farms with multiple turbines, fluctuations can synchronize and desynchronize, leading to variations in AM depth.[71] Most amplitude modulation is in the mid frequencies and most overall A-weighted AM is less than 4.5 dB in depth.[72]

Many confirmed and hypothesized causes of AM exist, including: blade passage in front of the tower, blade tip sound emission directivity, wind shear, inflow turbulence, and turbine blade yaw error. It has recently been noted that although wind shear can contribute to the extent of AM, wind shear does not contribute to the existence of AM in and of itself.

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[71] McCunney, Robert, et al. “Wind Turbines and Health: A Critical Review of the Scientific Literature.” *Journal of Occupational and Environmental Medicine.* 56(11) November 2014: pp. e108-e130.
[72] RSG, et al., “Massachusetts Study on Wind Turbine Acoustics,” Massachusetts Clean Energy Center and Massachusetts Department of Environmental Protection, 2016

Instead, there needs to be detachment of airflow from the blades for wind shear to contribute to AM.[73] While factors like the blade passing in front of the tower are intrinsic to wind turbine design, other factors vary with turbine design, local meteorology, topography, and turbine layout. Mountainous areas, for example, are more likely to have turbulent airflow, less likely to have high wind shear, and less likely to have turbine layouts that allow for blade passage synchronization for multiple turbines. AM extent varies with the relative location of a receptor to the turbine. AM is usually experienced most when the receptor is between 45 and 60 degrees from the downwind or upwind position and is experienced least directly with the receptor directly upwind or downwind of the turbines.

8.3 | METEOROLOGY

Meteorological conditions can significantly affect sound propagation. The two most important conditions to consider are wind shear and temperature lapse. Wind shear is the difference in wind speeds by elevation and temperature lapse rate is the temperature gradient by elevation. In conditions with high wind shear (large wind speed gradient), sound levels upwind from the source tend to decrease and sound levels downwind tend to increase due to the refraction, or bending, of the sound (Figure 133).

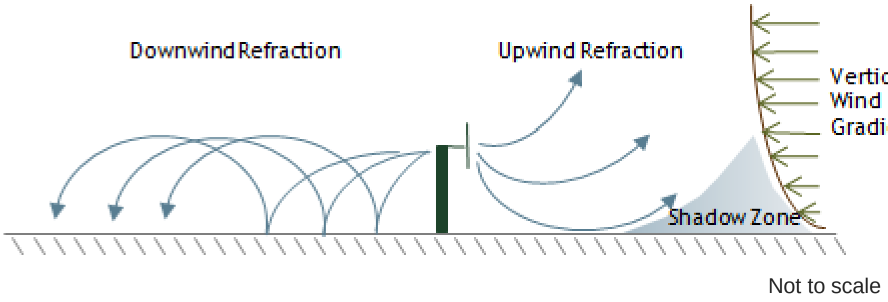

FIGURE 133: SCHEMATIC OF THE REFRACTION OF SOUND DUE TO VERTICAL WIND GRADIENT (WIND SHEAR)

With temperature lapse, when ground surface temperatures are higher than those aloft, sound will tend to refract upwards, leading to lower sound levels near the ground. The opposite is true when ground temperatures are lower than those aloft (an inversion condition).

High winds and high solar radiation can create turbulence which tends to break up and dissipate sound energy. Highly stable atmospheres, which tend to occur on clear nights with low ground-level wind speeds, tend to minimize atmospheric turbulence and are generally more favorable to downwind propagation.

In general terms, sound propagates along the ground best under stable conditions with a strong temperature inversion. This tends to occur during the night and is characterized by low ground-level winds. As a result, worst-case conditions for wind turbines tend to occur

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[73] "Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect." *RenewableUK*. December 2013.

downwind under moderate nighttime temperature inversions. Therefore, this is the default condition for modeling wind turbine sound.

8.4 | MASKING

As mentioned above, sound levels from wind turbines are a function of wind speed. Background sound is also a function of wind speed, i.e., the stronger the winds, the louder the resulting background sound. This effect is amplified in areas covered by trees and other vegetation.

The sound from a wind turbine can often be masked by wind noise at downwind receptors because the frequency spectrum from wind is similar to the frequency spectrum from a wind turbine. Figure 134 compares the shape of the sound spectrum measured during a 5 m/s wind event to that of a Vestas V136 3.6 MW wind turbine. As shown, the shapes of the spectra are similar at lower frequencies. At higher frequencies, the sounds from the masking wind noise are higher than the wind turbine. As a result, the masking of turbine noise occurs at higher wind speeds for some meteorological conditions. Masking will occur most, when ground wind speeds are relatively high, creating wind-caused noise such as wind blowing through the trees and interaction of wind with structures.

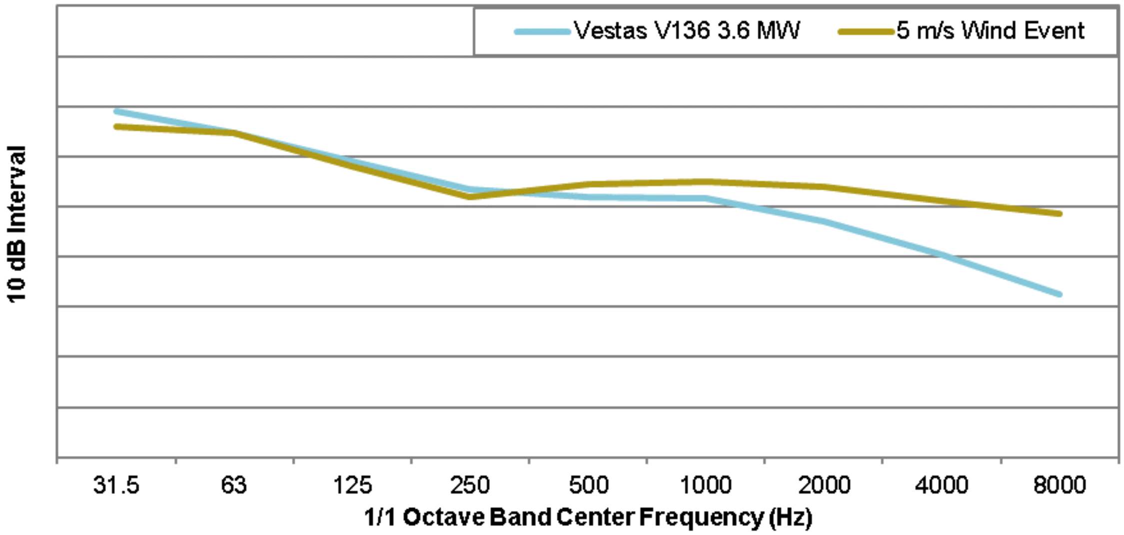

FIGURE 134: COMPARISON OF NORMALIZED FREQUENCY SPECTRA FROM THE WIND AND THE VESTAS V136 3.6 MW[74]

It is important to note that while winds may be blowing at turbine height, there may be little to no wind at ground level. This is especially true during strong wind gradients (high wind shear), which mostly occur at night. This can also occur on the leeward side of ridges where

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[74] The purpose of this Figure is to show the shapes to two spectra relative to one another and not the actual sound level of the two sources of sound. The level of each source was normalized independently. The Vestas V136 3.6 MW spectrum shown here uses, the highest 31.5 and 63 Hz 1/1 octave bands of any turbine considered for this project and are not the published 1/1 octave bands for this turbine.

the ridge blocks the wind. A site-specific analysis of sound level compared to 10-meter wind speed is found in Section 7.3.

8.5 | INFRASOUND AND LOW-FREQUENCY SOUND (ARTICLE 10 19[E] AND STIPULATION 19[E][4])

Infrasound is sound pressure fluctuations at frequencies below about 20 Hz. Sound below this frequency is only audible at high magnitudes. Low-frequency sound is in the audible range of human hearing, that is, above 20 Hz, but below 100 to 200 Hz depending on the definition.

Low-frequency aerodynamic tonal noise is typically associated with downwind rotors on horizontal axis wind turbines. In this configuration, the rotor plane is behind the tower relative to the oncoming wind. As the turbine blades rotate, each blade crosses behind the tower's aerodynamic wake and experiences brief load fluctuations. This causes short, low-frequency pulses or thumping sounds called blade impulsive noise. Large modern wind turbines are "upwind", where the rotor plane is upwind of the tower. As a result, this type of low-frequency noise is at a much lower magnitude with upwind turbines than downwind turbines, well below established infrasonic hearing thresholds.

Figure 135 shows the sound levels 350 meters from a wind turbine when the wind turbine was operating (T-on) and shut down (T-off) for wind speeds at hub height greater than 9 m/s. Measurements were made over approximately two weeks.[75] The red 90 dBG line is shown here as the ISO 7196:1995 perceptibility threshold. As shown, the wind turbines generated measurable infrasound, but at least 20 dB below audibility thresholds.

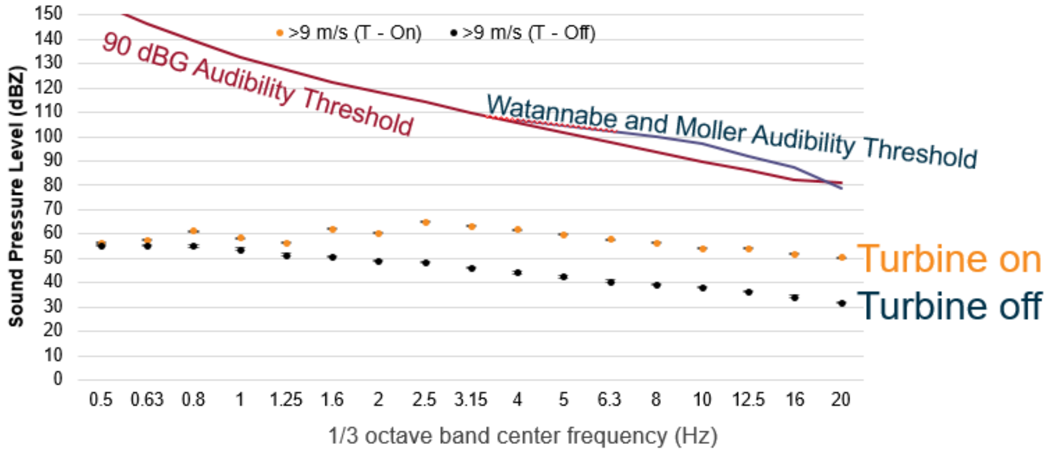

FIGURE 135: INFRASOUND FROM A WIND TURBINE AT 350 METERS COMPARED WITH PERCEPTION THESHOLDS

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[75] RSG, et al., "Massachusetts Study on Wind Turbine Acoustics," Massachusetts Clean Energy Center and Massachusetts Department of Environmental Protection, 2016 – Graphic from RSG presentation to MassDEP WNTAG, March 2016

Existing background infrasound in rural areas are generally comparable to wind turbine infrasound at typical receptor distances. As an example, RSG measured background infrasound just east of the Boutwell Hill State Forest, a relatively remote area in the Town of Cherry Creek, NY.[76] We then compared these measured background levels to those measured 350 meters from an operating wind turbine in Massachusetts.[77] As shown in Figure 136, the background infrasound levels are generally within 10 dB of the wind turbine infrasound, even with the wind turbine operating with wind speeds greater than 9 m/s. In all cases, both background and wind turbine infrasound are over 30 dB below the 90 dBG infrasound perception threshold.

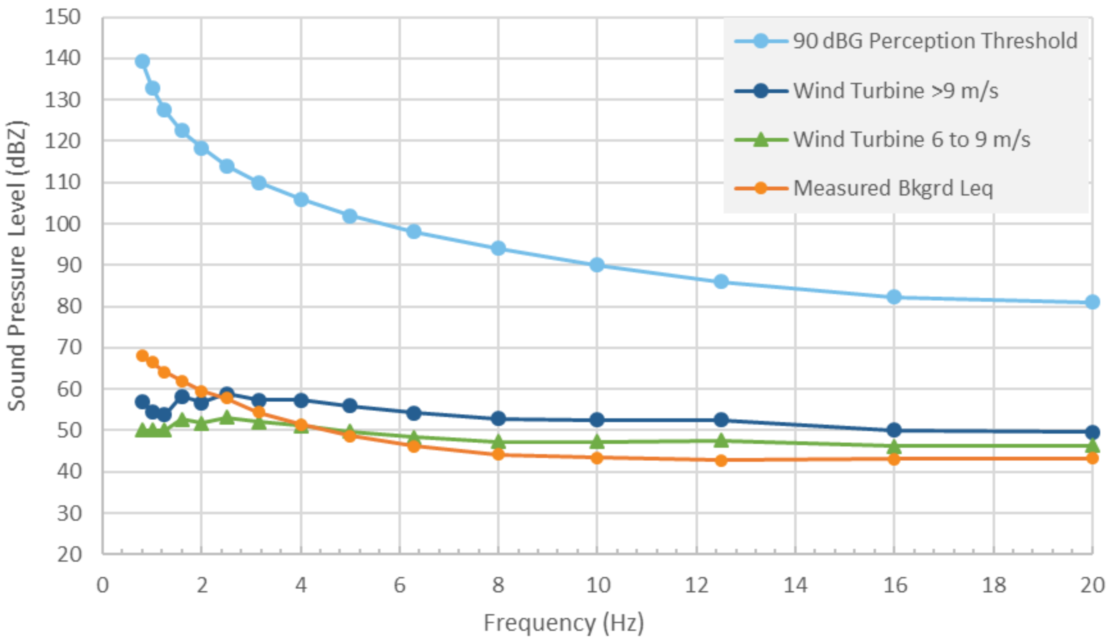

FIGURE 136: COMPARISON OF MEASURED BACKGROUND INFRASOUND AT A REMOTE SITE IN CHERRY CREEK NY WITH THOSE FROM MEASURED 350 METERS FROM AN OPERATING WIND TURBINE AND THE 90 dBG PERCEPTION THRESHOLD.

Low-frequency sound is produced, in part, by the generator and mechanical components. Much of this mechanical noise has been reduced in modern wind turbines through improved sound insulation at the hub. Low-frequency sound can also be generated by the blades at higher wind speeds when the inflow air is turbulent. At these wind speeds, low-frequency sound from the wind turbine blades is often masked by wind noise at the downwind receptors.

Finally, low-frequency sound is absorbed less by the atmosphere and ground than higher frequency sound. Our modeling takes into account frequency-specific ground attenuation and atmospheric absorption factors.

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[76] RSG, "Cassadaga Wind Preconstruction Noise Impact Assessment," Prepared for Cassadaga Wind, LLC, May 2016.
[77] RSG, et al. "Massachusetts study on wind turbine acoustics." Prepared for MassCEC and MassDEP, February 2016

8.6 | WIND TURBINE NOISE ABATEMENT MEASURES (STIPULATION 19(E)(3), ARTICLE 10/STIPULATION 19(J) AND 19(M))

Wind turbine noise can be abated using either factory-installed measures, siting methods, or measures implemented after the project is constructed.

WIND TURBINE DESIGN

Horizontal axis wind turbines, with three blades, positioned upwind of the tower are the only type typically used for utility-scale wind power. Turbines with the blades positioned downwind of the tower are obsolete and cause more noise issues than upwind designs due to the blades passing through the wake of the tower. Vertical axis wind turbines are not available in megawatt scale.

The design of the blade can have a substantial impact on noise generation. Noise control is considered during the blade design process.

Some turbine models are available with serrated trailing edges, that reduce wind turbine aerodynamic noise by smoothing the flow of air behind the blade, reducing turbulence and therefore noise emissions. Depending on the turbine model selected for construction, serrated trailing edge technology may or may not be available. On some models, serrations can be installed after the project is constructed.

PROJECT SITING

Changing of turbine setbacks from sensitive sound receptors can be used to decrease sound levels, however wind turbine layouts must also consider

- Energy production,
- Compliance with wind ordinance setback requirements,
- Compliance with setback requirements for other environmental conditions (water, flora, fauna, etc.),
- Spacing requirements for the turbines themselves,
- Access, and
- Landowner preferences.

As a result, modification of turbine arrangements to decrease sound pressure levels at receptors must be weighed against project performance and feasibility.

NOISE REDUCED OPERATIONS (NRO)

NROs are operations changes to the wind turbine to reduce noise generation. NROs are usually accomplished by adjusting turbine blade pitch, slowing the rotor speed of the turbines, which reduces aerodynamic noise produced by the blades. NROs are a readily available technology on most modern wind turbines and may be used to bring reduce turbine sound power to a level at or below the sound power of the turbine modeled in the Application. NROs can be implemented on as as-needed basis. For example, they can be programmed for selected wind speeds, wind directions, and times of day. The programs can be adjusted at any time after the wind turbines have commenced operations.

PHYSICAL ABATEMENT

Due to the inherent size of wind turbines, many physical noise control measures, such as noise barriers, active noise control, and tree plantings, tend to be impractical and we are unaware of them being implemented at any operating wind projects. At receptors, white noise machines or air conditioning can be used to reduce the prominence of wind turbine noise inside buildings, and the retrofits of residences, such as improved windows can be used to reduce interior sound levels.

9.0 SOUND PROPAGATION MODELING (ARTICLE 10/STIPULATION 19(D))

9.1 | PROCEDURES (STIPULATION 19(D)(3))

AVAILABLE MODELS

ISO 9613-2 is the most widely accepted wind turbine noise modeling methodology. Other algorithms that have been used in wind power projects include:

- CONCAWE.
- Nord2000.
- Harmonoise.
- NZS 6808-1998.

Both Nord2000 and NZS 6808-1998 are the approved method for specific countries (Nordic countries for Nord2000 and New Zealand and Australia for NZS 6808-1998). NZS 6808-1998 is a simplified method that assumes hemispherical sound propagation and uses the air absorption method from ISO 9613-2. Nord2000, Harmonoise, and CONCAWE have refinements that include the ability to calculate sound levels under varying meteorological conditions.

Harmonoise was developed with the aim of becoming the standard algorithm for noise predictions in Europe; although, this never occurred. The algorithm is available as an open source code and is implemented in several noise prediction software packages. Harmonoise allows modeling of various meteorological conditions, beyond the capabilities of ISO 9613-2, along with more sophisticated methods of handling shielding and ground effects. The use of this model for wind turbine noise has been limited, with few studies validating its accuracy.

CONCAWE was originally developed for the petroleum energy industry in Europe. Characteristics of the model that are unique, are the ability to predict sound levels for particular wind speeds and stability classes. The model has been validated for use with wind turbine noise in some studies.

None of these algorithms was originally developed for wind turbine noise prediction.

In the United States ISO 9613-2 is by far the most common algorithm used for sound propagation modeling, particularly for wind turbine noise. To our knowledge, the only other algorithm used is CONCAWE, but only in conjunction with ISO 9613-2 for special cases of modeling annualized sound levels under varying meteorological conditions.

