Appendix E

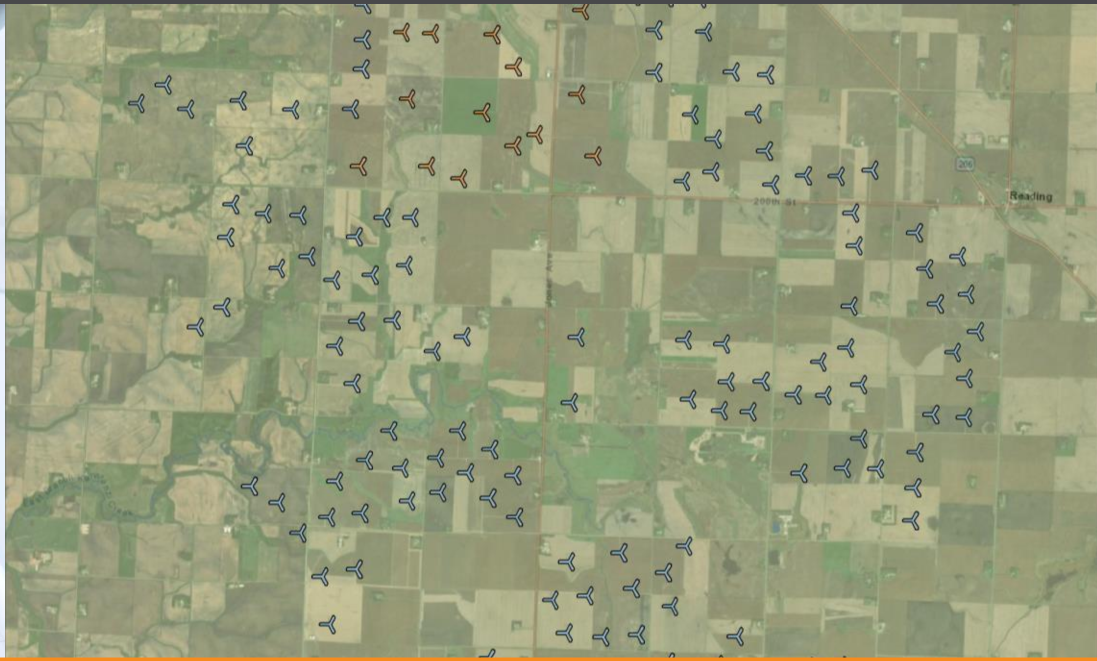
Noise Modeling for the Nobles Repower Project

Northern States Power Company
Nobles Wind Farm Repower Project
Docket No. IP-6646/WS-09-584
February 2021

NOBLES WIND FARM

NOISE ASSESSMENT

February 25, 2021



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1.0 INTRODUCTION

Xcel Energy (“Xcel”) operates the Nobles Wind Farm in Nobles County, Minnesota. They are submitting a Site Permit Application (“SPA”) to the Minnesota Public Utilities Commission (“PUC”) to repower the wind farm. Repowering the Nobles Wind Farm (“Project”) will involve removing the hub and blades from 133 of the existing GE 1.5 MW turbines and installing a new hub and blades onto the existing towers which will upgrade the towers to 1.6 MW GE turbines. In addition, one of the turbines will be removed and replaced with a Vestas V136 (3.45 or 3.6 MW). Additional details related to turbine modifications for the Project are provided in Section 2.0.

For the SPA, RSG conducted this noise assessment of the Project. Included in this report are:

- A description of the Project;
- A discussion of applicable sound level standards;
- A discussion of background sound levels;
- Sound propagation modeling procedures and results; and
- Conclusions.

Appendix A includes a primer on the science of sound, including descriptions of some of the acoustical terms used in this report, and Appendix B includes a discussion of sound issues that are particular to wind farms.

2.0 PROJECT DESCRIPTION

The Nobles Wind Farm is located in Nobles County, west of Reading, Minnesota. The Project is bounded by Interstate 90 to the south, 170th Street to the north, Minnesota Route 266 ("MN-266") to the northeast, McCall Avenue to the east, and Edwards Avenue to the west. Jones Avenue runs north to south and 200th Street runs east to west through the middle of the Project area. The closest Nobles turbine to Reading is T-104 which lies approximately 1,000 meters (0.6 miles) to the southwest. To the north, T-6 is the closest turbine to the City of Wilmont which lies approximately 2,800 meters (1.7 miles) north of the turbine. Lastly, to the south, the Town of Rushmore is approximately 1,850 meters (1.1 miles) south of T-59. The area around the Project is composed primarily of agricultural land uses with rural and farm residences spread throughout the area. The terrain is mostly flat.

The Project is currently composed of 134 GE 1.5 MW turbines. Repowering them will involve removing the hub and blades and replacing them to upgrade to GE 1.6-91 LNTE[1] (1.6 MW and 91-meter rotor diameter) and GE 1.6-97 LNTE (1.6 MW and 97-meter rotor diameter) turbines. One of the turbines, T-47 will be taken down completely, and a Vestas V136 (3.45 to 3.6 MW) turbine will be installed near its existing location.

The Project turbines are not the only wind turbines in the area. Community Wind South ("CWS"), which is composed of 15 Senvion MM92 2.05 MW wind turbines, is located in the middle-northern region of the Project area. The Nobles turbines surround CWS on the west, south, and east sides. There are also three turbines north of the Project between T-6 and the City of Wilmont ("Three Northern Turbines"). The three turbines are:

- Wilmont Hills - NEG Micon NM 72 1.5 MW turbine,
- Arnold Wind Farm - Vestas V82 1.65 MW turbine, and
- Don Sneve Wind Farm – NEG Micon NM54 950 kW turbine.

It is our understanding that CWS may be preparing to repower as well, which will upgrade the existing turbines to Vestas V110 2.2 MW turbines. The analysis presented in this report considers sound emissions from all of the turbines mentioned above.

A map of the Project area, Project turbines, and surrounding wind power developments is provided in Figure 1.