MODELS USED

Modeling for this project was in accordance with the standard ISO 9613-2, “Acoustics – Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation.” The ISO standard states,

> This part of ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level … under meteorological conditions favorable to propagation from sources of known sound emissions. These conditions are for downwind propagation … or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night.

The model takes into account source sound power levels, surface reflection and absorption, atmospheric absorption, geometric divergence, meteorological conditions, walls, barriers, berms, and terrain. The acoustical modeling software used here was CadnaA, from Datakustik GmbH. CadnaA is a widely accepted acoustical propagation modeling tool, used by many noise control professionals in the United States and internationally.

ISO 9613-2 also assumes downwind sound propagation between every source and every receptor, consequently, all wind directions, including the prevailing wind directions, are taken into account.

For long-term modeling (greater or equal to eight-hour averaging times, the ISO 9613-2 model is modified using CONCAWE meteorological adjustments. This process is described in detail in Section 9.6.

MODELING ASSUMPTIONS (STIPULATION 19(D)(4))

Seventy-six turbine locations were modeled with the Vestas V136 3.6 MW turbine. The project area was modeled with mixed ground (G=0.5) with no dense foliage. To account for additional uncertainty, 2 dB was added to the results. These model parameters have been shown to yield conservative results for wind turbines, though the level of conservativeness depends upon several factors including: turbine layout, meteorology, receptor height, and topography.[78,79,80,81,82] Model input parameters are listed in Appendix B.

An alternative modeling methodology suggested by Bowdler et al 2009 is to model with the apparent sound power level, with hard ground (G=0), and 0 dB added to the results. To determine which would yield a higher sound level, we modeled the project using this method

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[78] Duncan, E., and Kaliski, K., "Improving Sound Propagation Modeling for Wind Power Projects", Acoustics '08, 2008, Paris, France.

[79] Bowdler, Dick et al., "Prediction and Assessment of Wind Turbine Noise: Agreement about Relevant Factors for Noise Assessment from Wind Energy Projects." Acoustics Bulletin. 34(2), pp. 35-37.

[80] Evans, Tom and Cooper, Jonathan. "Comparison of Predicted and Measured Wind Farm Noise Levels and Implications for Assessments of New Wind Farms." Acoustics Australia: April 2012. Vol. 40, No. 1.

[81] RSG, et al., "Massachusetts Study on Wind Turbine Acoustics," Massachusetts Clean Energy Center and Massachusetts Department of Environmental Protection, 2016 Chapter 6

[82] "A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise." Institute of Acoustics. May 2013.

and compared the results to G = 0.5 plus 2 dB as described in the previous paragraph. We found that the previous method yielded equal or higher sound pressure levels for 84 percent of the receptors, and 99 percent of the results were within a range of -2.0 dB to +0.5 dB (where the negative results indicate higher levels for the previous method). We therefore proceeded to use G = 0.5 plus 2 dB for the remainder of the modeling.

These parameters are most conservative for flat terrain and least conservative, but still conservative, for concave terrain. To assess the concavity of the terrain around the Project, we evaluated the mean propagation height for any nonparticipating receptor with a maximum one-hour L_{eq} of 43.5 dBA or greater. Concave terrain was reported when the mean propagation height exceeds 1.5 (abs ($h_s - h_r$) /2), where h_s is the turbine height above ground (82 meters) and h_r is the receptor height above ground (4 meters).[83] The result of the analysis showed that no receptor with a modeled sound level of 43.5 dBA or higher had concave terrain between the source and receptor.

Receptor heights will affect the modeled sound level. A 4-meter (13 foot) receptor height generally results in 1 to 2 dB higher predictions than a 1.5-meter (5 foot) receptor height. In our modeling, 4 meters was used for modeling discrete receptors (like homes) and 1.5 meters was used for contour mapping.

Turbines were modeled at the manufacturer's published maximum apparent sound power level of 105.5 dBA. (Stipulation 19(e)(5)) This sound power was based on measurements made by the manufacturer using a prototype turbine. This turbine was selected because the applicant is committing to only select a turbine that can achieve a manufacturer guaranteed apparent sound power of 105.5 dBA or less, to minimize sound impacts.

Uncertainty in the model was accounted for by the use of harder ground than what exists around the project, four-meter receptor heights, and an additional 2 dB added to the results.

For low-frequency noise, the highest 31.5 and 63 Hz 1/1 Octave band sound power of any turbine considered was modeled instead of the published Vestas data for the same frequencies. All turbine data used is the most recently available from the manufacturer at the time of this writing.

Results calculated with these parameters are used to model the maximum one-hour equivalent average sound level.

The transformer sound power is shown in Table 17. It was determined using the manufacturer's design sound pressure level of 81 dBA (measured according to IEEE C57.12), along with the dimensions and spectrum of a similar sized transformer measured elsewhere by RSG.

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[83] "A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise." Institute of Acoustics. May 2013.

9.2 | TONALITY (ARTICLE 10/STIPULATION 19(E)(2))

Tonal prominence of the Vestas V136 3.6 MW turbine is shown in Figure 137 and the tonal prominence of the transformer is shown in Figure 138. In the case of the turbine, the tonality criteria of ANSI S12.9 Part 4 is not met in any 1/3 octave band. The transformer meets the criteria for the Fans Off (ONAN) conditions, but not the Fans On (ONAF) condition. Transformers are usually tonal in the 125 Hz, 250 Hz, 315 Hz, 500 Hz, or 630 Hz 1/3 octave bands during the ONAN condition, but not the ONAF condition due to masking from the cooling fans. The higher sound power of the ONAF configuration was modeled as a conservative assumption.

Note that this tonality analysis is based on the sound power of the source and not the sound pressure level at the receiver. Tonality is generally reduced at the receiver due to masking from broadband background sound.

TABLE 17: TRANSFORMER SOUND POWER SPECTRUM

Source	1/1 Octave Band Center Frequency									Sum	Sum
	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	(dBA)	(dBZ)
Transformer - ONAF	97	98	114	105	107	101	94	85	75	107	115
Transformer - ONAN	84	82	113	102	105	82	69	62	57	104	114

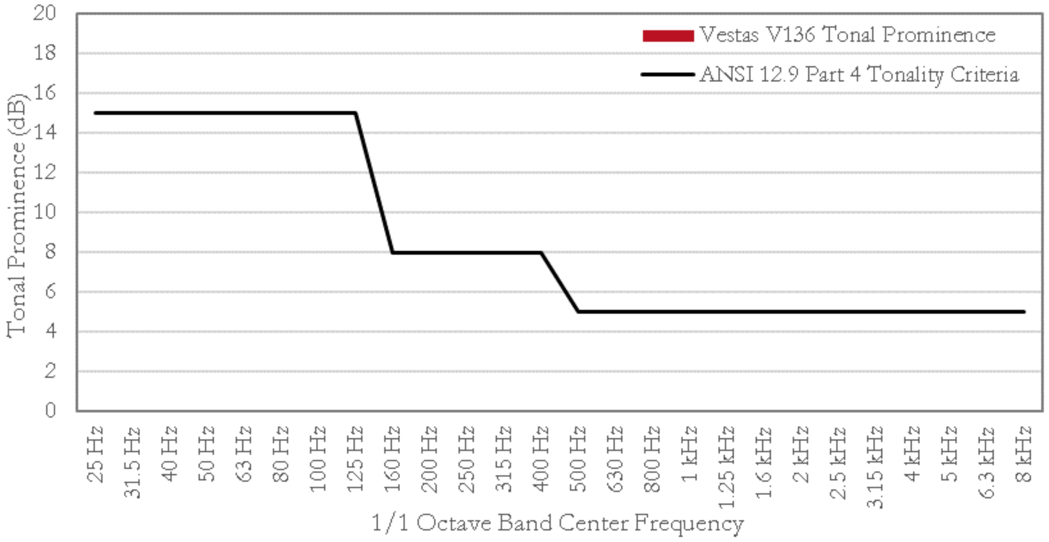

FIGURE 137: VESTAS V136 3.6 MW TURBINE TONAL PROMINENCE

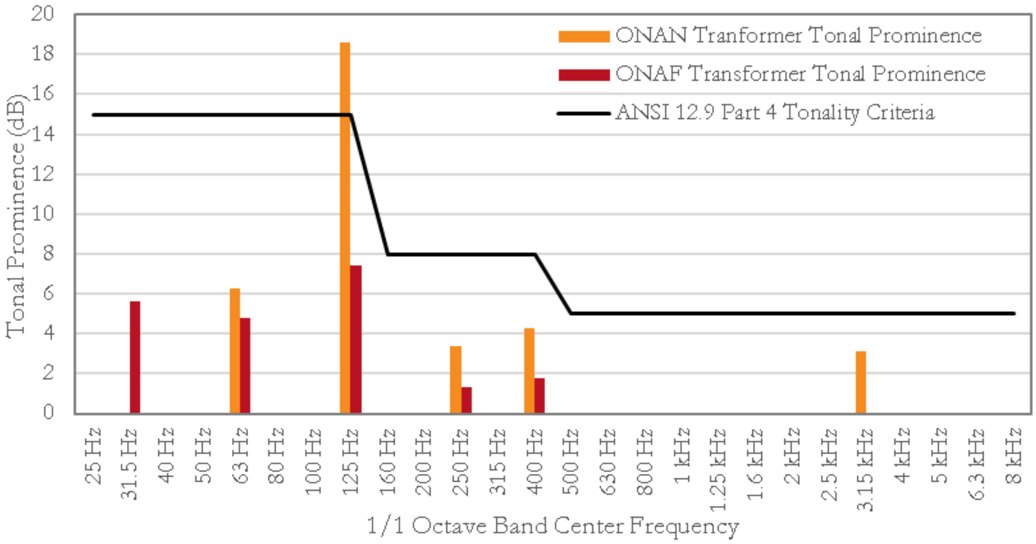

FIGURE 138: TYPICAL TRANSFORMER TONAL PROMINENCE

9.3 | SHORT-TERM MODELING RESULTS (ARTICLE 10/STIPULATION D(1))

Mitigated short-term sound propagation modeling results are shown in Figures 139 to 150. Results show sound levels are at or below 45 dBA L_{1h} at all nonparticipating receptors and at or below 43.9 dBA L_{1h} at all nonparticipating residences in the Town of Cohocton. Mitigation was achieved through used of NROs or shutdowns on appropriate turbines. Sound propagation modeling results at each individual receptor location are shown in Table 31 for A-weighted results and Table 32 for 1/1 octave band results, both located in Appendix C.

Table 18 shows low-frequency sound propagation modeling results for the worst-case nonparticipating receptor. Results are less than or equal to ANSI S12.9 Part 4 Annex D and ANSI S12.2 Section 6 criteria in the 31.5 Hz and 63 Hz 1/1 octave bands. The 65 dB threshold is exceeded in the 16 Hz 1/1 octave band by up to 1.5 dB. Note that the 16 Hz octave band data is extrapolated based upon measurements at other wind power projects and this extrapolation is based on the 31.5 Hz and 63 Hz bands of the worst-case turbine considered for this project. If low-frequency data were used for the Vestas V136 3.6 MW, there would not be an exceedance.

Figure 151 shows extrapolated infrasonic emissions at the worst-case nonparticipating receptor. This data is based on the slope of low-frequency and infrasonic sound level data for the Vestas V136 3.6 MW turbine for the 16 and 8 Hz 1/1 octave bands, as well as the measured slope of infrasound from wind turbines.[84] Results show sound levels, ranging from 20 to 80 dB below infrasonic hearing thresholds.

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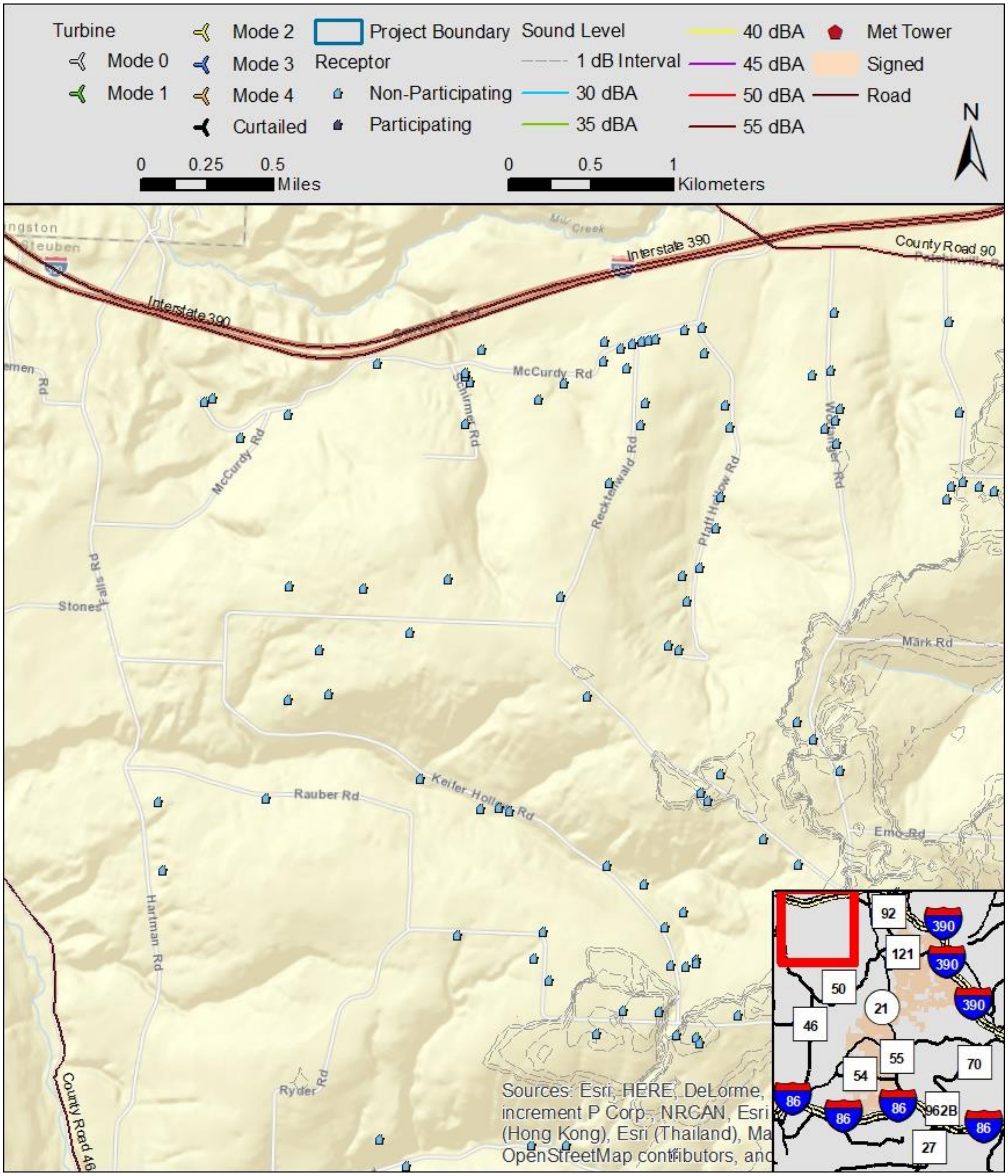
[84] RSG, et al., “Massachusetts Study on Wind Turbine Acoustics,” Massachusetts Clean Energy Center and Massachusetts Department of Environmental Protection, 2016 Chapter 6



Sources: Esri, HERE, DeLorme, increment P Corp., NRCAN, Esri (Hong Kong), Esri (Thailand), Ma OpenStreetMap contributors, and

FIGURE 139: MITIGATED SHORT-TERM SOUND PROPAGATION MODELING RESULTS—VIEW 1 (ARTICLE 10/STIPULATION 19(A))

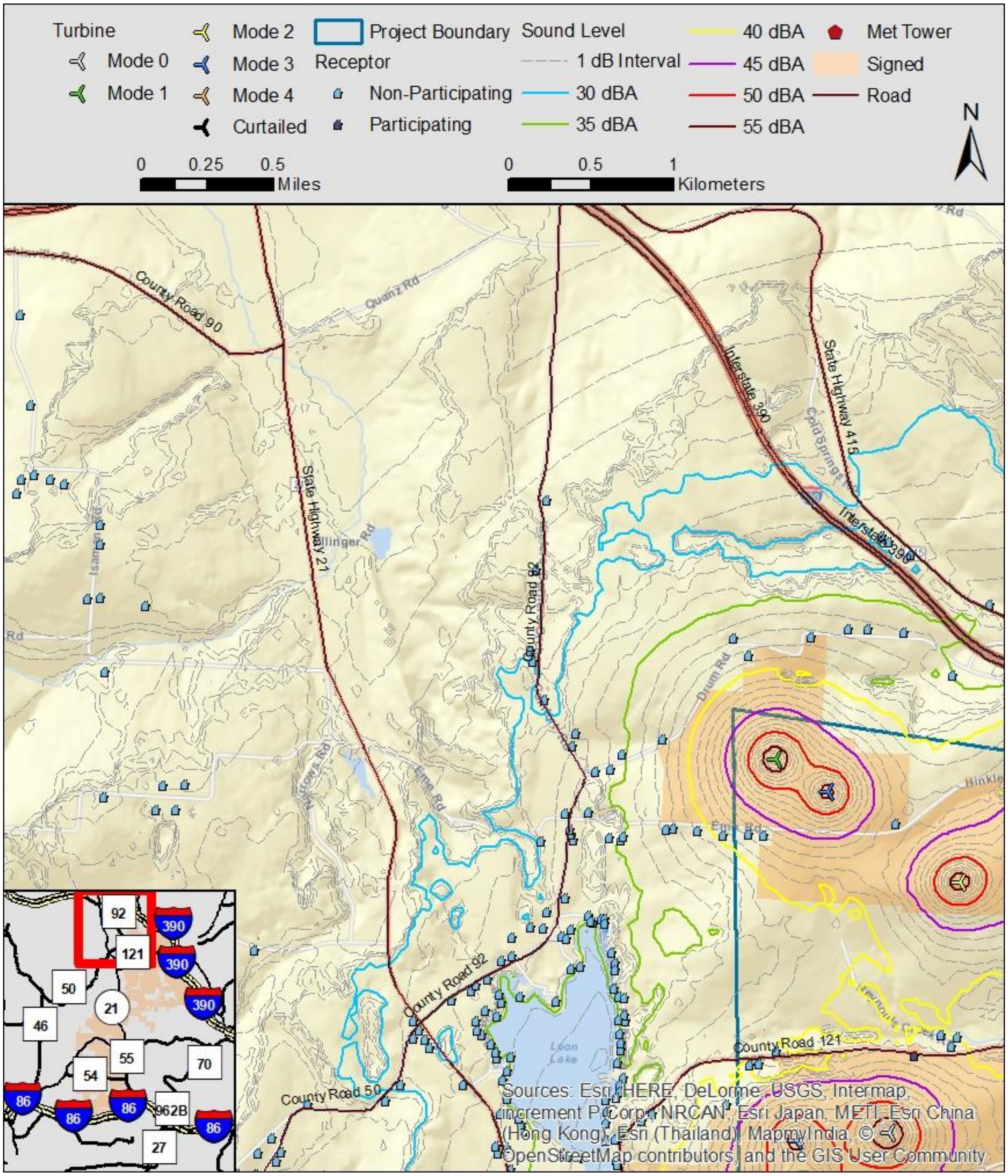


FIGURE 140: MITIGATED SHORT-TERM SOUND PROPAGATION MODELING RESULTS - VIEW 2 (ARTICLE 10/STIPULATION 19(A))