[1] Low Noise Trailing Edge ("LNTE") are blades that result in lower overall sound levels than standard blades. Some other manufacturers refer to them as STE or Serrated Trailing Edge.

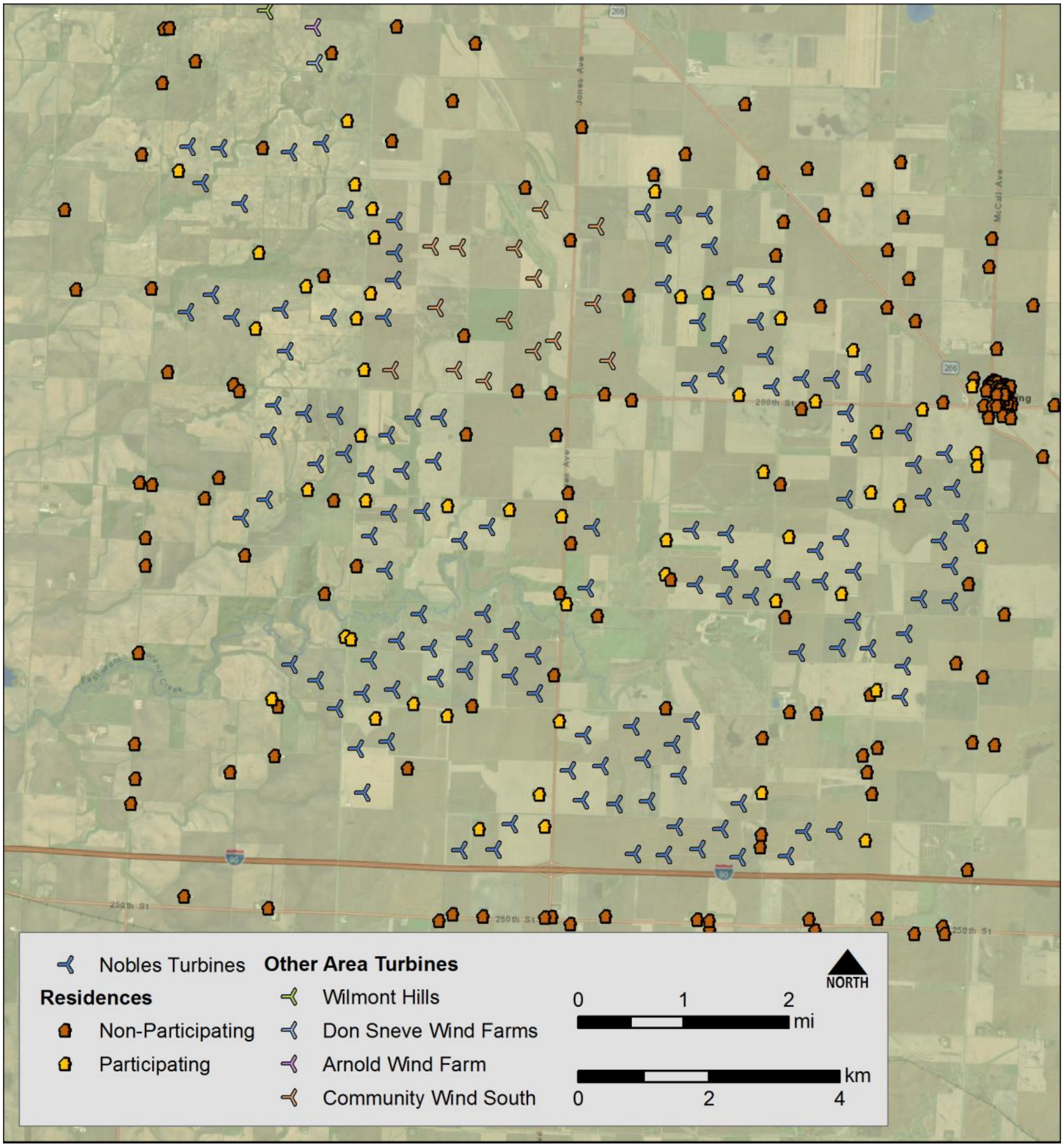

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FIGURE 1: PROJECT AREA MAP

3.0 SOUND LEVEL STANDARD & GUIDELINES

3.1 LOCAL STANDARDS

The Nobles County Land Use Ordinance references the state noise standards as the applicable noise limit for wind turbines. Specifically, in Section 729.7 it states:

1. *Noise – All WECS shall comply with Minnesota Rules 7030 governing noise.*

3.2 STATE STANDARDS

Minnesota Statute §116.07 charges the Pollution Control Agency with adopting noise standards. These standards are set in Minnesota Rules Chapter 7030, for which a wind power project must demonstrate it will comply with to receive a site permit from the PUC. The rule provides daytime and nighttime[2] sound level limits (Table 1) for a variety of land uses, which are grouped into three categories identified by a Noise Area Classification ("NAC"). The sensitive land uses around the Project are primarily within NAC 1 which includes residences (including farmhouses) and contains the most restrictive sound limits.

TABLE 1: SOUND LEVEL LIMITS (dBA) FROM MN RULES 7030.0040

NOISE AREA CLASSIFICATION	DAYTIME		NIGHTTIME	
	L_{50}	L_{10}	L_{50}	L_{10}
1	60	65	50	55
2	65	70	65	70
3	75	80	75	80

The Rule says that the limits are for the "…preservation of public health and welfare" and that they are "…consistent with speech, sleep, annoyance, and hearing conservation requirements…", but that they "…do not, by themselves, identify the limiting levels of impulsive noise[3] needed for the preservation of public health and welfare."

[2] MN Rules 7030.0020 define daytime as 7:00 a.m. to 10:00 p.m. and nighttime as 10:00 p.m. to 7:00 a.m.

[3] Impulsive noise is defined in Minnesota Rules Chapter 7030.0020. Typical, wind turbine sound at the distance of a residential receiver is not considered impulsive.

4.0 BACKGROUND SOUND LEVELS

Given the extent of existing operational wind farms in the area, background sound levels can be challenging to measure, particularly on a long-term basis. As such, background sound levels from other PUC dockets were reviewed to provide context to what the background sound levels in the Project area may. Factors that were considered included types of roadways that run through the project areas, land use, proximity to Nobles Wind Farm, population density, and how recent the background sound level data was collected.

Of the dockets reviewed the background sound level data reported in Docket #19-576 (Three Waters Wind Farm) seem to be most appropriately applicable to the Project. Similarities between the project areas include:

- Location – Just 30 kilometers (~19 miles) separate the areas
- Land use – Primarily agricultural with a mixture of rural and farm residences
- Population density – 0 to 50 people per square mile in both areas[4]
- Types of Roadways
  - Both areas are bordered by Interstate 90, a principal arterial road.
  - Nobles project area is bordered or transected by three minor collector roads (Edwards Avenue, 200th Street, and McCall Avenue), one major collector road (Jones Avenue), and one minor arterial road (MN-266).
  - The area monitored in Docket #19-576 is bordered or transected by has three major collector roads and one minor collector road.

In addition, the background sound level data in Docket #19-576 was measured recently in 2019 and in accordance with the most recent guidance[5] by the Minnesota Department of Commerce.

4.1 BACKGROUND SOUND LEVEL SUMMARY

As discussed in the noise assessment[6] in Docket #19-576, the average daytime L_{50} over the course of the entire monitoring period and across the monitored area was 38 dBA, and the average nighttime L_{50} over the course of the entire monitoring period and across the monitored area was 33 dBA. Some of the monitored locations showed a large difference between the L_{EQ} and the 10th-percentile sound levels (L_{90}) which indicated that the soundscapes were often

[4] Map of Minnesota Population Density, LeGISlative Coordinating Commission, July 2001, https://www.gis.leg.mn/pdf/pop/popdens00.pdf
[5] "Guidance for Large Wind Energy Conversion System Noise Study Protocol and Report," July 2019.
[6] Docket, #19-576, Document ID 20202-160279-04, "Updated Preliminary Noise Compliance Assessment", RSG, February 4, 2020.

dominated by transient or intermittent sounds, such as vehicle passbys and aircraft overflights. The hourly L_{50} varied over the course of the monitoring period and across the monitored locations. The minimum 1-hour nighttime L_{50}s were between 19 and 28 dBA, while the maximum 1-hour nighttime L_{50}s were typically between 42 and 45 dBA, with a few hours as high as 48 dBA.

Given the similarities between the two areas, similar background sound levels could be expected at the Project site.

5.0 SOUND PROPAGATION MODELING

5.1 MODELING PROCEDURE

Modeling for the 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 assumes downwind sound propagation between every source and every receiver, consequently, all wind directions, including the prevailing wind directions, are taken into account.

Model input parameters are listed in Appendix C including the modeled sound power spectra for each turbine model. For this analysis, we utilized a ground absorption factor of G=0.7, which is appropriate for comparing modeled results to the L_{50} metric used in the state standard, particularly when summing model results with the background L_{50} levels.[7] A 2-dB uncertainty factor was added to the turbine sound power level to account for uncertainty.[8] A search distance up to 10,000 meters (6.2 miles) allows for the contributions of distant turbines to be considered

[7] Generally accepted wind turbine modeling procedure calls for a ground absorption factor of G = 0.5, with a 2 dB uncertainty factor added to the manufacturer's guaranteed levels, to predict a maximum $L_{EQ(1-hr)}$. In this case, the Minnesota state limit utilizes an L_{50} metric instead of maximum $L_{EQ(1-hr)}$, which means a ground factor of G=0.7 can be used. Based on data from the Massachusetts Study on Wind Turbine Acoustics (2016) by Mass CEC, the L_{50} from wind turbines is typically 0.7 to 1.0 dB lower than the L_{EQ}. Using a ground factor of G=0.7 instead of 0.5 lowers the sound level projection of the model by 0.7 dB, on average, and as such serves as an adjustment factor to shift from an L_{EQ}-based model to and L_{50} -based model to adhere to the Minnesota L_{50} noise standard.

[8] Kaliski, et. al., Regulating and predicting wind turbine sound in the U.S., Inter-Noise 2018.

at receivers. The contribution of distant turbines will depend on the geometry and geography of the Project.

Residences were modeled as discrete receivers at a height of 4 meters (13 feet) above ground level.[9] A total of 222 residences were modeled throughout the Project area. The grid, represented in the results maps by sound pressure level contours, is also calculated at a height of 4 meters (13 feet). Use of a 4-meter receiver height in the model results in a conservative calculation of the expected sound levels at 1.5 meters (5 feet), which may be used for post-construction compliance monitoring. Modeling at a height of 4 meters is supported by post-construction monitoring at a number of projects,[8] and by the Institute of Acoustics' Good Practice Guide on Wind Turbine Noise (2013), "as it has the effect of reducing the potential oversensitivity of the calculation to the receiver region ground factor compared to lower receiver heights." The sound pressure level contours represent turbine-only sound levels.

5.2 MODELED SCENARIOS

Three different scenarios were modeled:

- Scenario 1: Existing turbines only at all wind projects.
- Scenario 2: Repower Nobles turbines, existing CWS turbines, and existing Three Northern Turbines
- Scenario 3: Repower Nobles turbines, repower CWS turbines, and existing Three Northern Turbines

For Scenario 2 and 3, the repowered Nobles turbines are a mixture of the GE 1.6-91 LNTE and GE 1.6-97 LNTE turbines and one turbine, T-47, modeled as a Vestas V136. Some of the GE 1.6-91 LNTE and GE 1.6-97 LNTE turbines were modeled with varying levels of Noise Reduced Operations ("NRO") to ensure that all residences are at 47 dBA or less.[10] The sound power levels used in the model and the NRO for each turbine are listed in Appendix C.

For Scenario 2, the CWS turbines were modeled as the existing Senvion MM92, but for Scenario 3, the CWS turbines were converted to Vestas V110 with STE.[11]

[9] Some other site permit applications (PUC Docket Nos. 17-307, 18-179, and 19-394, for example) have used receiver heights of 1.5 meters as opposed to 4 meters. However, using a receiver height of 4 meters is more conservative and results in a projected sound level that is 1.6 dB higher, on average than the results modeled at a height of 1.5 meters.