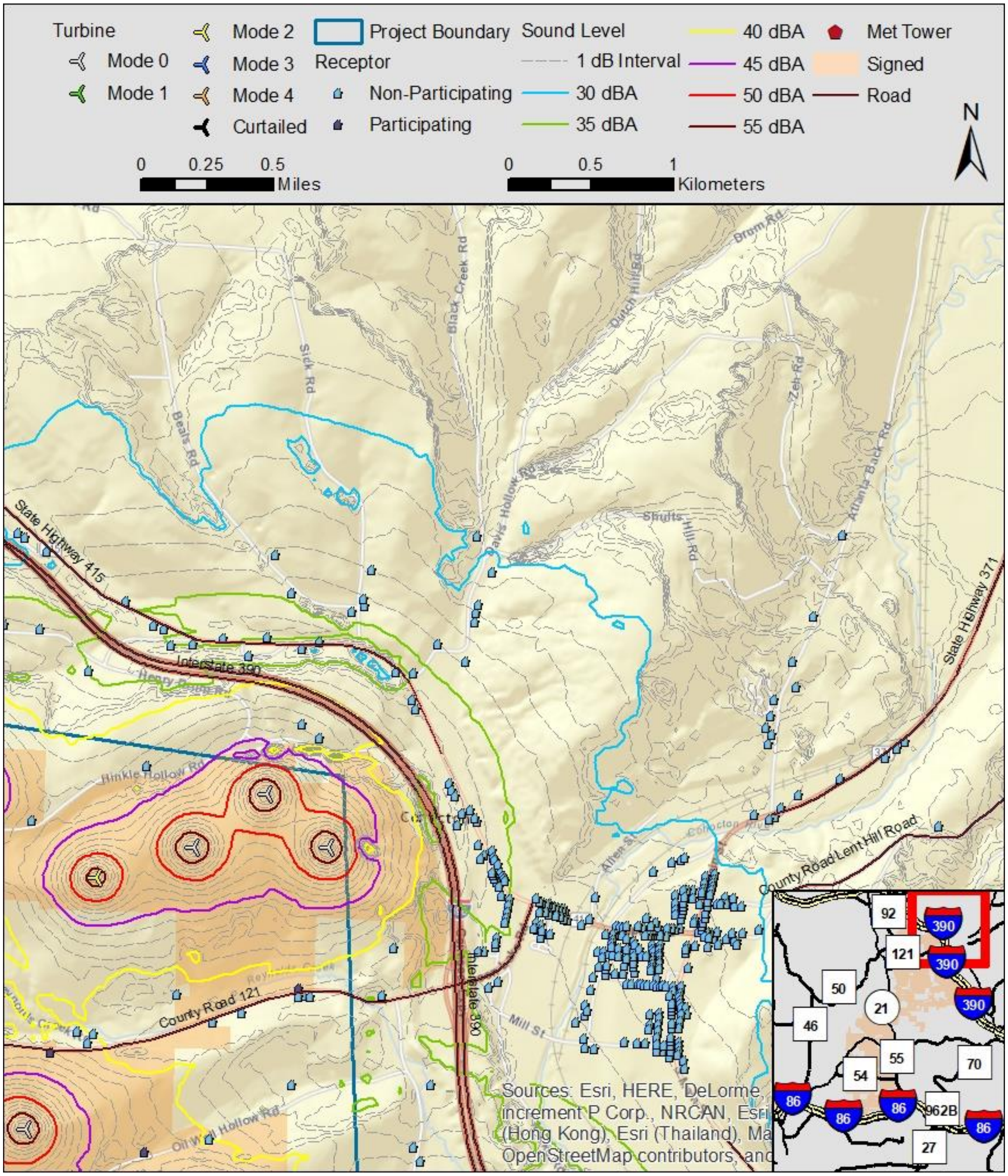
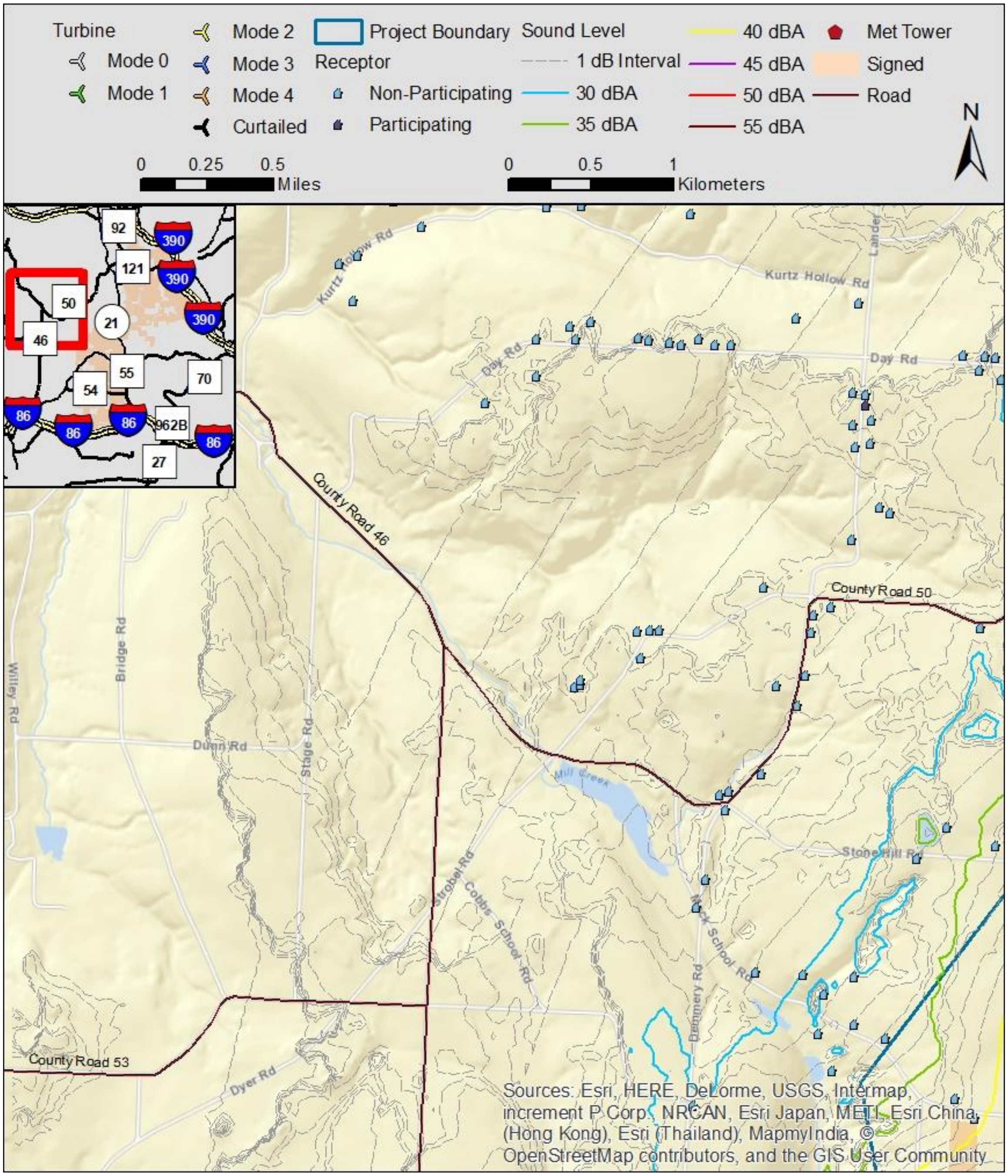


FIGURE 141: MITIGATED SHORT-TERM SOUND PROPAGATION MODELING RESULTS—VIEW 3 (ARTICLE 10/STIPULATION 19(A))



Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

FIGURE 142: MITIGATED SHORT-TERM SOUND PROPAGATION MODELING RESULTS—VIEW 4 (ARTICLE 10/STIPULATION 19(A))

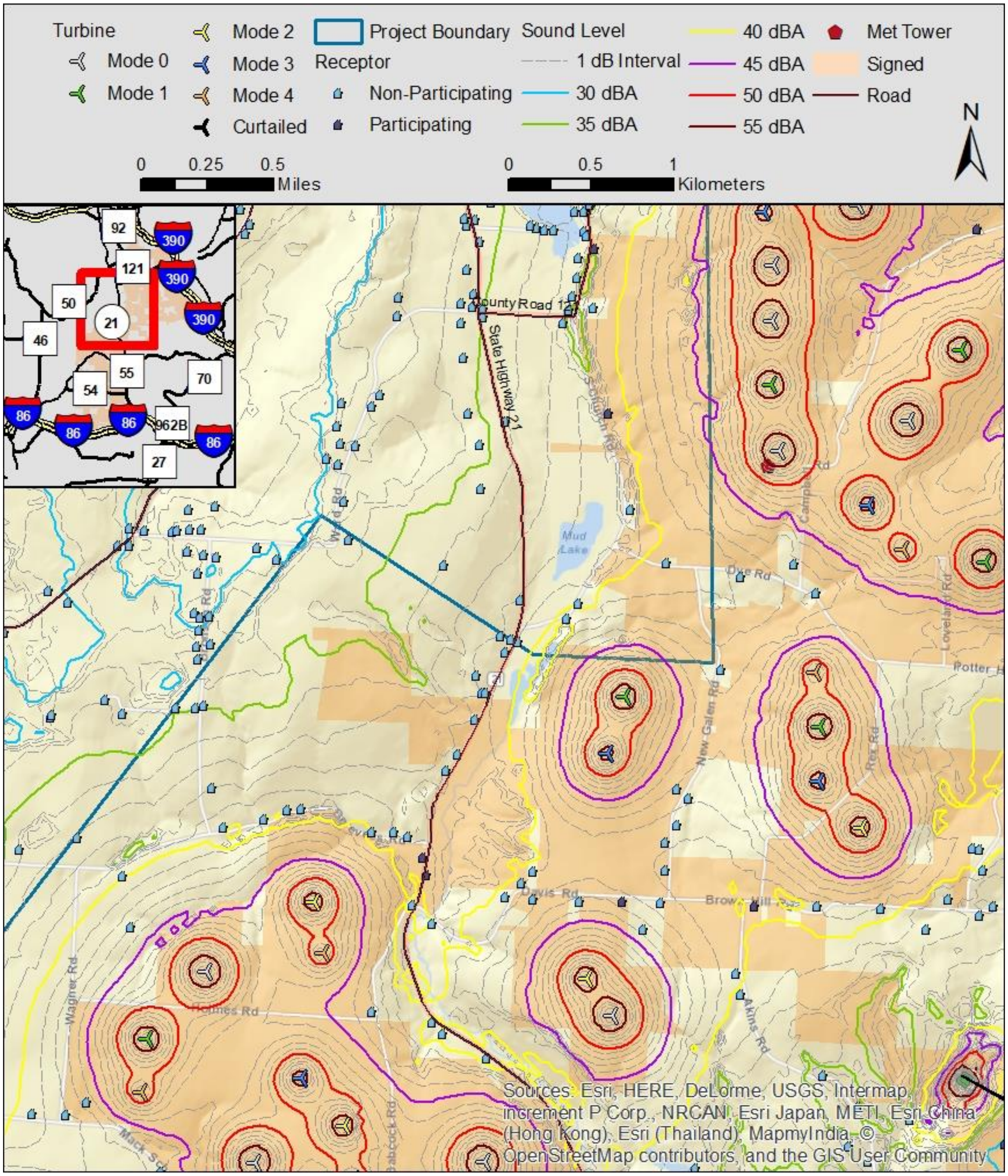


FIGURE 143: MITIGATED SHORT-TERM SOUND PROPAGATION MODELING RESULTS—VIEW 5 (ARTICLE 10/STIPULATION 19(A))

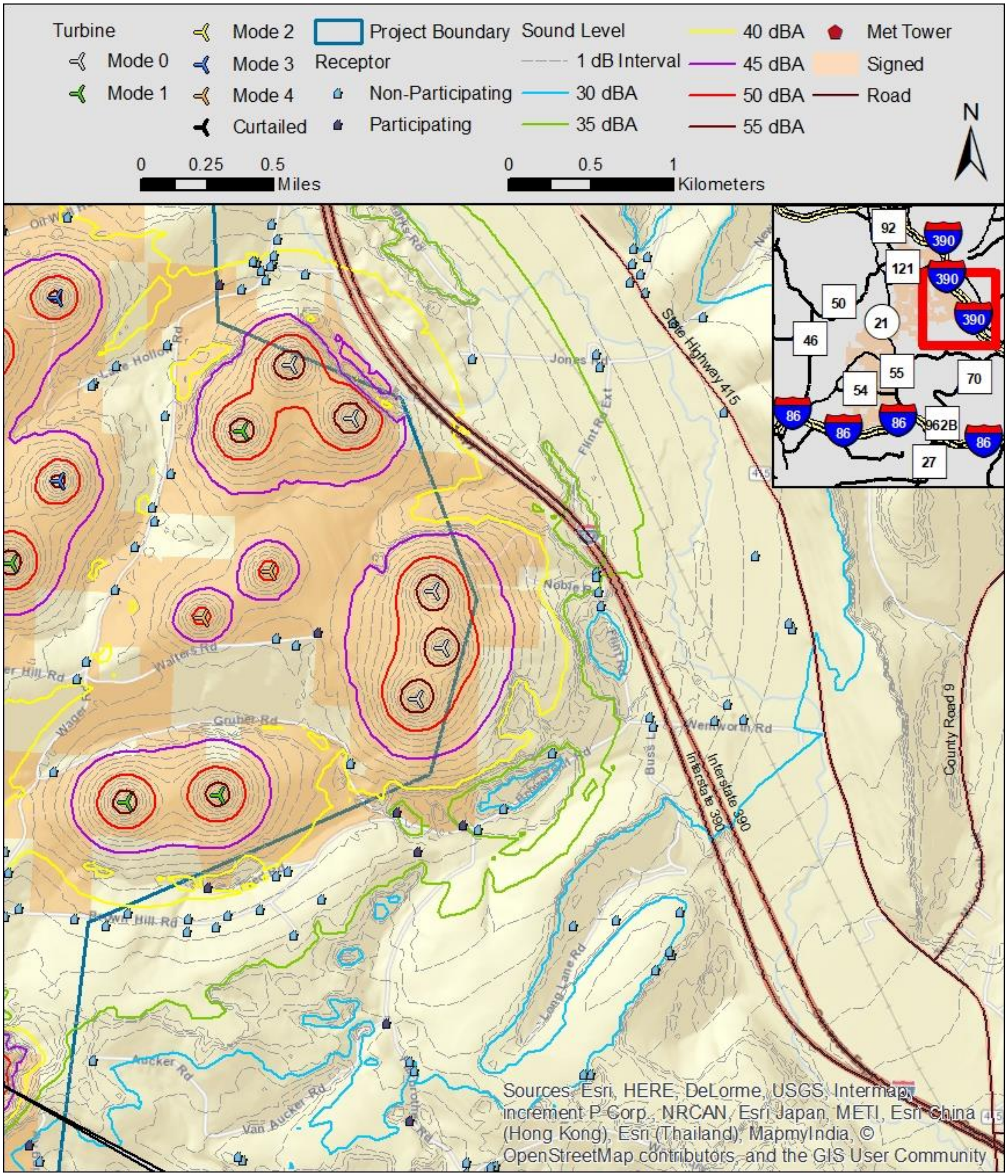


FIGURE 144: MITIGATED SHORT-TERM SOUND PROPAGATION MODELING RESULTS—VIEW 6 (ARTICLE 10/STIPULATION 19(A))

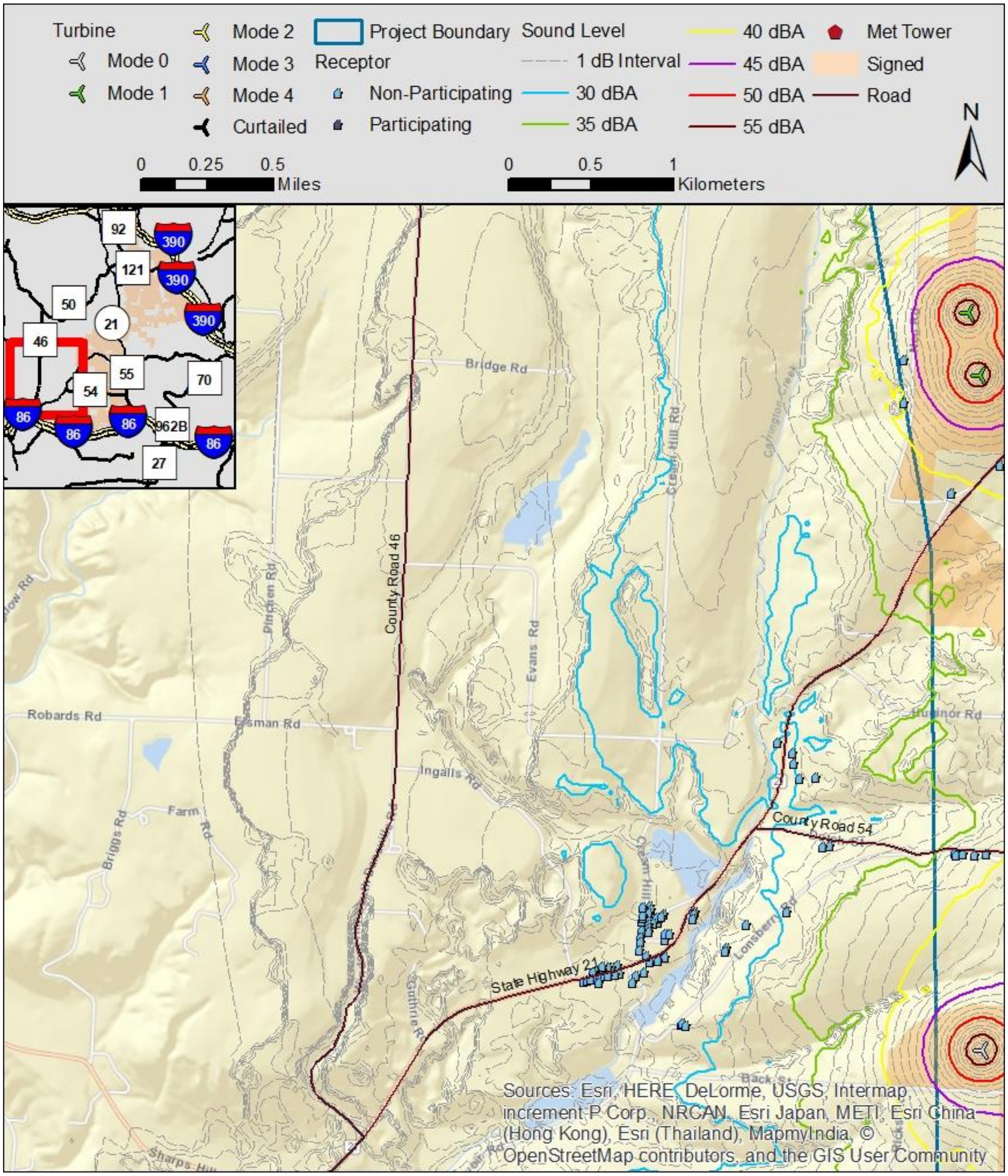


FIGURE 145: MITIGATED SHORT-TERM SOUND PROPAGATION MODELING RESULTS—VIEW 7 (ARTICLE 10/STIPULATION 19(A))