[10] MN Department of Commerce guidance[5] states that, "If background sound levels are equal to or greater than the applicable state standard at nearby receptors, the wind farm should not contribute more than 47 dB(A) to total sound levels at nearby receptors. Therefore, for example, when nighttime background sound levels are at 50 dB(A), a maximum turbine-only contribution of 47 dB(A) would result in a non-significant increase in total sound of 3 dB(A)."

[11] Serrated Trailing Edge. See also footnote 1 in Section 2.0.

5.3 MODEL RESULTS

A summary of the sound propagation model results for each scenario is presented in Table 2. For each scenario results are presented as turbine-only sound levels from the sound propagation model and total sound levels. The latter is calculated by summing (logarithmically)[12] the modeled turbine-only sound levels with a relatively high nighttime background sound level ($L_{50,\ 1\text{-hr}}$) of 45 dBA.

TABLE 2: MODEL RESULTS SUMMARY

SCENARIO	SOUND SOURCE	STATISTICAL L50 METRIC[13]	RESIDENCE CLASSIFICATION		
			ALL RESIDENCES	PARTICIPATING	NON-PARTICIPATING
Scenario 1 (All Existing Area Turbines)	Turbine-Only	Avg	40	46	39
		Max	49	49	47
		Min	28	39	28
	Total Sound (Background + Turbine)	Avg	46	48	46
		Max	50	50	49
		Min	45	46	45
Scenario 2 (Repower Nobles)	Turbine-Only	Avg	40	46	38
		Max	47	47	47
		Min	27	39	27
	Total Sound (Background + Turbine)	Avg	46	48	46
		Max	49	49	49
		Min	45	46	45
Scenario 3 (Repower Nobles & Repower CWS[14])	Turbine-Only	Avg	40	46	38
		Max	47	47	47
		Min	27	39	27
	Total Sound (Background + Turbine)	Avg	46	48	46
		Max	49	49	49
		Min	45	46	45

Under the existing scenario (Scenario 1), the highest modeled turbine-only sound level (L_{50}) at a non-participating residence is 47 dBA, and the average across all non-participating residences is 39 dBA. At participating residences, the highest modeled turbine only sound level under Scenario 1 is 49 dBA.

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[12] $L_{p1,2} = 10 \times \log_{10}\left(10^{L_{p1}/10} + 10^{L_{p2}/10}\right)$

[13] The average L_{50} across all residences is provided as a simple means of comparing the overall potential impact across the project area between the different scenarios. The maximum L_{50} represents the worst-case receptors. The minimum L_{50} represents the receptor with the least projected wind turbine sound.

[14] Assumes the CWS repower uses Vestas V110 with STE.

Under Scenarios 2 and 3, the summarized results are identical to each other and similar, but generally slightly lower, than Scenario 1. The highest modeled turbine-only sound level (L_{50}) at a non-participating residence is 47 dBA under Scenarios 2 and 3, and the average across all non-participating residences is 38 dBA. At participating residences, the highest modeled turbine only sound level under Scenarios 2 and 3 is 47 dBA.

Results for each residence are provided in Appendix D. As can be seen in Appendix D, most receptors are projected to see a reduction in the maximum turbine-only sound level (L_{50}), with the change in sound level as a result of the repower being ± 2 dB. On average, receptors across the project area will see a reduction of 0.3 dB in turbine-only sound level. These changes in level are not considered a noticeable difference.

As discussed in Section 4.1, background sound levels can vary from hour to hour, and they can vary by location. Hourly nighttime background sound levels (L_{50}) in the Project area are expected to typically be 45 dBA or less, and thus, Appendix D provides the model results summed with a range of potential background L_{50} values from 30 to 45 dBA in 5 dB increments. Table 2 shows the results of the modeled turbine-only sound levels with a credible worst-case nighttime background sound level ($L_{50,\ 1\text{-hr}}$) of 45 dBA. Using this credible worst-case ambient nighttime background noise level, the sound level limits would not be exceeded at any participating or non-participating residence. It is possible for the background L_{50} to be greater than 45, but the Project has been modeled such that no receptors exceed a turbine-only sound level of 47 per Department of Commerce Guidance.[10]

5.4 MAPPED MODEL RESULTS

Maps of model results for each scenario are provided in Figures 2 through 4. Results are presented as contour lines representing 5-dB increments of calculated A-weighted turbine-only sound pressure levels. The pink contour line, however, does not represent a 5-dB increment, but rather 47 dBA.