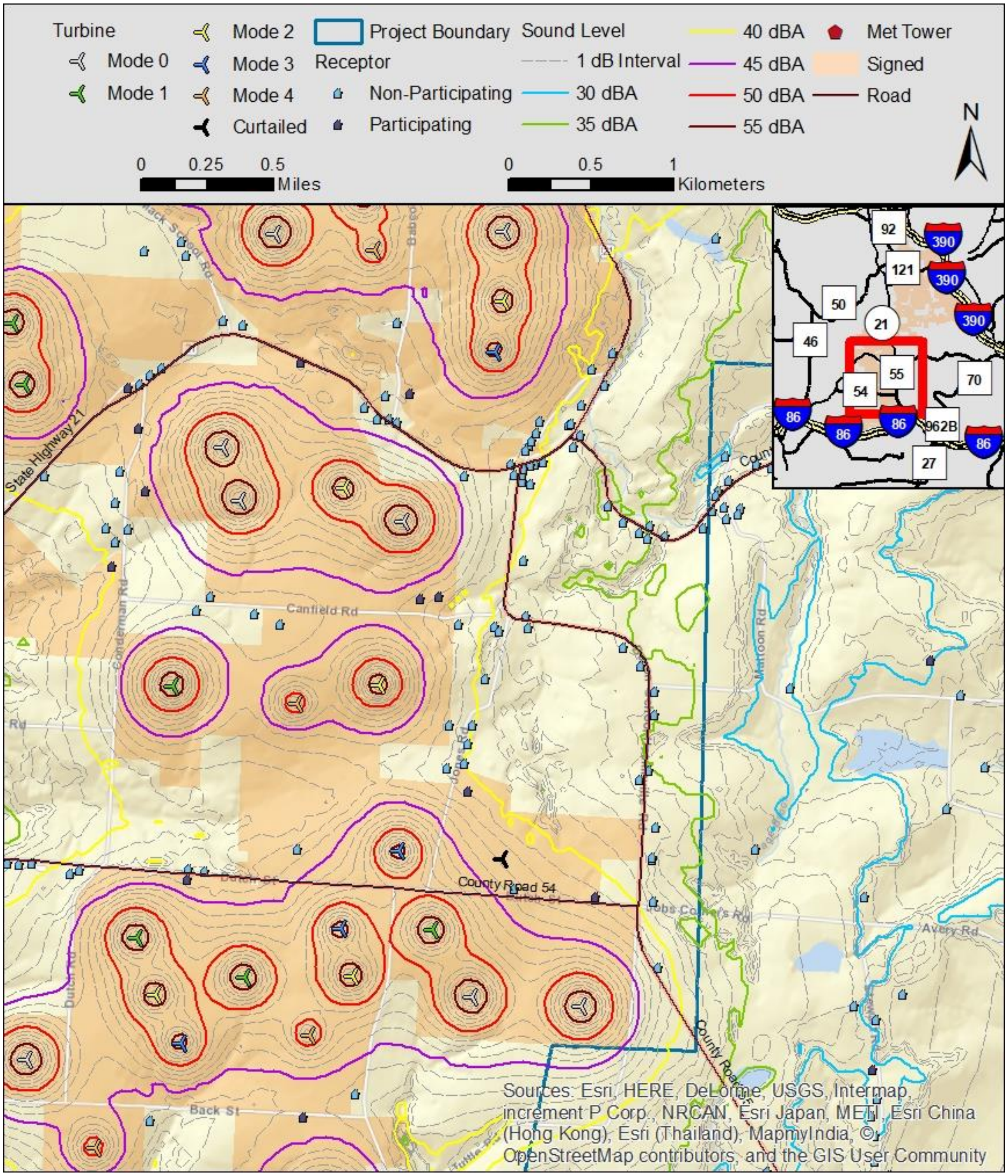


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FIGURE 146: MITIGATED SHORT-TERM SOUND PROPAGATION MODELING RESULTS—VIEW 8 (ARTICLE 10/STIPULATION 19(A))

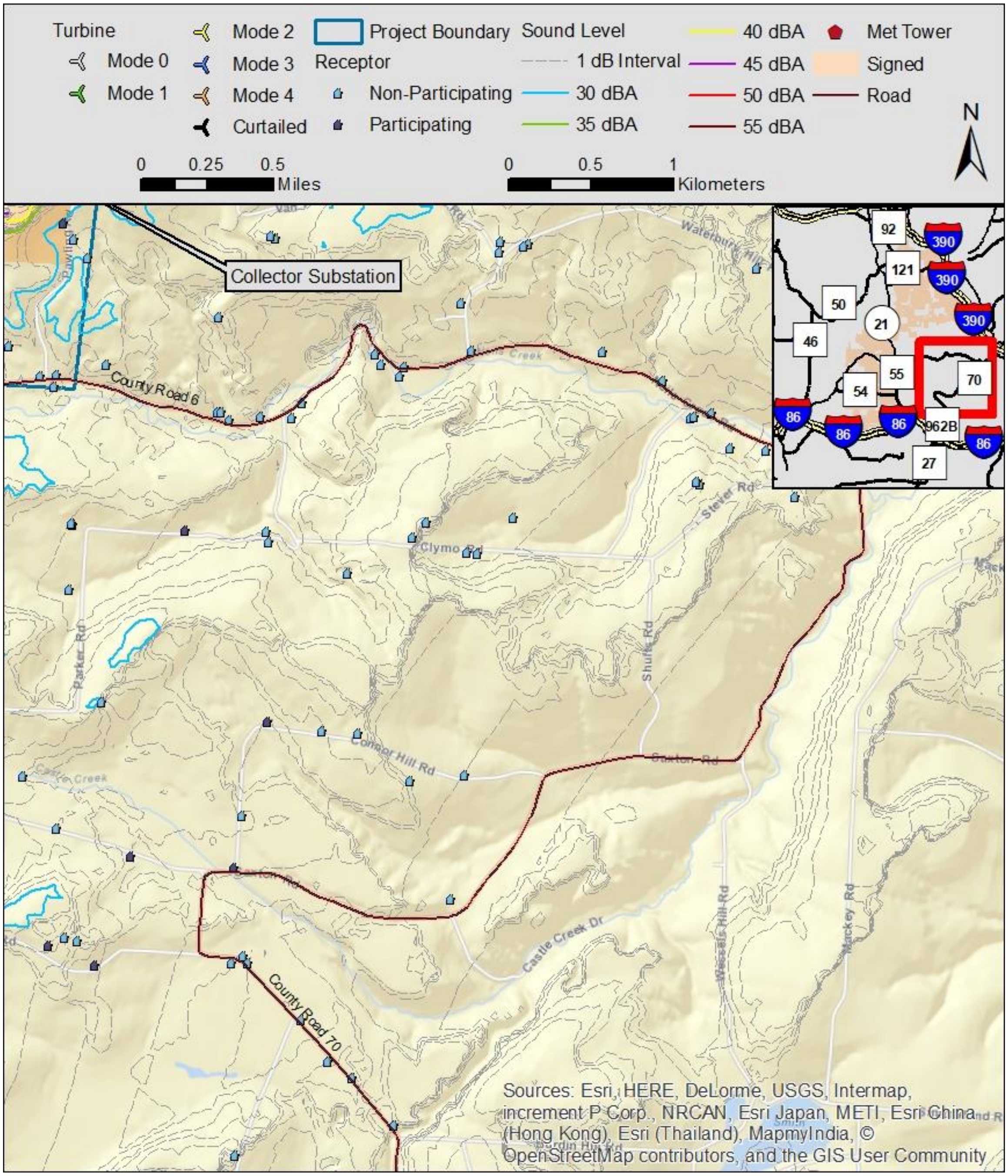


FIGURE 147: MITIGATED SHORT-TERM SOUND PROPAGATION MODELING RESULTS—VIEW 9 (ARTICLE 10/STIPULATION 19(A))

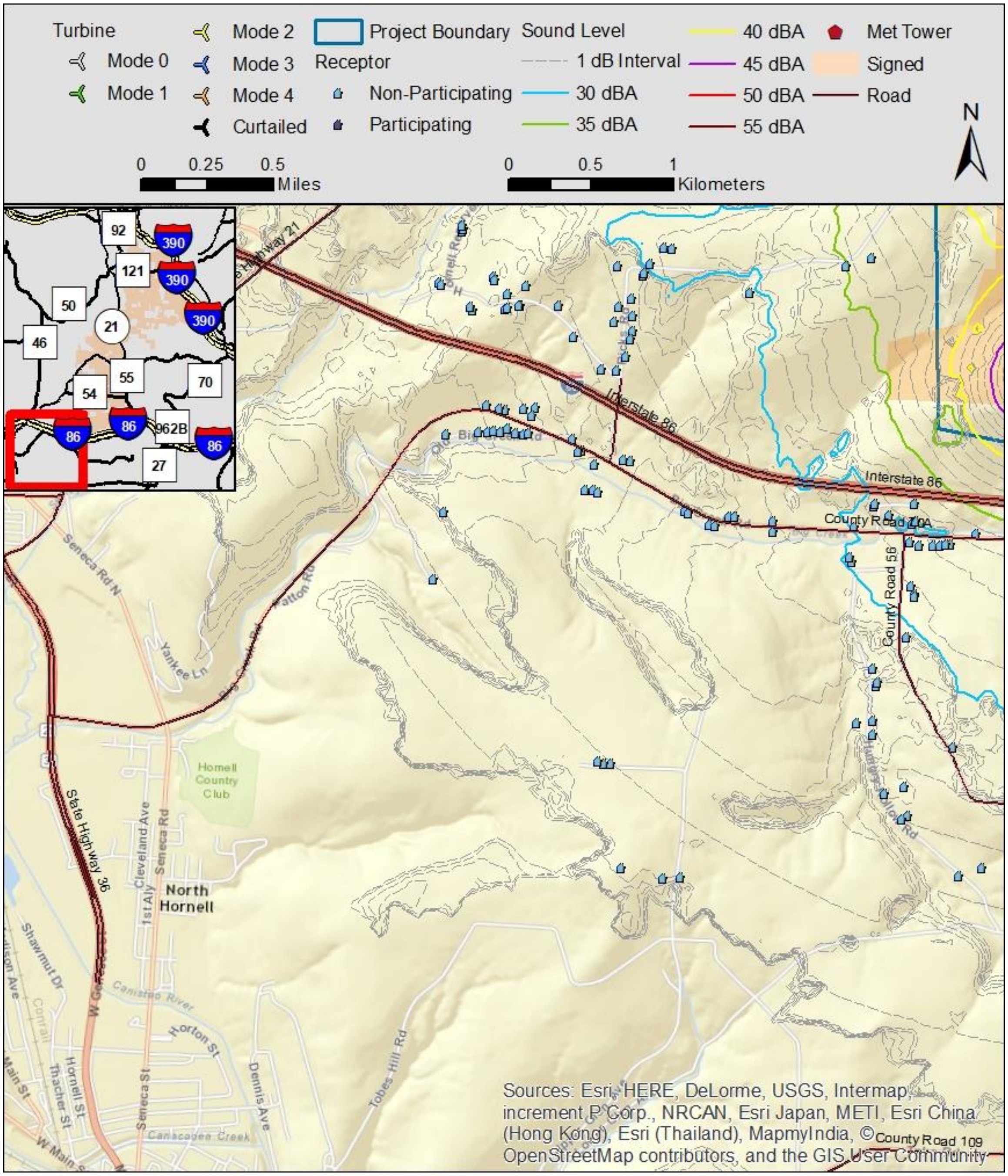
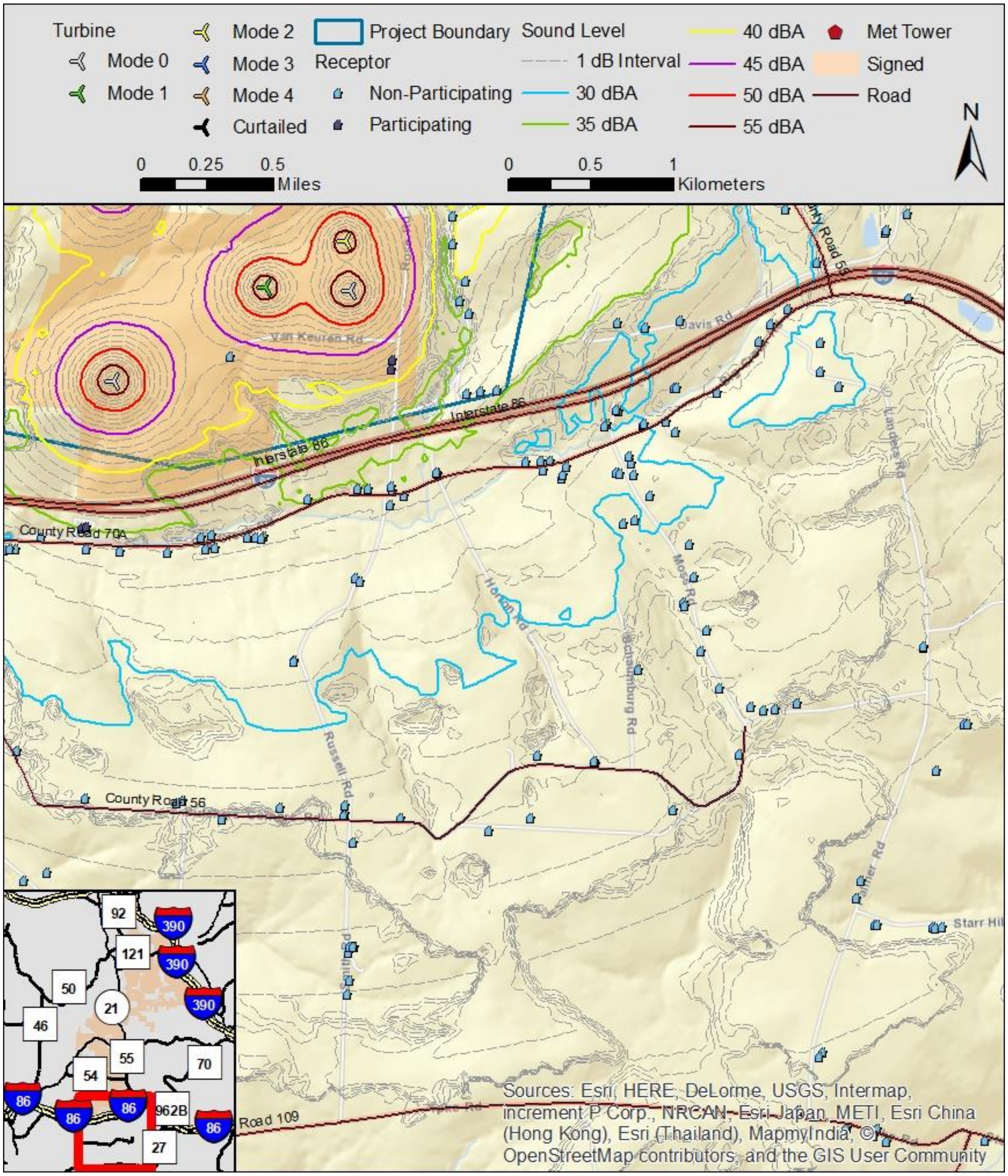
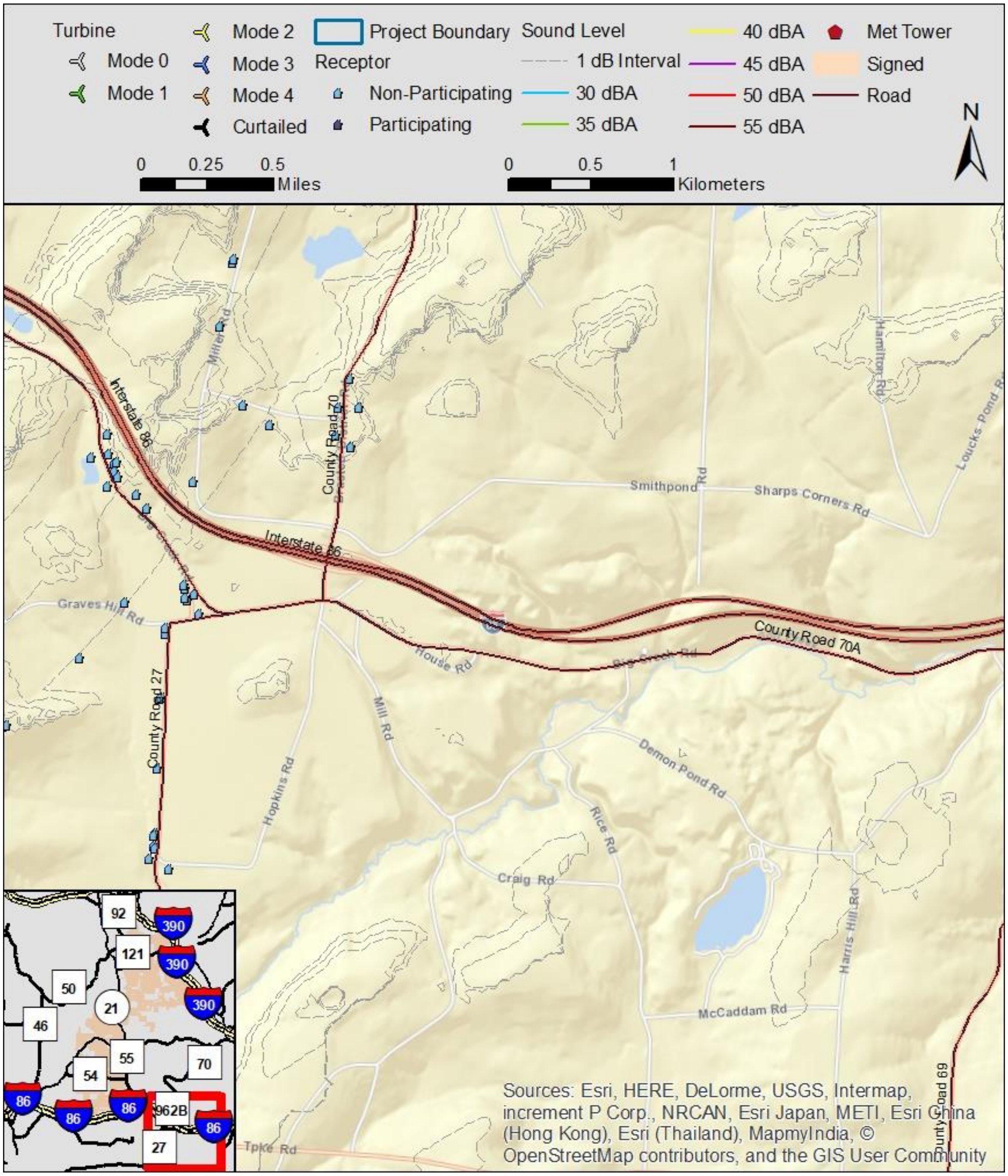


FIGURE 148: MITIGATED SHORT-TERM SOUND PROPAGATION MODELING RESULTS—VIEW 10 (ARTICLE 10/STIPULATION 19(A))



Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

FIGURE 149: MITIGATED SHORT-TERM SOUND PROPGATION MODELING RESULTS—VIEW 11 (ARTICLE 10/STIPULATION 19(A))



Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

FIGURE 150: MITIGATED SHORT-TERM SOUND PROPGATION MODELING RESULTS - VIEW 12 (ARTICLE 10/STIPULATION 19(A))

TABLE 18: LOW-FREQUENCY MODELING RESULTS AND COMPARISON WITH THRESHOLDS (STIPULATION 19(E)(4) AND 19(K)(4))

Descriptor	1/1 Octave Band Sound Level (dBZ)		
	16 Hz	31.5 Hz	63 Hz
ANSI S12.2 Section 6			
Moderately Perceptible Vibration and Rattle Likely	65	65	70
ANSI S12.9 Part 4 Annex D			
Sound Level Below Which Annoyance is Minimal	65	65	65
Modeled Project Low-Frequency Sound			
Worst-Case Nonparticipating Receptor[85]	**66**[86]	**64**	**60**

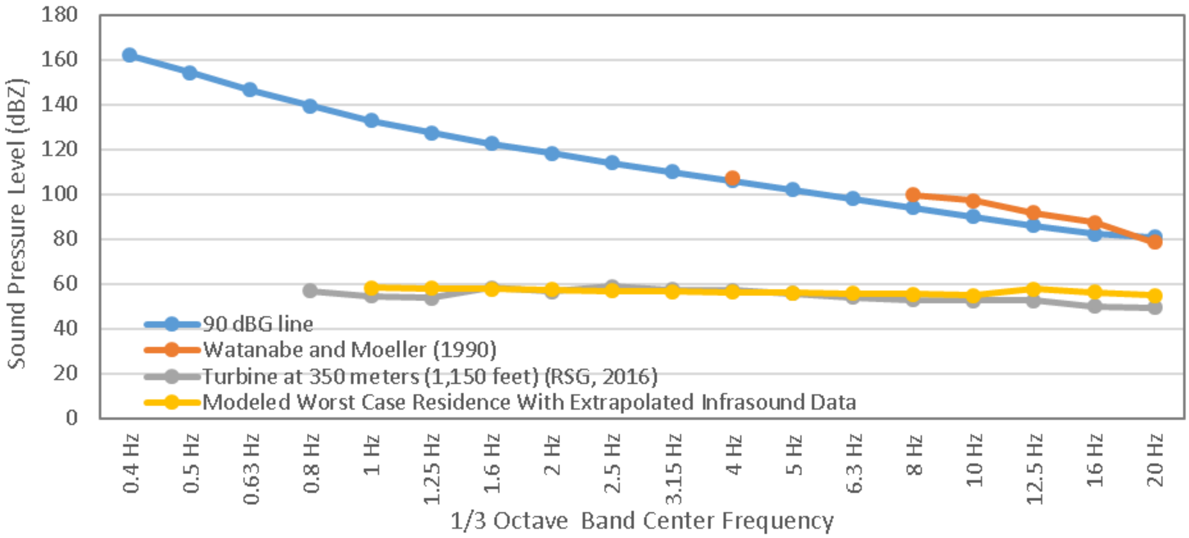


FIGURE 151: EXTRAPOLATED INFRASONIC EMISSIONS FOR BARON WINDS PROJECT COMPARED WITH MEASURED DATA AND INFRASONIC HEARING THRESHOLDS

9.4 | NUMBER HIGHLY ANNOYED (ARTICLE 10/STIPULATION 19(K))

The projected number of highly annoyed receptors is shown in Table 19. The data was derived from results of the Health Canada study on wind turbine noise annoyance along with adjustments to sound levels to compensate for differences in sound propagation

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[85] Modeling results obtained using hybrid wind turbine sound power spectrum. Vestas V136 3.6 MW data used for the 125 to 8 kHz 1/1 octave bands and data for the worst-case considered turbine used for the 31.5 and 63 Hz 1/1 octave bands.

[86] Extrapolated, based upon typical spectral slope shape of Vestas V136 3.6 MW turbine, from the 31.5 Hz 1/1 octave band result of the worst-case turbine considered for the project.

modeling methods with the current report.[87,88] That is, Health Canada modeled using ISO 9613-2 with the wind turbine's apparent sound power, a ground factor of G=0.7, and a 4-meter receiver height, while this report uses the same methodology with a ground factor of 0.5.

The results in Table 19 show that approximately 22 receptors will be highly annoyed due to wind turbine noise indoors. This corresponds to approximately 2.3 percent of the receptors located in the sound level range analyzed (> 30 dBA).

TABLE 19: PROJECTED NUMBER HIGHLY ANNOYED—BASED ON HEALTH CANADA DATA

Sound Pressure Level (1-hour L_{eq}–dBA)	Number of Receptors at Sound Pressure Level	Percent Highly Annoyed Indoors	Percent Highly Annoyed Outdoors	Receptors Highly Annoyed Indoors	Receptors Highly Annoyed Outdoors
30	61	0.8	0.7	0.5	0.4
31	68	0.9	0.9	0.6	0.6
32	95	1.1	1.1	1.0	1.1
33	104	1.3	1.4	1.3	1.5
34	145	1.5	1.7	2.2	2.5
35	95	1.8	2.2	1.7	2.0
36	70	2.1	2.6	1.4	1.8
37	36	2.4	3.2	0.9	1.1
38	39	2.8	3.8	1.1	1.5
39	30	3.3	4.6	1.0	1.4
40	42	3.8	5.5	1.6	2.3
41	34	4.4	6.5	1.5	2.2
42	51	5.0	7.7	2.6	3.9
43	18	5.8	9.0	1.0	1.6
44	26	6.7	10.6	1.7	2.7
45	21	7.6	12.3	1.6	2.6
46	0	8.7	14.2	0.0	0.0
47	0	9.9	16.4	0.0	0.0
48	0	11.3	18.8	0.0	0.0
49	0	12.8	21.5	0.0	0.0
50	0	14.4	24.5	0.0	0.0
Total	935			21.7	29.4

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[87] Michaud, David, et al. "Exposure to Wind Turbine Noise: Perceptual Responses and Reported Health Effects." *J. Acoust. Soc. Am.* 139(3). March 2016. pp. 1443-1454.

[88] Old, I., Kaliski, K., "Wind turbine noise dose response – Comparison of recent studies," Proceedings of the 7th International Conference of Wind Turbine Noise, May 2017.

9.5 | CUMULATIVE IMPACT MODELING (ARTICLE 10 19(E) AND STIPULATION 19(D)(4))

Cumulative impact modeling is the inclusion of other nearby wind projects in the modeling.

Before cumulative impact modeling is done, a screening assessment was performed to determine if the other nearby wind projects, specifically Cohocton/Dutch Hill and Howard, would contribute to the sound levels in the Baron project area.

The screening analysis was conducted using the following steps:

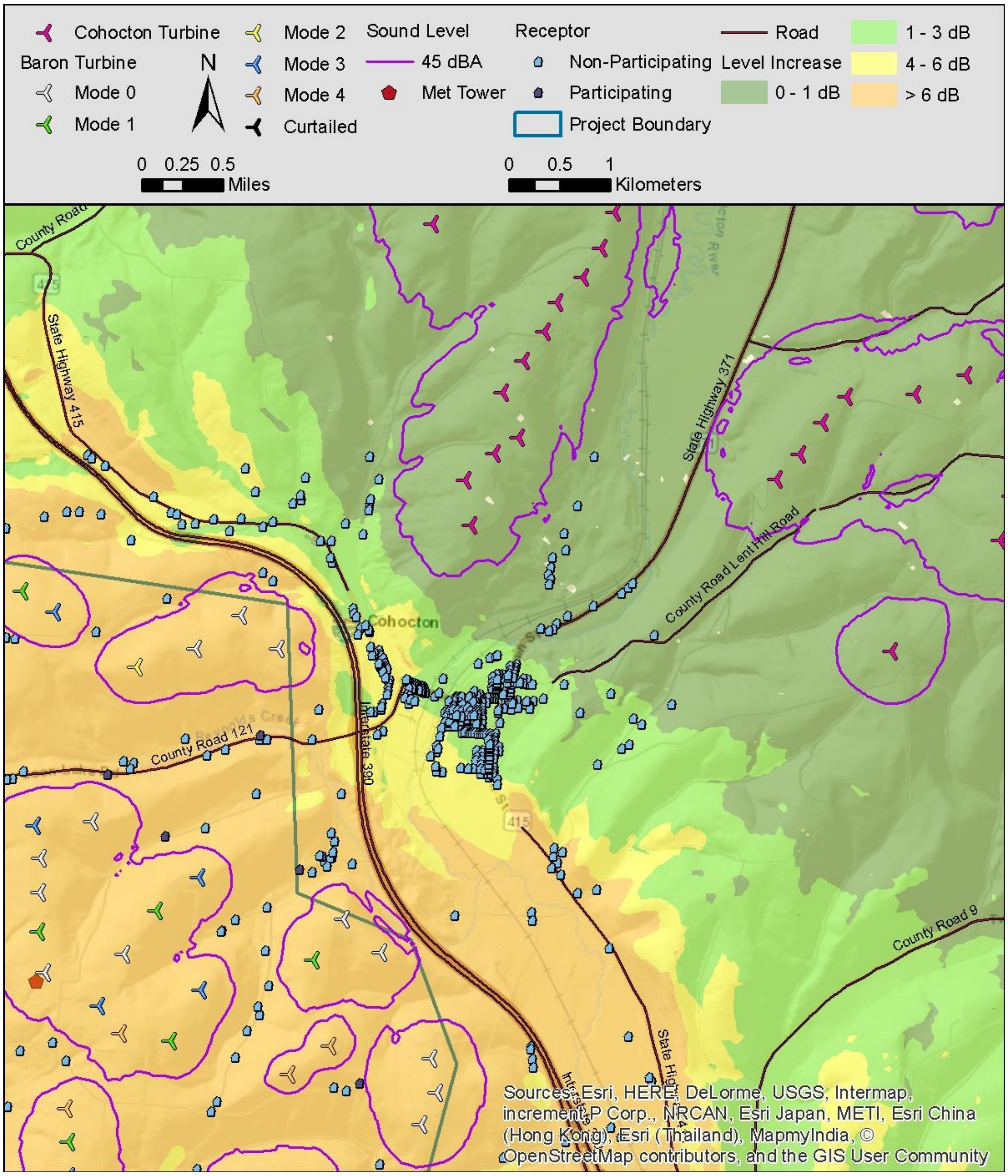
1) 10-minute L_{90} sound levels for the closest monitors to Cohocton/Dutch Hill and Howard were collected. These monitoring locations were:
    a. Henkle Hollow, which was 1.5 miles from the closest Cohocton wind turbines north of the Project.
    b. Dye Road, which was 1.4 miles from the closest Cohocton turbine in the middle of the Project.
    c. Rose Road, which was 2.8 miles from the closest Howard turbine, south of the Project.
2) 10-minute L_{90} sound levels were obtained for the remaining "background" locations, which included Kurtz, Haskinville, Brasted Rd, and Loon Lake.
3) The data were screen to only include periods when background contamination would be limited. Given the proximity of Henkle Hollow and Rose Road to interstate highways, we chose to include only nighttime sound levels, from 10 pm to 7 am, when traffic noise contamination would be lowest. We then disqualified any period where the difference between the L_{90} and L_{eq} was greater than 80th percentile difference for that monitoring location.
4) The remaining background sound levels were arithmetically averaged for each 10-minute period.
5) The averaged background sound level from Step 4 was then logarithmically subtracted from the cumulative impact locations in Step 1 to obtain a "Howard-only" or "Cohocton-only" sound level for each valid 10-minute period.
6) These sound levels from Step 5 were than collated into the maximum eight-hour L_{eq} and overall average L_{eq}.
7) These were then compared to the 45 dBA L_{8h} and 40 dBA $L_{night, outside}$ design goals. If the arithmetic difference between the levels in Step 6 and their respective design goal was greater than 10 dB, then that wind project would not be included for interactive modeling for that time period. Otherwise it would be included.

The results of the cumulative impact screening are shown in Table 20.

TABLE 20: CUMULATIVE IMPACT SCREENING RESULTS

WIND PROJECT	AVERAGING TIME	PROJECT SOUND LEVEL (dBA)	DESIGN GOAL (dBA)	DIFFERENCE (dB)	INCLUDE IN CUMULATIVE IMPACTS?
Cohocton North	L_{8h}	38	45	7	Yes
	$L_{night, outside}$	30	40	10	No
Cohocton Middle	L_{8h}	37	45	8	Yes
	$L_{night, outside}$	30	40	10	No
Howard	L_{8h}	33	45	12	No
	$L_{night, outside}$	26	40	14	No

With the Cohocton/Dutch Hill project added into sound propagation modeling, sound levels increase around portions of the Cohocton/Dutch Hill Wind Farm project area, primarily around the three Cohocton turbines located near the collector substation. A map showing these cumulative sound levels is shown in Figure 152 for the northeastern part of the Cohocton/Dutch Hill Wind project and Figure 153 for the southwestern part of the Cohocton wind project near the collector substation. The cumulative modeled 45 dBA contour is shown as a purple line. Solid color gradations indicate the increase in wind turbine sound level resulting from addition of the Baron Winds project. A 0 to 1 dB increase (dark green) indicates that the Cohocton/Dutch Hill project dominates. A 1 to 3 dB increase (light green) indicates that sound from Cohocton/Dutch Hill will contribute to at least half of the turbine only sound level. An increase of 4 to 6 dB (yellow) indicates that Baron winds will dominate turbine-only sound level but is within the NYSDEC guidelines for sound level increases above ambient. An increase of more than 6 dB (orange) indicates that the Baron Winds project dominates. Both Figure 152 and Figure 153 indicate that in the few cases where 45 dBA L_{1h} is exceeded, Baron Winds is contributing to less than half of the modeled sound level. Forty-five dBA L_{1h} is only exceeded at eight locations near the three southwestern Cohocton/Dutch Hill turbines



Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

FIGURE 152: CUMULATIVE SOUND PROPAGATION MODELING RESULTS (L_{1H}) AND SOUND LEVEL INCREASE DUE TO COHOCTON/DUTCH HILL - NORTHEASTERN COHOCTON/DUTCH HILL PROJECT AREA[89]

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[89] In Figure 152 and Figure 153, sound levels are shown at a 4-meter grid height, to demonstrate what sound levels would be modeled at receptors.

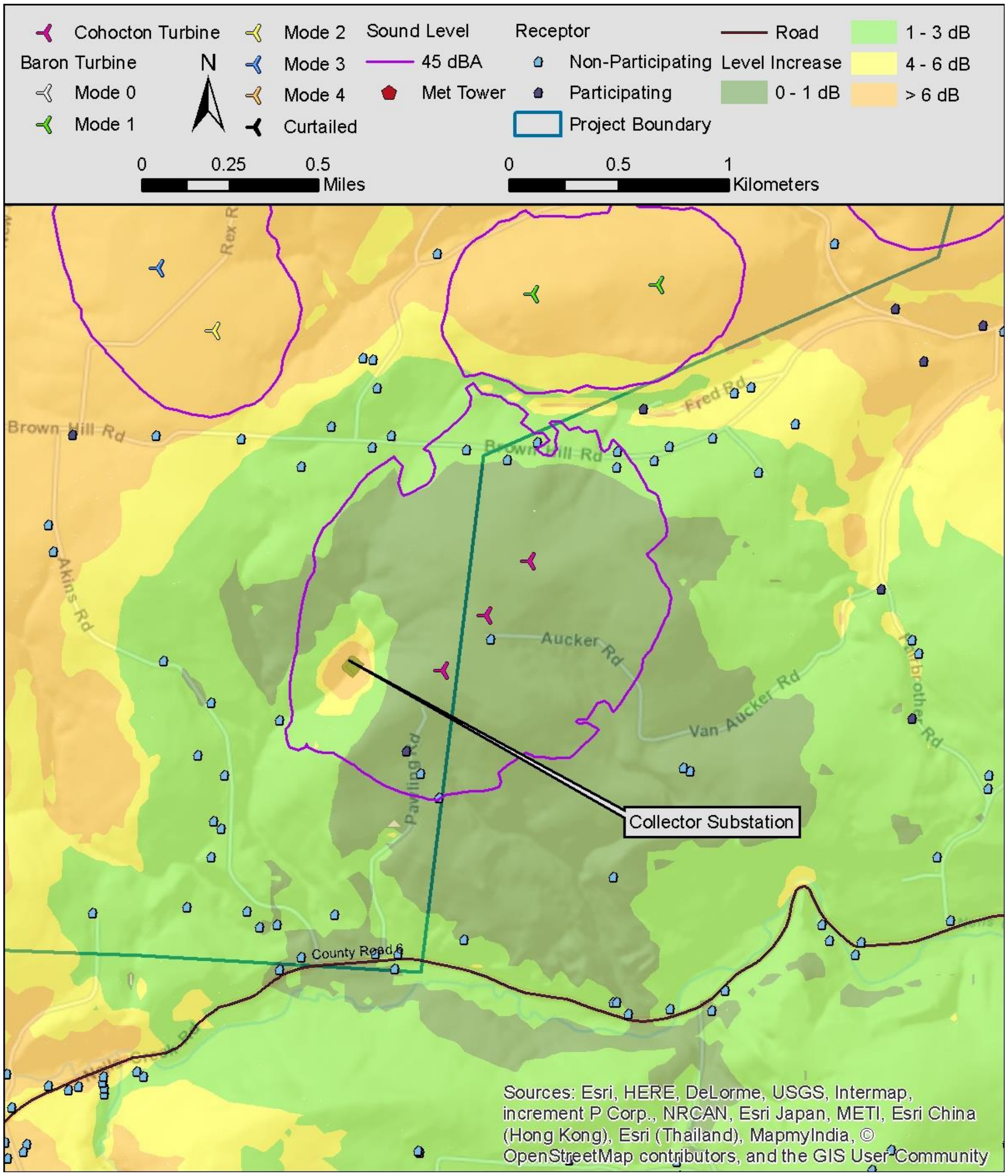

FIGURE 153: CUMULATIVE SOUND PROPAGATION MODELING RESULTS (L_{1H}) AND SOUND LEVEL INCREASE DUE TO COHOCTON/DUTCH HILL - SOUTHWESTERN COHOCTON/DUTCH HILL PROJECT AREA

9.6 | ANNUALIZED MODELING USING HOURLY METEOROLOGICAL ADJUSTMENTS (ARTICLE 10 19(F) AND STIPULATION 19(D)(2))

As described in Section 4.2, WHO, in its "Guidelines for Community Noise," reviewed the latest research on the health effects of noise and recommended 45 dBA averaged over an eight-hour night and a 60 dBA maximum, measured outside the bedroom window, to protect against sleep disturbance. In October 2009, WHO Europe updated the review of the scientific literature, and found a no-adverse-effect noise level of 40 dB $L_{night, outside}$, which is the A-weighted annual average nighttime sound level.