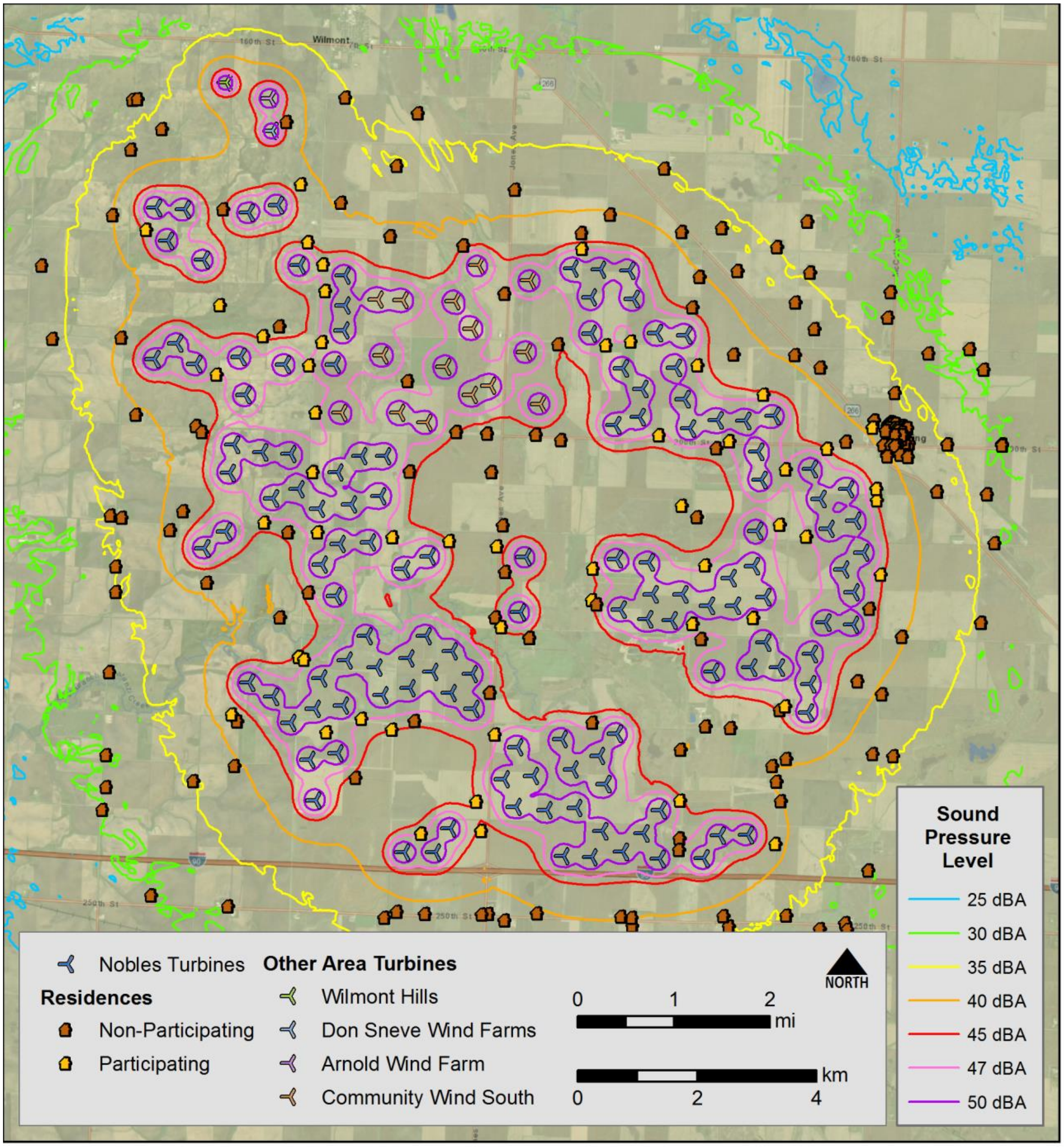

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FIGURE 2: MAP OF SOUND PROPAGATION MODEL RESULTS FOR SCENARIO 1 (EXISTING TURBINES)

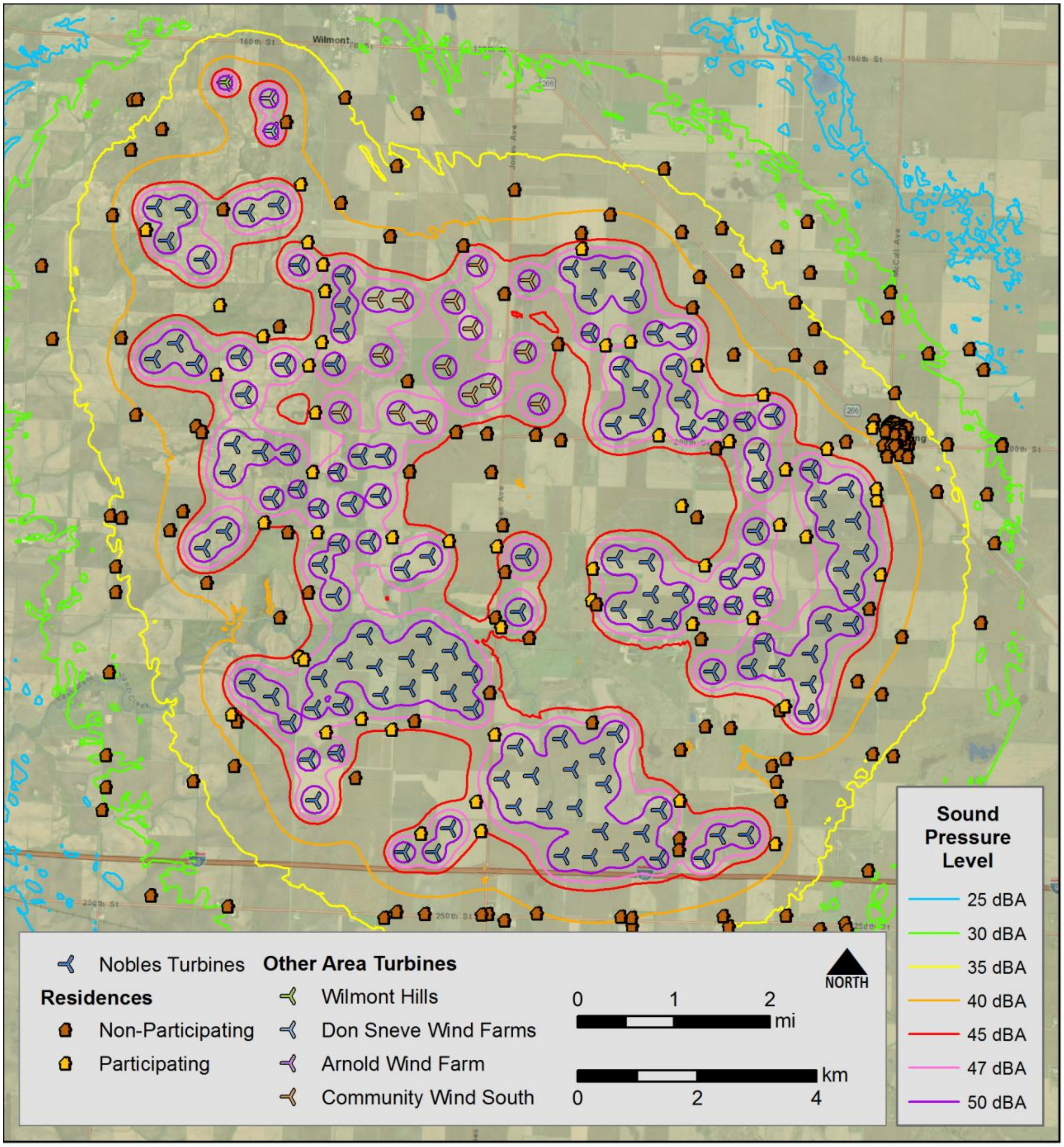

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FIGURE 3: MAP OF SOUND PROPAGATION MODEL RESULTS FOR SCENARIO 2 (REPOWER NOBLES)