In Section 9.3, we modeled the maximum one-hour sound level from the proposed wind project. This is based on a worst-case meteorology of a moderate nighttime inversion, or equivalently, winds blowing from each source to each receptor, and the least atmospheric attenuation. In reality, one wind direction occurs at a time, winds are not such that they are always generating the highest sound output from the turbines, and the temperature and humidity do not always yield the lowest atmospheric attenuation. As a result, the eight-hour, and annual average nighttime, L_{50}, and even L_{10} sound levels will tend to be less than the one maximum one-hour L_{eq}.

To model the maximum eight-hour, annual average nighttime, L_{50}, and L_{10} sound level, we undergo the following procedure:

1. 8,760 hours of data is obtained from the project meteorological tower. The data includes wind speed at two or more heights, wind direction, the standard deviation of wind direction, and temperature.
2. Cloud cover and relative humidity is obtained from the Dansville Municipal Airport, the closest National Weather Service station, about 14 kilometers (8.7 miles) to the northwest.
3. Atmospheric stability is calculated for each hour. The "stability class" is calculated following the procedure in the U.S. EPA's "On-site meteorological program guidance for regulatory modeling applications." Stability Class ranges from A to G, with Class A being a highly unstable atmosphere and Class G being stable. Stability Class is a function of wind speed, cloud cover, solar angle, daytime/nighttime, and ceiling height.
4. A sound propagation model is run for 64 different combinations of wind speed, wind direction, and atmospheric stability, using the CadnaA model and meteorological adjustments from CONCAWE's "The propagation of noise from petroleum and petrochemical complexes to neighboring communities," as implemented in CadnaA. A ground absorption factor of G=1 is used.
5. A raw unadjusted sound level is obtained for each receptor for each hour by matching each hour's wind speed, wind direction, and stability class to those used in the model runs.
6. The model is calibrated for each receptor such that the maximum hourly sound level is the same as that run using ISO 9613-2. After calibration, the calculations are repeated.
7. The hourly sound level at each receptor is adjusted to account for the different sound power by hub-height wind speed using the manufacturer sound curves. No sound is generated below cut-in and above cut-out wind speeds. The sound power assumed in the model is adjusted based on a randomized normal distribution

between -2 dB and +2 dB. The randomly selected number is held constant for each hour at each receptor. Because the uncertainty is added after the calibration of Step 7, this methodology gives a higher one-hour maximum sound level than the L_{1h} modeling from the previous section. Therefore, the results from this section are only valid for comparing to averaging periods equal to or greater than eight hours.

8. The result is 8,524 hours of sound levels for each receptor. Note that 236 hours are invalid due to missing met tower data (most likely due to icing and/or maintenance downtime).
9. From these, annual statistics are calculated, including the maximum nighttime sound level, $L_{night, outside}$, and daytime and nighttime L_{10} and L_{50} by season and over the year.

This type of modeling has been used in several wind turbine permitting processes, including Cassadaga Wind in New York, Deerfield Wind in Vermont, Kingdom Community Wind in Vermont, and Black Fork Wind in Ohio.

In the Kingdom Community Wind case, one of the residences most exposed to wind turbine sound was predicted to have an annualized equivalent sound level of 40 dBA. Postconstruction measurements of the same project and at the same location were conducted for seven seasons, for a minimum of two weeks per season. The turbine-only sound level averaged over all seasons was measured to be 35 dBA. That is, the model over-predicted annual average sound levels by about 5 dB. This indicates that the modeling, performed for the project, in a similar manner as described above, is conservative.

The results of the modeling are shown in Appendix C. In Table 33, periods where rotors are not spinning due to low wind speeds are included in the calculation of annual averages. In Table 34, these periods are not included. Of these two, only the results in Table 33 give accurate estimates of annual impact. Table 34 is only provided for information purposes only at the request of NYSDPS. In Table 35, results including the Cohocton/Dutch Hill wind power project are shown.

The result from Table 33 are summarized in Table 21. This shows that the relevant Project design goals are met at all receptors. In Table 35, with the Cohocton/Dutch Hill project included, are summarized in Table 22. As shown, sound levels do not exceed any Project design goal where the sound level contribution from Baron Winds is greater than the contribution from Cohocton/Dutch Hill.

TABLE 21: SUMMARY OF ANNUALIZED IMPACTS FROM BARON WINDS

DESIGN GOAL	LIMIT	AVERAGE MODELED LEVEL	MAXIMUM MODELED LEVEL
Sleep disturbance	45 dBA L_{8h} at night	31 dBA	45 dBA
Health effects	40 dBA $L_{\text{night, outside}}$	24 dBA	40 dBA
Participants	55 dBA L_{8h} at night	37 dBA	45 dBA
Participants	50 dBA $L_{\text{night, outside}}$	31 dBA	39 dBA
Property Line	55 dBA L_{8h} at night	n/a	50 dBA

TABLE 22: SUMMARY OF CUMULATIVE ANNUALIZED IMPACTS

DESIGN GOAL	LIMIT	AVERAGE MODELED LEVEL	MAXIMUM MODELED LEVEL (WHERE BARON WINDS HAS LARGEST CONTRIBUTION)
Sleep disturbance	45 dBA L_{8h} at night	32 dBA	45 dBA[90]
Health effects	40 dBA $L_{\text{night, outside}}$	25 dBA	40 dBA[91]
Participants	55 dBA L_{8h} at night	38 dBA	47 dBA
Participants	50 dBA $L_{\text{night, outside}}$	32 dBA	40 dBA
Property Line	55 dBA L_{8h} at night	n/a	50 dBA

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[90] There are five receptors that exceed 45 dBA, but Baron Winds contribution to these exceedances are less than or equal to 1 dB.

[91] There are four receptors that exceed 40 dBA, but Baron Winds contribution to these exceedances are less than or equal to 1 dB.

10.0 TURBULENCE INTENSITY AND WIND SHEAR (ARTICLE 10 19(E)(6)/STIPULATIONS 19(E)(6))

To determine wind shear and turbulence intensity conditions present at the site, RSG analyzed a year of meteorological data taken from Sand Hill, at the project site. The wind speed at two anemometer heights (40 meters and 60 meters) and wind speed standard deviation were used to calculate the turbulence intensity present at the site.

Turbulence intensity is the ratio of the wind speed standard deviation to the wind speed at a given measurement height. As is shown in the equation below:

$$Turbulence\ Intensity = \frac{Wind\ Speed\ Standard\ Deviation}{Average\ Wind\ Speed}$$

Results show that the turbulence intensity is higher overall during the day than at night. Figure 154 shows the turbulence intensity by hour at the site. These values are not higher than what has been found by RSG at other proposed wind power projects. Figure 155 shows the turbulence intensity by hub-height wind speed. This shows that turbulence intensity decreases slightly from cut-in to 7 or 8 m/s. Beyond this point there is no consistent trend other than the general narrowing of the dataset. Wind speeds above this range are probably most prevalent during storm conditions. Wind turbines generate turbulence in the wake of the blade, consequently turbines that are regularly downwind of other turbines may experience more turbulence that this data indicates.

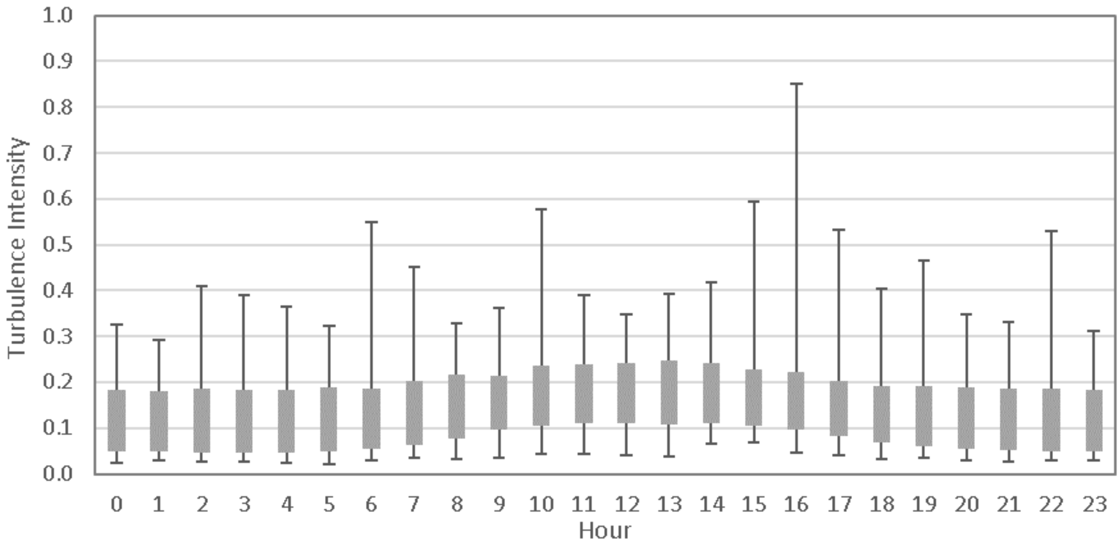

FIGURE 154: TURBULENCE INTENSITY BY HOUR—GREY BOXES SHOW 90% OF DATA AND THE "WHISKERS" ARE +5% AND -5% OUTLIERS

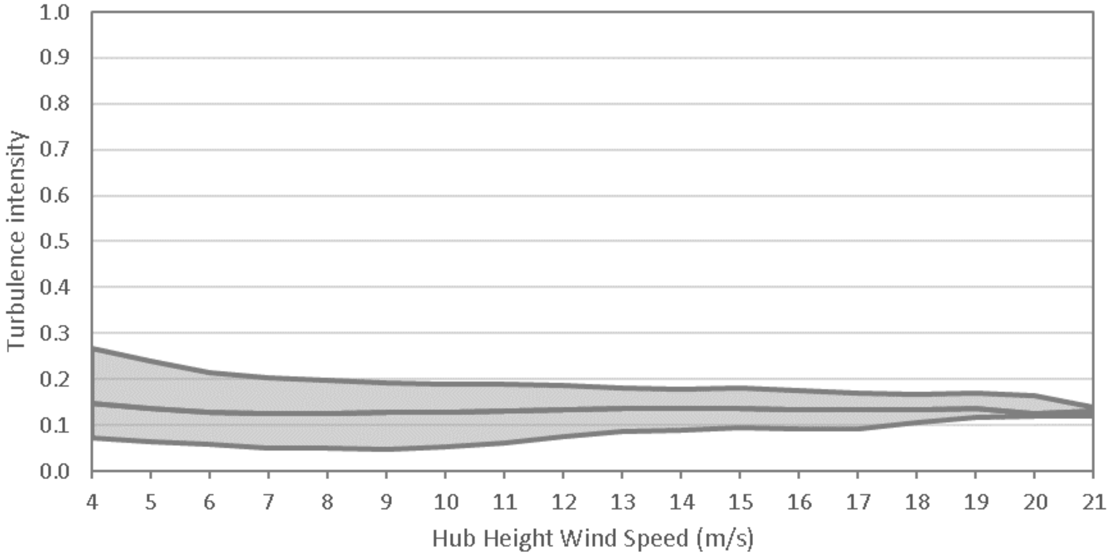

FIGURE 155: TURBULENCE INTENSITY BY HUB-HEIGHT WIND SPEED (84 METERS). THE SHADED AREA INDICATES THE MIDDLE 90 PERCENT OF DATA AND THE GRAY LINE WITHIN THE MIDDLE 90 PERCENT IS THE MEDIAN

Wind shear shows how wind speed varies with above-ground height. Wind shear was determined by RSG using the equations found in Annex D of IEC 61400-11. The equation used is shown below:

$$V_z = V_{z,ref}\left(\frac{z}{z_{ref}}\right)^{\propto}$$

In this case V_z is the wind speed at height z and $V_{z,ref}$ is the wind speed at height z_{ref}. ∝ is the wind shear coefficient.

Figure 156 shows the wind shear coefficient as calculated at Sand Hill by hour. This shows that wind shear is higher at night and particularly in the early morning, when the atmosphere is more stable than during the day. It also shows the variability of wind shear, the upper 5th percentile is four times the lower 5th percentile at night. Figure 157 shows the wind shear by hub-height wind speed, this indicates that the periods with highest wind shear occur near the cut-in wind speed for the turbine, when sound emissions will be lowest. Figure 158 compares the turbulence intensity and wind shear for the same periods. This shows that periods with relatively high wind shear and turbulence intensity are generally not coincident. In general, the stable atmosphere required for high wind shear should not also be turbulent.

What is important to note is that most periods with high wind shear do not also simultaneously have high turbulence intensity. Most wind shear data falls into a relatively narrow range, with outliers falling over a much larger range. As is mentioned in Section 8.2, wind shear alone can exacerbate AM, but it is not sufficient to cause AM. For high levels of AM to occur blade stall, or detached flow must occur. So, high wind shear generally must be coincident with high turbulence intensity to cause high levels of AM, an uncommon condition at Baron Winds.

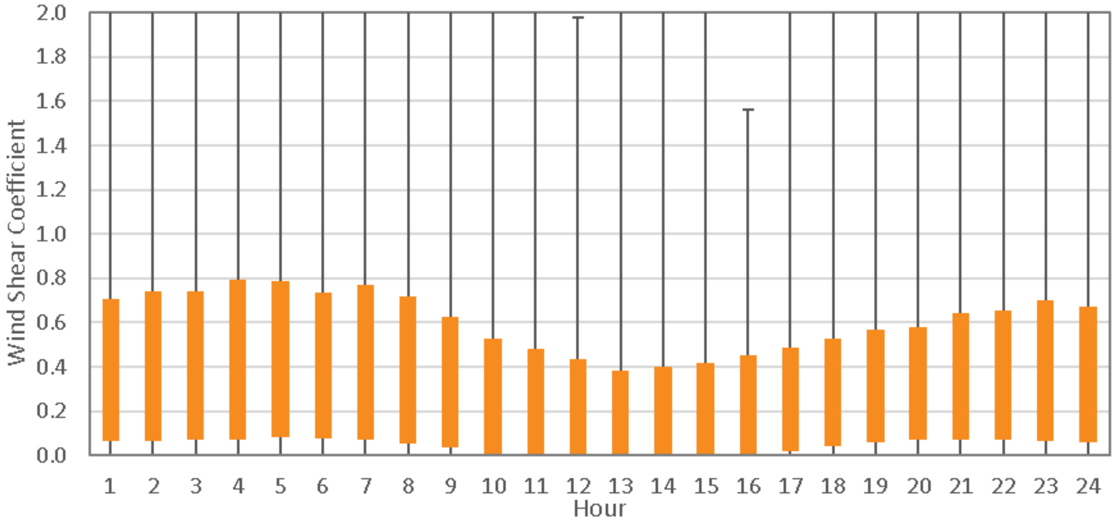

FIGURE 156: WIND SHEAR COEFFICIENT BY HOUR. ORANGE BOXES INDICATE THE MIDDLE 90 PERCENT AND THE "WHISKERS" ARE THE + OR - 5 PERCENT OUTLIERS

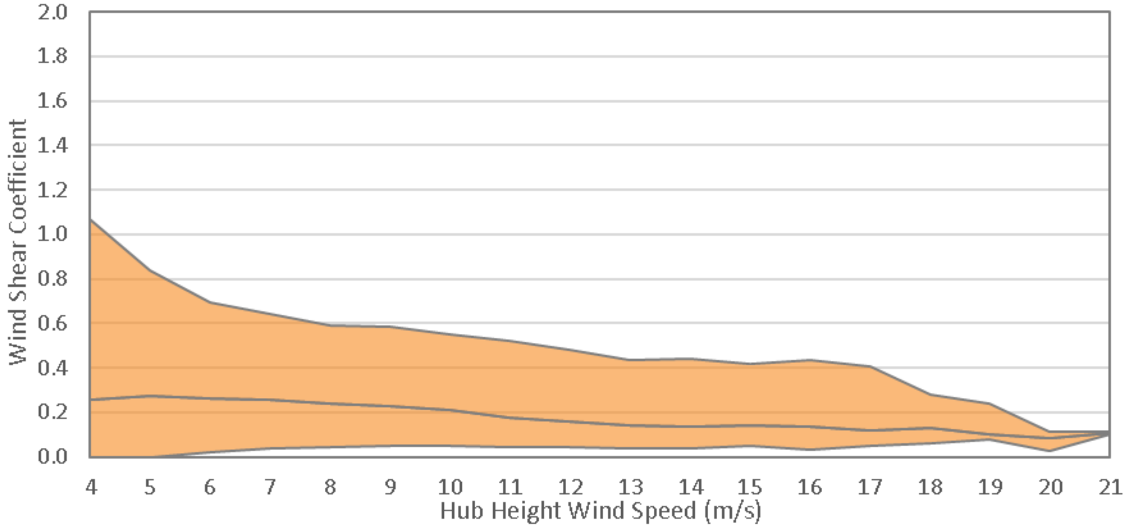

FIGURE 157: WIND SHEAR COEFFICIENT BY HOUR. SHADED ORANGE AREA INDICATES THE MIDDLE 90 PERCENT AND THE GREY LINE WITHIN THE ORANGE AREA INDICATES THE MEDIAN

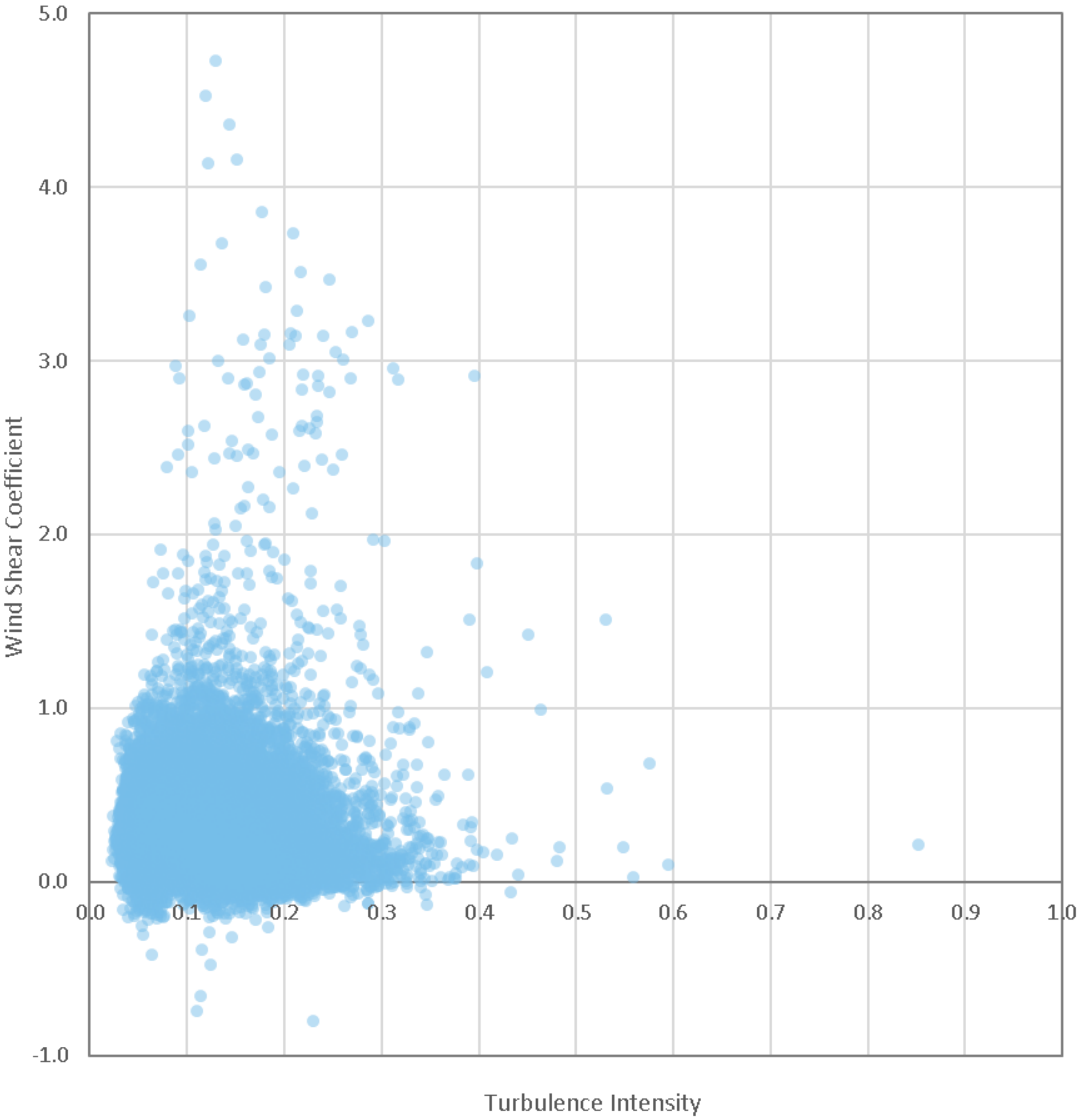

FIGURE 158: TURBULENCE INTENSITY AND WIND SHEAR COMPARISON

11.0 GROUND-BORNE VIBRATION (ARTICLE 10 /STIPULATIONS 19(K)(6))

While uncommon, some residents near wind farms have asserted that vibration from wind farms has seemed to be transmitted through the ground. As a result, there have been some studies on this topic. The more researched concern is on the influence of ground-borne vibration on seismic measurement stations that are used for earthquake detection and nuclear weapon test monitoring.

Research studying the vibration due to wind farms show magnitudes below the threshold of perception and health impacts, even at distances far less than typical receptor distances. For example, Botha 2013 found magnitudes of less than 0.00001 m/s at a distance of 92 m.[92] For comparison, the ANSI S2.71 thresholds for perception are 0.0001 m/s or less for all frequencies. This is based upon the threshold of perception for the most sensitive humans. Others have found that the ground waves due to wind farms decay according to $1/(r^{1/2})$, where r is the distance between the turbine and the receptor (Styles et al 2005).[93] Consequently, the magnitude at a distance of 450 m would be approximately 0.000005 m/s, this scales by the square root of the number of turbines. If we assume that four turbines are at the distance of 450 meters, a conservative assumption, then the magnitude will be 0.00001 m/s, or a tenth of the threshold of perception for the most sensitive humans. To meet this threshold, 100 turbines would have to be located at a distance of 450 meters.

Seismic stations are orders of magnitude more sensitive than humans are to vibration. They are so sensitive that even in environments far from high levels of development, some ground-borne vibration will always be sensed. As a result, the question is not whether the installations can sense vibration, but rather how vibration can be produced without harming the usefulness of the monitoring station. In the case of the Eskdalemuir seismic station in Scotland, it was found that the environmental seismic noise was approximately 0.336 nm (nanometers). Based on this, it was found that wind power should not be allowed at distances below 10 km, but up to 1 GW of wind power could be allowed at a distance of 25 km and 1 TW at 50 km (Styles et al 2005). These limits were intended to hide the influence from wind turbines in the environmental seismic noise that was already present at the site. Eskdalemuir is renowned for a particularly low influence of anthropogenic noise.

Measurements near a wind farm in Germany found that at about a 2 km distance, the wave-field amplitude reduced to the level of other anthropogenic seismic noise and recommended a 6 km setback between a proposed wind farm and a gravitational wave detection device in Italy (Fiori et al 2009).[94] The increased distance is determined by multiplying the distance of

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[92] Botha, Paul. "Ground Vibration, Infrasound and Low Frequency Noise Measurements from a Modern Wind Turbine." *Acta Acustica United with Acustica.* 99(2013). pp. 537-544.
[93] Styles, Peter, et al. "Microseismic and Infrasound Monitoring of Low Frequency Noise and Vibrations from Wind Farms." *Keele University.* 18 July 2005.
[94] Fiori, Irene, et al. "A Study of the Seismic Disturbance Produced by the Wind Park Near the Gravitational Wave Detector GEO-600." *Third International Meeting on Wind Turbine Noise.* Aalborg, Denmark: 17-19 June 2009.

the turbines measured in Germany with the square root of the number of proposed turbines (nine). Based upon this, the setbacks between Baron and the nearest seismologically sensitive facility should be 17.4 km. If the nearby Howard and Cohocton/Dutch Hill Wind farms are included, the setback would be 25 km.

A list of the nine closest seismological stations is shown in Table 23 below, the closest five are shown graphically in Figure 159. The closest station to the closest Baron Winds turbine, is Binghamton, New York, 128 km away and well outside of recommended 25 km setback.

TABLE 23: CLOSEST SEISMOLOGICAL STATIONS TO BARON WINDS

Location	Longitude (deg)	Latitude (deg)	Distance (km)
Binghamton, NY	-75.99	42.20	128
Effingham, ON	-79.31	43.09	158
Standing Stone, PA	-77.89	40.64	195
Erie, PA	-79.99	42.12	199
Kingston, ON	-76.49	44.23	209
Sadowa, ON	-79.14	44.77	282
Williamsburg, ON	-75.28	45.00	331
Lake Ozonia, NY	-74.58	44.62	334
Ottawa, ON	-75.77	45.36	347

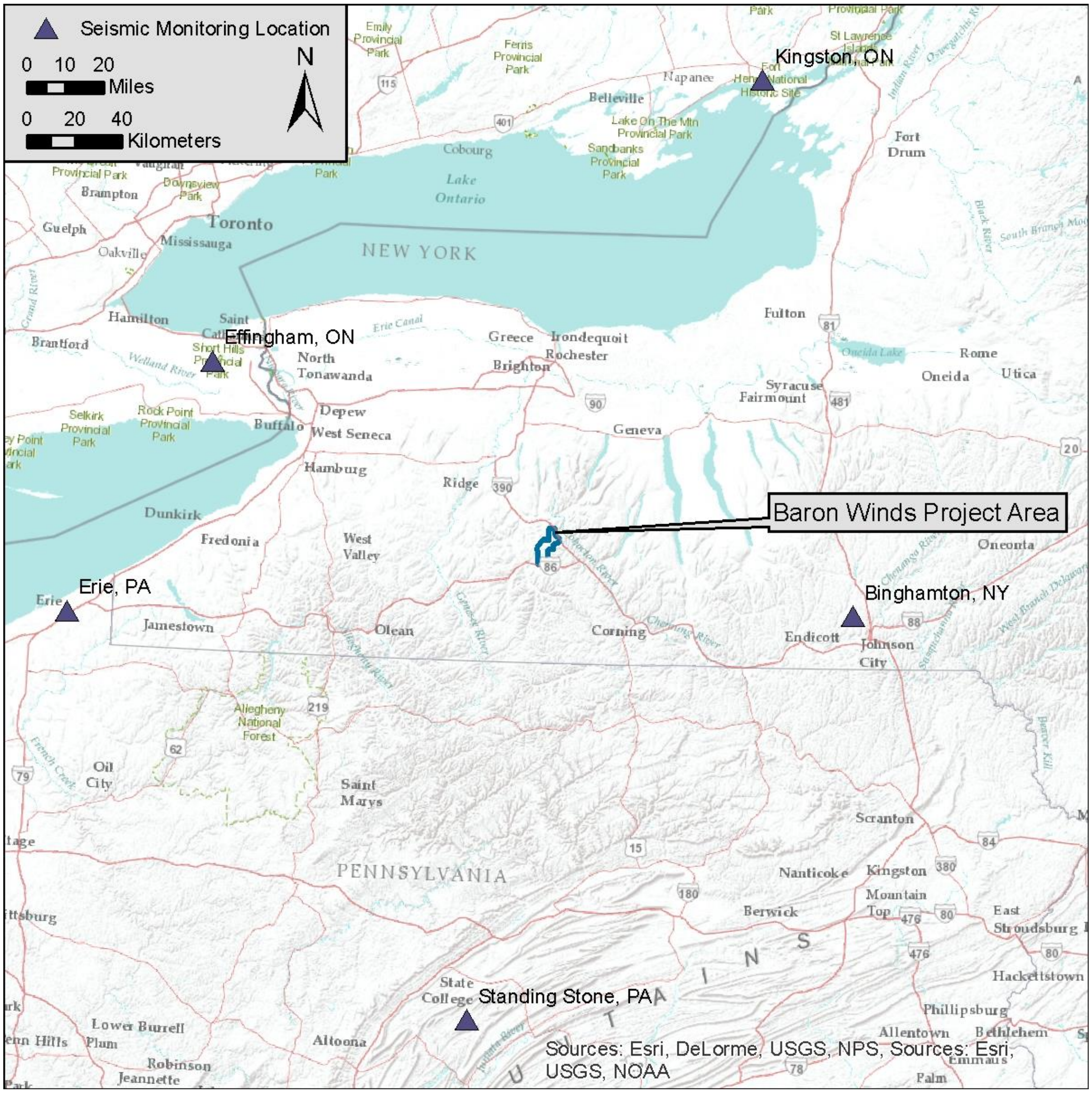

FIGURE 159: NEARBY SEISMIC MONITORING LOCATIONS

12.0 CONSTRUCTION NOISE (ARTICLE 10/STIPULATIONS 19(C))

Construction noise modeling was performed using the ISO 9613-2 environmental noise prediction algorithm, as implemented in Datakustik's CadnaA sound propagation modeling software package. Discrete receptor and grid heights are the same as was used in operational sound propagation modeling for the project, as described in Section 11.1. Sound source information was obtained either from the literature, RSG measurements, the FHWA's Reference Energy Mean Emission Levels (REMEL) data, or FHWA's Roadway Construction Noise Model. Modeling procedures generally followed guidelines in the FHWA's Highway Construction Noise Handbook, where appropriate and where data was available.

Construction of the turbines will take place primarily on the ridge lines throughout the project area. While there may be activity closer to receptors for road construction and utility work, such work will be of a relatively short duration.

Equipment used for construction will be varied. Sound power levels of some of the louder pieces of equipment are shown in Table 24.

Figure 160 and Figure 161 show sound propagation modeling results for construction around turbine T40. This is the turbine that has a nonparticipating receptor that most closely matches EverPower's internal setback requirement (1,500 feet or 428 meters). Figure 161 shows sound levels with all construction sources operating and Figure 160 shows sound levels with all sources operating that will be used in the construction phase where the land is cleared of vegetation (the loudest construction phase). Figure 162 shows modeling of the area surrounding the northern laydown yard and concrete batch plant. Figure 163 shows modeling of the surrounding the southern laydown yard and batch plant. The closest nonparticipating receptor to the southern batch plant is approximately 216 meters (710 feet) and the closest nonparticipating receptor to the northern batch plant is approximately 140 meters (460 feet).

The results are shown as maximum 1-second L_{eq}, with all pieces of equipment operating at their maximum sound level at the same time. Under actual operations, not all pieces of equipment will be operating simultaneously and emitting the highest sound levels.

The highest sound level at a nonparticipating receptor near T40 is 62 dBA with all sources operating. The "all sources" scenario will not happen in practice, since sources from different construction phases do not operate simultaneously. By phase of operation, the highest sound level is 60 dBA during the Clearing Phase.

Construction activities will also take place at two "laydown" areas where a concrete batch plant may operate. The highest sound level at a nonparticipating receptor is 66 dBA near the northern laydown area/batch plant and 62 dBA near the southern laydown area/batch plant.

Construction is proposed to take place from April to October at turbine sites. Major construction work will occur during the hours as permitted by local laws. In addition, certain work, like tower section and blade erection could also extend into throughout night, depending on conditions.

Construction at each turbine site will take approximately 60 days, not including turbine erection. Due to the setbacks involved and the limited duration of the activities, construction noise should create minimal adverse impacts.

The potential for structural damage due to vibration during construction is minimized, as no blasting is proposed.

Each turbine location will require deliveries from approximately 40 concrete trucks, 20 gravel trucks, three trucks carrying the blades, four trucks carrying tower sections, and a truck each for each crane. This results in a total of approximately 138 truck trips, for a total of 276 total pass bys at a given location, occurring over a 60-day period. According to FHWA categorization, 240 of these trips would be with “medium” trucks and 36 would be with “heavy” trucks. Pass-by sound levels for each type of truck are shown in Table 25. These levels assume an L_{Afmax} metric, a pass-by distance of 50 feet, and a speed of 50 miles per hour with the truck accelerating. Values were calculated using the Federal Highway Administration’s (FHWA) REMEL equations for calculated vehicle emission sound levels.

TABLE 24: MODELED SOURCES FOR CONSTRUCTION AREAS AND LAYDOWN AREA/BATCH PLANT WITH MODELED MAXIMUM SOUND LEVELS

Equipment	Modeled Sound Power (dBA)	Sound Pressure level at Closest Nonparticipating Receptor from T40 (dBA)	Sound Pressure Level at Closest Nonparticipating Receptor from Northern Laydown Yard/Batch Plant (dBA)	Sound Pressure Level at Closest Nonparticipating Receptor from Southern Laydown Yard/Batch Plant (dBA)
Turbine Construction Site				
Bulldozer	117	46	-	-
Backhoe	112	41	-	-
Concrete Truck	113	42	-	-
Chipper	131	60	-	-
Heavy Truck	115	40	-	-
Medium Truck	110	36	-	-
2250 S3 Lift Crane	110	39	-	-
M250 Auxiliary Crane	114	44	-	-
Excavator	115	45	-	-
Pneumatic Drill	132	55	-	-
Truck Being Loaded with Rock	118	48	-	-
Total - Site Clearing	131	60	-	-
Total - Turbine Erection	117	46	-	-
Total - Foundation	119	49	-	-
Total - Excavation	132	57	-	-
Laydown Area/Concrete Batch Plant				
Cement Blower	115	-	61	57
Cement Blower Truck	101	-	47	43
Concrete Truck - Mixing	113	-	60	56
Backup Alarm	109	-	55	52
Heavy Truck	115	-	60	56

TABLE 25: FHWA REMEL PASS-BY SOUND LEVELS BY TRUCK TYPE

Truck Type	Passbys per Turbine	Sound Pressure Level at 50 feet (15 meters) (dBA)
Medium	240	80
Heavy	36	84