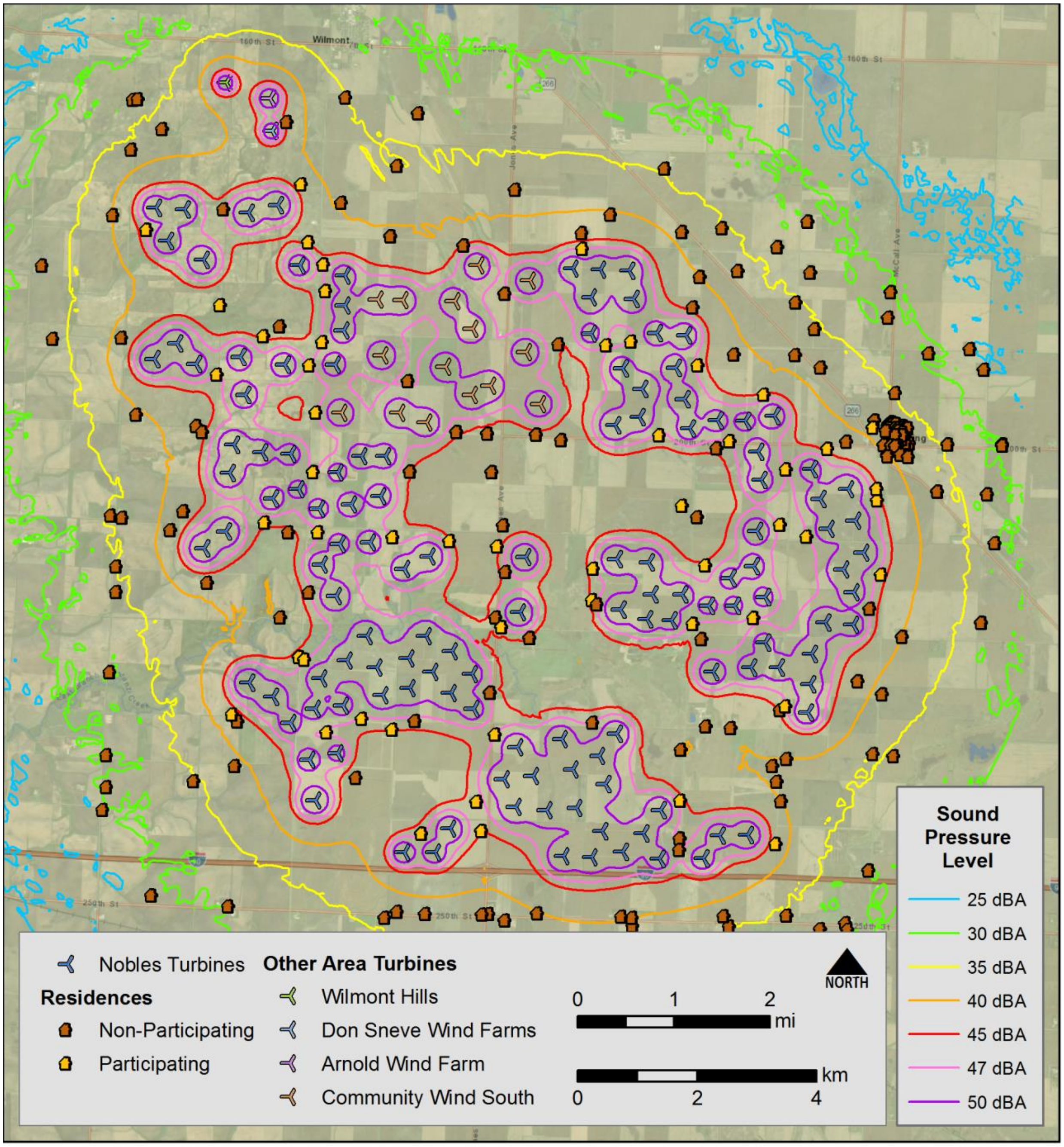

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FIGURE 4: MAP OF SOUND PROPAGATION MODEL RESULTS FOR SCENARIO 3 (REPOWER NOBLES & REPOWER CWS)

6.0 CONCLUSIONS

Xcel is proposing to repower the Nobles Wind Farm by upgrading 133 of the GE 1.5 MW turbines to GE 1.6-91 and GE 1.6-97 turbines by replacing the hub and blades and leaving the current towers in place. In addition, one turbine will be taken down completely and replaced with a Vestas V136. For the SPA, RSG performed a noise assessment of the Project including sound emissions from neighboring wind power projects so that cumulative noise impacts could be assessed. The noise assessment included three scenarios:

- Scenario 1: Existing turbines only at all wind projects.
- Scenario 2: Repower Nobles turbines, existing CWS turbines, and existing Three Northern Turbines
- Scenario 3: Repower Nobles turbines, repower CWS turbines, and existing Three Northern Turbines

Background sound levels were not measured in the existing area due to difficulties measuring long-term background sound levels with several operational projects in the area. Instead, background sound levels recently measured for another PUC Docket in a similar area approximately 19 miles east the Nobles Wind Farm are discussed in Section 4.1 to provide context to the expected background sound levels in the Project vicinity.

Conclusions of the assessment are as follows:

1. Background sound levels are expected to be similar to those presented in Docket #19-576 which resulted in minimum 1-hour nighttime L_{50}s between 19 and 28 dBA and maximum 1-hour nighttime L_{50}s between 42 and 45 dBA, with a few hours as high as 48 dBA.
2. State noise regulations require that wind power generation facilities show compliance with a nighttime limit of 50 dBA (L_{50}) and a daytime limit of 60 dBA (L_{50}) at residences, but guidance from the Department of Commerce recommends that turbine-only sound levels not exceed 47 dBA.[10]
3. Sound propagation modeling was performed in accordance with ISO 9613-2 at 222 discrete receivers modeled at a height of 4 meters above grade, with spectral ground attenuation and a ground factor of G=0.7. As discussed in Section 5.1, these modeling parameters represent the highest hourly L_{50} of the proposed facility.
4. Projected sound levels from the Project are lower for most residences as a result of the repower project, but not such that it would likely be a noticeable reduction given that the average reduction across the modeled receptors is 0.3 dB.

5. The Projected sound levels from the repowered Project are 47 dBA or less at all residences. The highest projected turbine-only sound level (L_{50}) at a participating and a non-participating residence is 47 dBA. The average sound level across all modeled residences is 40 dBA. These results are the same if CWS repowers with Vestas V110 with STEs or if CWS does not repower.
6. Given that the projected turbine-only sound levels from the Project are 47 dBA or less, the Project is not expected to exceed the noise regulations on a turbine-only basis, nor significantly contribute[10] to sound levels in excess of the most conservative background sound level limit of 50 dBA L_{50}.

APPENDIX A. ACOUSTICS PRIMER

Expressing Sound in Decibel Levels

The varying air pressure that constitutes sound can be characterized in many different ways. The human ear is the basis for the metrics that are used in acoustics. Normal human hearing is sensitive to sound fluctuations over an enormous range of pressures, from about 20 micropascals (the "threshold of audibility") to about 20 pascals (the "threshold of pain").[15] This factor of one million in sound pressure difference is challenging to convey in engineering units. Instead, sound pressure is converted to sound "levels" in units of "decibels" (dB, named after Alexander Graham Bell). Once a measured sound is converted to dB, it is denoted as a level with the letter "L".

The conversion from sound pressure in pascals to sound level in dB is a four-step process. First, the sound wave's measured amplitude is squared and the mean is taken. Second, a ratio is taken between the mean square sound pressure and the square of the threshold of audibility (20 micropascals). Third, using the logarithm function, the ratio is converted to factors of 10. The final result is multiplied by 10 to give the decibel level. By this decibel scale, sound levels range from 0 dB at the threshold of audibility to 120 dB at the threshold of pain.

Typical sound sources, and their sound pressure levels, are listed on the scale in Figure 5.

Human Response to Sound Levels: Apparent Loudness

For every 20 dB increase in sound level, the sound pressure increases by a *factor* of 10; the sound *level* range from 0 dB to 120 dB covers 6 factors of 10, or one million, in sound *pressure*. However, for an increase of 10 dB in sound *level* as measured by a meter, humans perceive an approximate doubling of apparent loudness: to the human ear, a sound level of 70 dB sounds about "twice as loud" as a sound level of 60 dB. Smaller changes in sound level, less than 3 dB up or down, are generally not perceptible.

[15] The pascal is a measure of pressure in the metric system. In Imperial units, they are themselves very small: one pascal is only 145 millionths of a pound per square inch (psi). The sound pressure at the threshold of audibility is only 3 one-billionths of one psi: at the threshold of pain, it is about 3 one-thousandths of one psi.