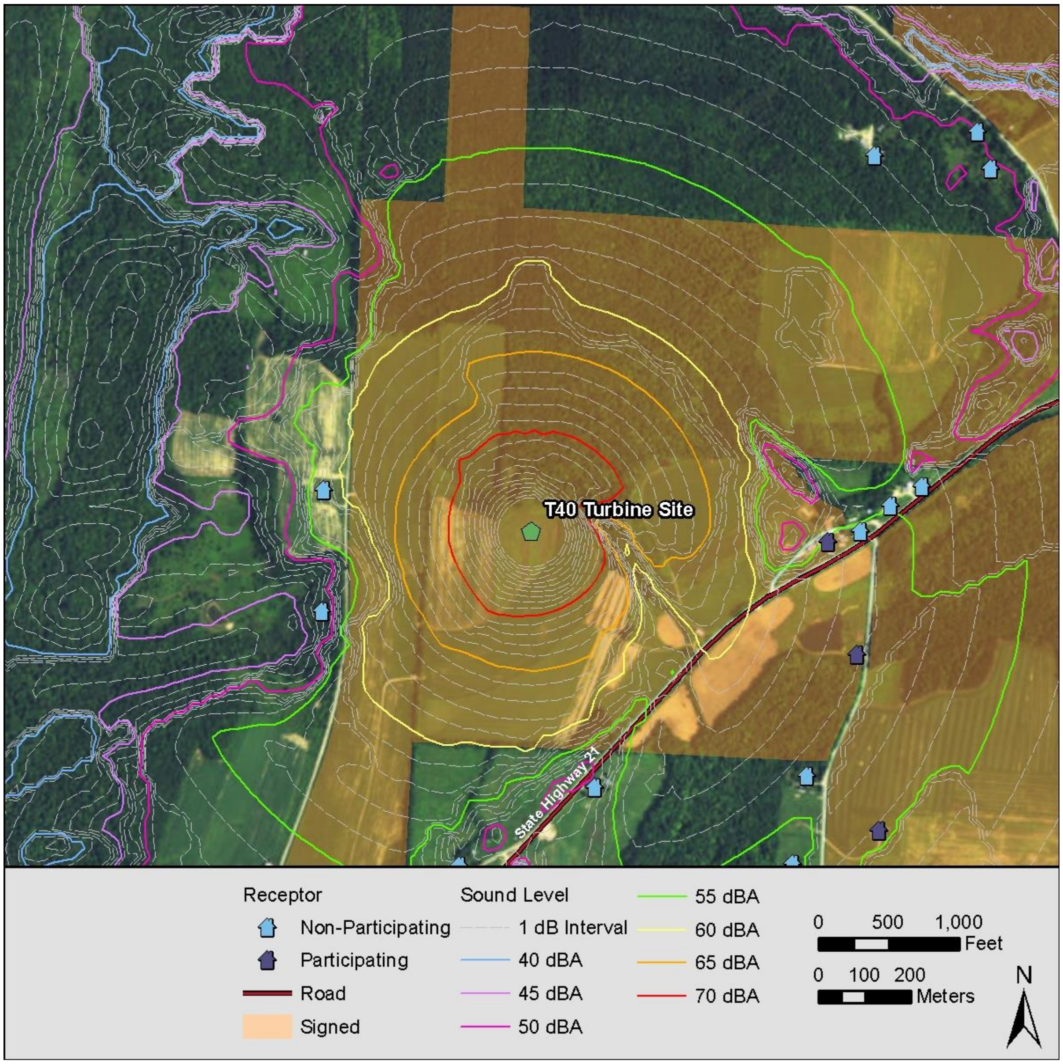

FIGURE 160: CONSTRUCTION SOUND LEVELS FROM T40 TURBINE SITE—CLEARING PHASE SOURCES

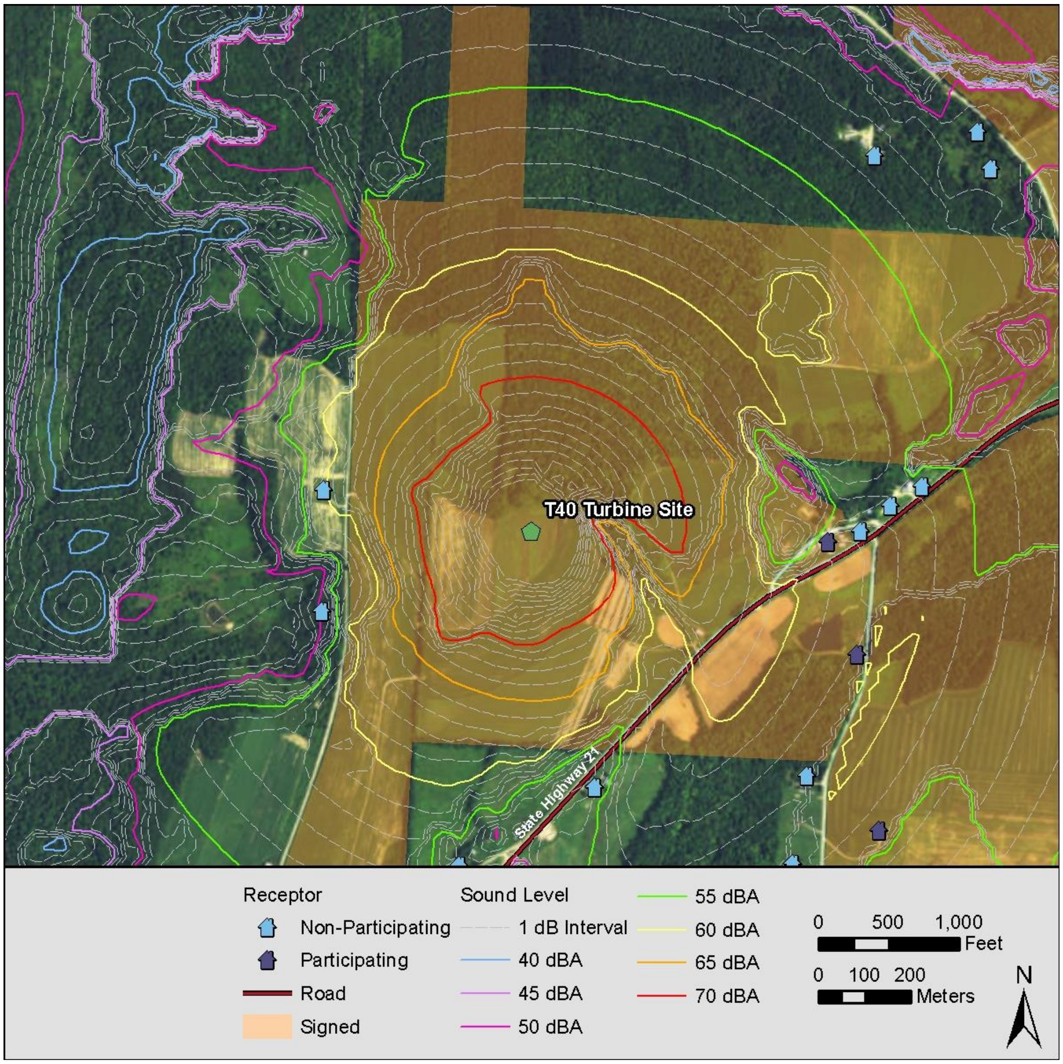

FIGURE 161: CONSTRUCTION SOUND LEVELS FROM T40 TURBINE SITE—ALL CONSTRUCTION SOURCES

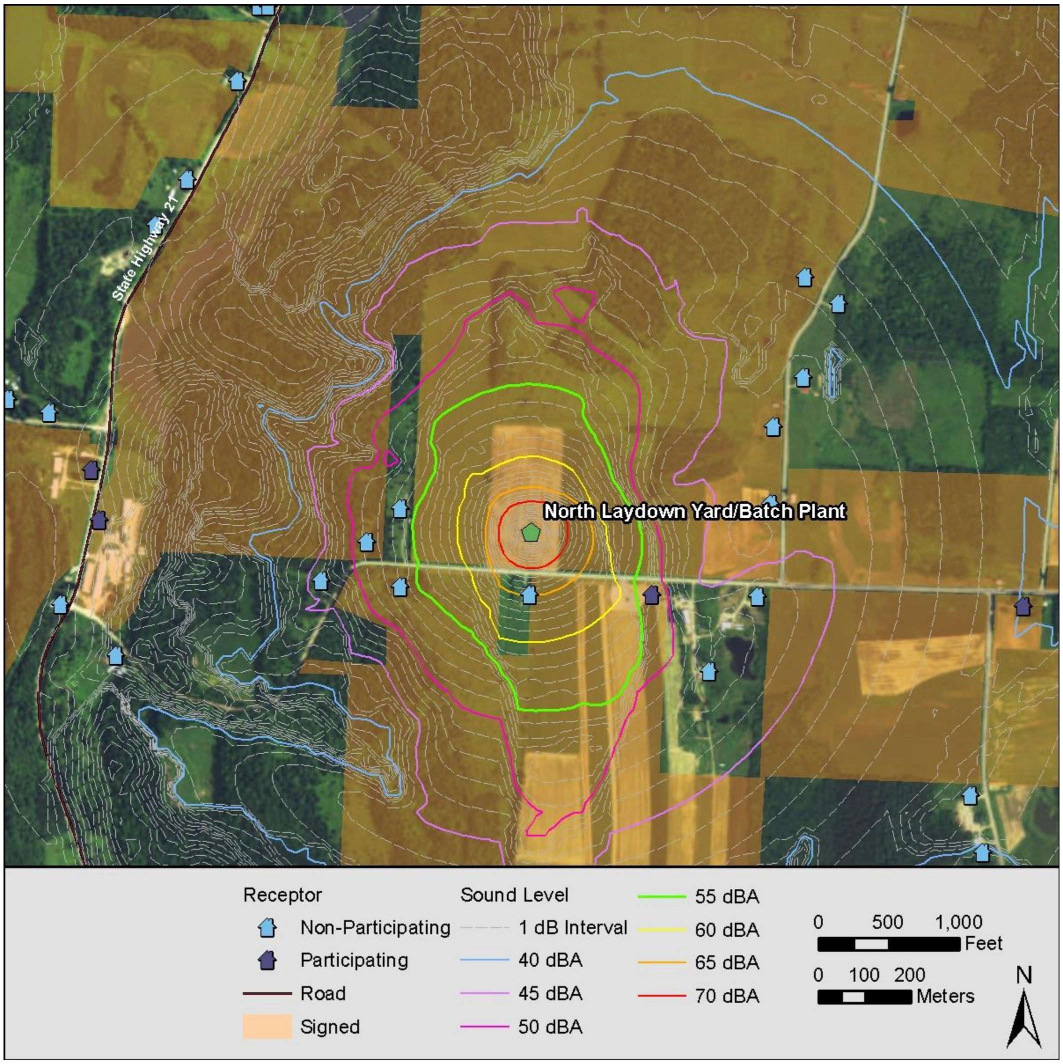

FIGURE 162: SOUND LEVELS FROM NORTHERN LAYDOWN YARD/BATCH PLANT

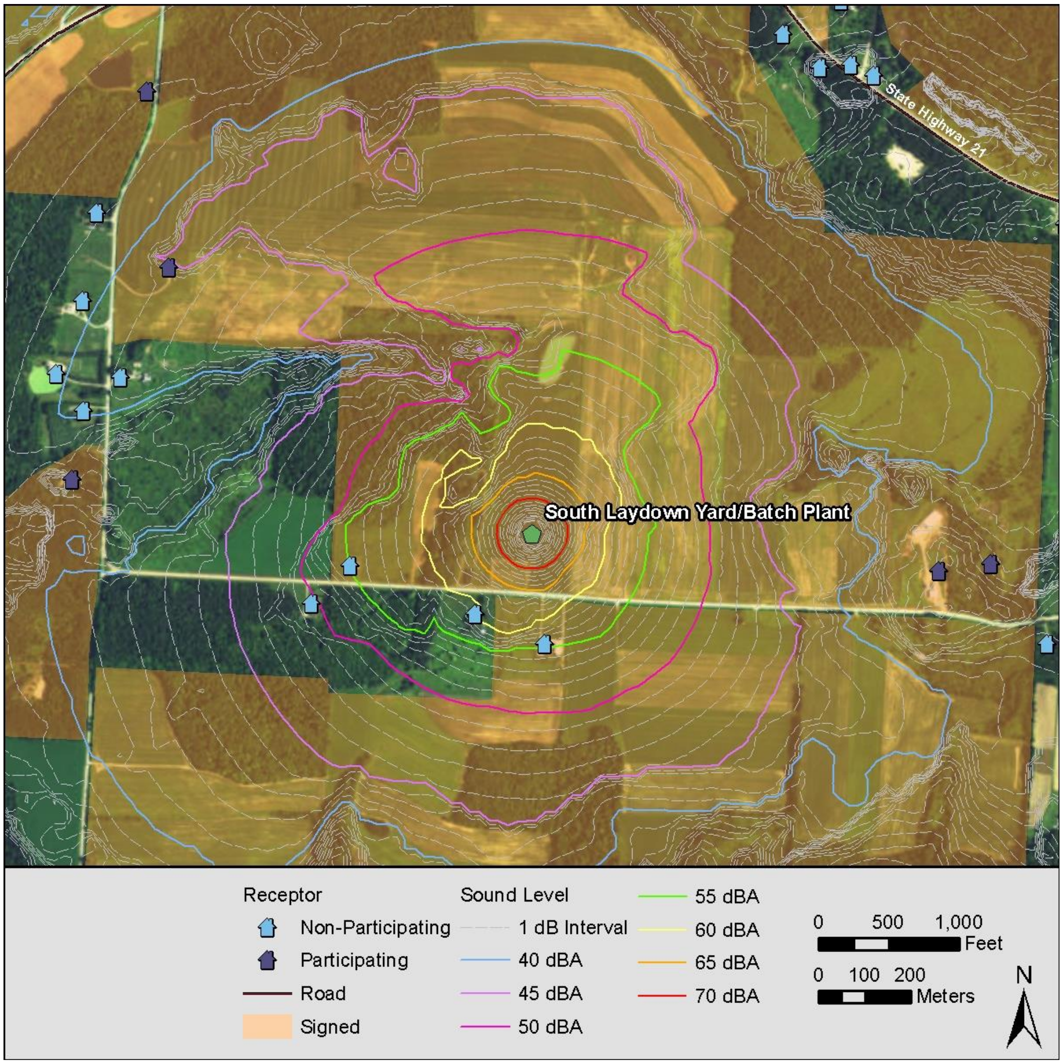

FIGURE 163: SOUND LEVELS FROM SOUTHERN LAYDOWN YARD/BATCH PLANT

13.0 SUMMARY AND CONCLUSIONS

Baron Winds, LLC, a wholly owned subsidiary of EverPower Wind Holdings, Inc., is proposing to construct a wind farm in Steuben County, New York. The project is proposed to include up to 76 turbines with a nameplate capacity of up to 300 MW. In preparation for Article 10 proceedings, RSG prepared a noise impact assessment for the project. Summary and conclusions are as follows

- The Project is being permitted under the jurisdiction of the NYSDPS and the Article 10 regulations for permitting power projects.
- No federal noise standard is applicable to the project. No fixed state sound limits exist. NYSDPS Article 10, found in New York, Code, Rules, and Regulations 16, Chapter 10, Exhibit 19 (1001.19) does not specify a fixed limit, instead setting criteria for assessment.
- The Towns of Cohocton, Dansville, Fremont, and Wayland have wind turbine siting ordinances, which include noise limits.
- The assessment was performed in accordance with stipulation made between Baron Winds LLC and the NYSDEC, DOH, and DPS, town noise regulations, and NYSDPS Article 10 requirements.
- The project design goals, Town regulator limits, and proposed regulatory limits for the project are shown in Table 1.
- A literature review shows that wind turbine sound is often perceived as more intrusive than other environmental sound sources, this is due to tonal content, AM, and some low-frequency content. Although wind turbines do produce infrasound, it is well below human hearing thresholds at typical receptor distances and there is no strong evidence that subaudible infrasound is perceptible and can cause adverse health impacts. If wind turbine noise levels are too high, it can cause annoyance and sleep disturbance. These impacts can be minimized through proper project design and operation.
- The project is rural overall in a flat-to-hilly area with widespread agricultural use. The Village of Haskinville is located within the project area.
- Background sound level measurement was performed at seven locations throughout the project area for two weeks in each location in both the summer and winter season. Monitoring locations were chosen to represent different soundscapes within the Project area. A summary of background sound levels, is shown in the chart below. Background sound levels are indicative of the rural nature of the area. Sound sources included car pass bys, wind noise, airplane overflights, biogenic sound (birds, insects, etc.,), recreational equipment (snowmobiles, etc.,) and agricultural equipment. Most of these noise sources are intermittent, resulting in highly variable

sound levels at most of the sites. This variation can be seen in the spread between the statistical sound levels (L_{10}, L_{50}, and L_{90}).

	Location	Sound Pressure Level (dBA)											
		Overall				Day				Night			
		Leq	L90	L50	L10	Leq	L90	L50	L10	Leq	L90	L50	L10
Combined	Brasted Road	46	19	28	42	47	22	31	45	41	17	24	35
	Loon Lake	48	25	37	51	49	29	40	53	45	22	30	46
	Dye/Rex Road	37	21	28	38	38	22	29	39	34	20	27	36
	Haskinville Road	42	21	34	45	43	27	37	46	39	19	26	42
	Rose Road	35	22	29	37	36	23	30	38	32	20	27	35
	Henkle Hollow Road	38	23	30	40	39	24	32	41	35	22	29	37
	Walter Kurtz Road	38	20	29	41	39	22	30	42	34	19	27	38

- Sound propagation modeling was performed using ISO 9613-2 sound propagation modeling algorithms at participating and nonparticipating receptors (sensitive sound receptors). This includes 1,293 long-term permanent or seasonal residences, 10 nonresidential property line locations, 19 cabins, a church, and 43 participating residences.

- The Vestas V136 3.6 MW turbine, with an 82-meter hub height and 136-meter rotor diameter, combined with the worst-case low-frequency octave bands of any turbine under consideration, was modeled as a worst-case assumption.

- Using ISO 9613-2 to model short-term sound levels for compliance with Town sound level limits, the highest sound level at a nonparticipating receptor is 45 dBA (1-hour equivalent average sound level or L_{1h}). In the Town of Cohocton, sound levels did not exceed 43.9 dBA (L_{1h}). To achieve this sound level, one turbine was curtailed and several turbines were placed into noise reduced operations. Final mitigation needed to comply with Certificate sound conditions will be refined when the final turbine is selected.

- The L_{10} used in the Town of Fremont's sound level limit is typically less than 2 dB above the L_{eq} for wind turbine sound. Therefore, the project is expected to meet the 50 dBA L_{10} Town of Fremont sound level regulations. The assessment method for the Town of Cohocton has resulted in postconstruction monitored sound levels up to 1.1 dB above predictions for the Cohocton/Dutch Hill wind power project. As a result, sound levels of 43.9 dBA or less modeled in Cohocton are expected to meet Town of Cohocton Regulations.

- Infrasound and low-frequency sound from the project will exceed the levels required to produce moderately perceptible building vibrations under ANSI S12.2-2008 by no more than 1 dB at the closest nonparticipating receptors in the 16 Hz 1/1 octave band. This is assuming low-frequency and infrasound data for the worst-case turbine considered for this project, applied to the turbine with the worst-cause audible frequency sound. If low-frequency and infrasound data for the V136 3.6 MW turbine were assumed, the threshold would not be exceeded. Extrapolated infrasound levels from the project are below established perception thresholds.

- Addition of the nearby Cohocton/Dutch Hill Wind Farm to short-term sound propagation modeling indicates that combined sound levels of the project only exceeds 45 dBA L_{1h} at eight locations, where Cohocton/Dutch Hill project dominates. For long-term modeling, in no case does addition of the Cohocton/Dutch Hill project cause exceedances of the proposed regulatory limit (L_{8h}) or design goal ($L_{night,outside}$)
- Using the CONCAWE sound propagation modeling algorithm with ISO 9613-2 and one year of meteorological data, long-term average and statistical sound levels were calculated.
- Long-term averages show that the highest nighttime sound level at a nonparticipating receptor (averaged over a single night) is 45 dBA L_{8h}. Sound level averages over the night for an entire year are 40 dBA or less at all nonparticipating receptors. With the Cohocton/Dutch Hill project included, neither design goal is exceeded at a location where sound level contribution from Baron Winds is greater than that of Cohocton/Dutch Hill.
- Long-term averages at participating properties meet all relevant design goals.
- Although AM cannot be accurately predicted at this time, analysis of the wind shear and turbulence intensity over 1-year of meteorological data shows that conditions necessary for excessive AM are uncommon.
- The closest seismological stations to the Project are well outside of recommended distances to prevent interference due to ground-borne vibration.
- Construction noise was modeled using ISO 9613-2 around two turbine sites and the laydown yard/batch plant. Maximum 1-second L_{eq} sound levels at a representative turbine site with a setback to a nonparticipating residence that most closely matches EverPower's internal 1,500-foot (428 meter) criteria is 63 dBA with all sound sources operating and 60 dBA during the site clearing phase. Maximum sound levels near the laydown yard/batch plant were calculated to be 66 dBA. These are maximum levels, and will not be consistently experienced by nearby receptors. Impacts will also be of relatively short duration, particularly near turbine sites.

Based upon results from the analysis completed in this report, showing adherence of the project to the proposed noise design goals, regulatory limits and Town noise ordinances, we can conclude that adverse impacts due to sound from construction and operation of the proposed Baron Winds wind power project have been minimized to the extent practicable.