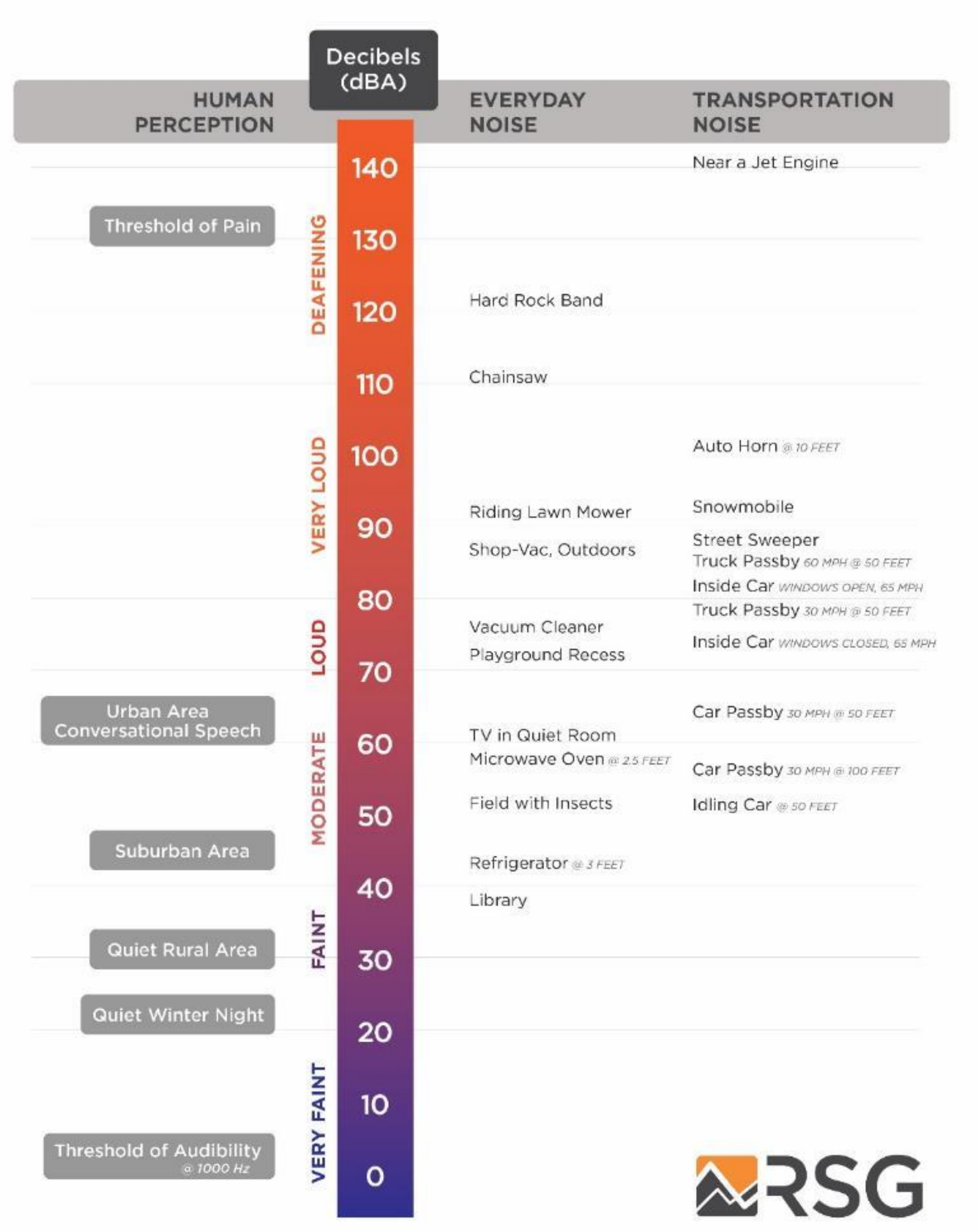

FIGURE 5: A SCALE OF SOUND PRESSURE LEVELS FOR TYPICAL SOUND SOURCES

Frequency Spectrum of Sound

The "frequency" of a sound is the rate at which it fluctuates in time, expressed in Hertz (Hz), or cycles per second. Very few sounds occur at only one frequency: most sound contains energy at many different frequencies, and it can be broken down into different frequency divisions, or bands. These bands are similar to musical pitches, from low tones to high tones. The most common division is the standard octave band. An octave is the range of frequencies whose upper frequency limit is twice its lower frequency limit, exactly like an octave in music. An octave band is identified by its center frequency: each successive band's center frequency is twice as high (one octave) as the previous band. For example, the 500 Hz octave band includes all sound whose frequencies range between 354 Hz (Hertz, or cycles per second) and 707 Hz. The next band is centered at 1,000 Hz with a range between 707 Hz and 1,414 Hz. The range of human hearing is divided into 10 standard octave bands: 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1,000 Hz, 2,000 Hz, 4,000 Hz, 8,000 Hz, and 16,000 Hz. For analyses that require finer frequency detail, each octave-band can be subdivided. A commonly-used subdivision creates three smaller bands within each octave band, or so-called 1/3-octave bands.

Human Response to Frequency: Weighting of Sound Levels

The human ear is not equally sensitive to sounds of all frequencies. Sounds at some frequencies seem louder than others, despite having the same decibel level as measured by a sound level meter. In particular, human hearing is much more sensitive to medium pitches (from about 500 Hz to about 4,000 Hz) than to very low or very high pitches. For example, a tone measuring 80 dB at 500 Hz (a medium pitch) sounds quite a bit louder than a tone measuring 80 dB at 60 Hz (a very low pitch). The frequency response of normal human hearing ranges from 20 Hz to 20,000 Hz. Below 20 Hz, sound pressure fluctuations are not "heard", but sometimes can be "felt". This is known as "infrasound". Likewise, above 20,000 Hz, sound can no longer be heard by humans; this is known as "ultrasound". As humans age, they tend to lose the ability to hear higher frequencies first; many adults do not hear very well above about 16,000 Hz. Most natural and man-made sound occurs in the range from about 40 Hz to about 4,000 Hz. Some insects and birdsongs reach to about 8,000 Hz.

To adjust measured sound pressure levels so that they mimic human hearing response, sound level meters apply filters, known as "frequency weightings", to the signals. There are several defined weighting scales, including "A", "B", "C", "D", "G", and "Z". The most common weighting scale used in environmental noise analysis and regulation is A-weighting. This weighting represents the sensitivity of the human ear to sounds of low to moderate level. It attenuates sounds with frequencies below 1000 Hz and above 4000 Hz; it amplifies very slightly sounds between 1000 Hz and 4000 Hz, where the human ear is particularly sensitive. The C-weighting scale is sometimes used to describe louder sounds. The B- and D- scales are seldom used. All of these frequency weighting scales are normalized to the average human hearing response at

1000 Hz: at this frequency, the filters neither attenuate nor amplify. G-weighting is a standardized weighting used to evaluate infrasound.

When a reported sound level has been filtered using a frequency weighting, the letter is appended to “dB”. For example, sound with A-weighting is usually denoted “dBA”. When no filtering is applied, the level is denoted “dB” or “dBZ”. The letter is also appended as a subscript to the level indicator “L”, for example “L_A” for A-weighted levels.

Time Response of Sound Level Meters

Because sound levels can vary greatly from one moment to the next, the time over which sound is measured can influence the value of the levels reported. Often, sound is measured in real time, as it fluctuates. In this case, acousticians apply a so-called “time response” to the sound level meter, and this time response is often part of regulations for measuring sound. If the sound level is varying slowly, over a few seconds, “Slow” time response is applied, with a time constant of one second. If the sound level is varying quickly (for example, if brief events are mixed into the overall sound), “Fast” time response can be applied, with a time constant of one-eighth of a second.[16] The time response setting for a sound level measurement is indicated with the subscript “S” for Slow and “F” for Fast: L_S or L_F. A sound level meter set to Fast time response will indicate higher sound levels than one set to Slow time response when brief events are mixed into the overall sound, because it can respond more quickly.

In some cases, the maximum sound level that can be generated by a source is of concern. Likewise, the minimum sound level occurring during a monitoring period may be required. To measure these, the sound level meter can be set to capture and hold the highest and lowest levels measured during a given monitoring period. This is represented by the subscript “max”, denoted as “L_{max}”. One can define a “max” level with Fast response L_{Fmax} (1/8-second time constant), Slow time response L_{Smax} (1-second time constant), or Continuous Equivalent level over a specified time period L_{EQmax}.

Accounting for Changes in Sound Over Time

A sound level meter’s time response settings are useful for continuous monitoring. However, they are less useful in summarizing sound levels over longer periods. To do so, acousticians apply simple statistics to the measured sound levels, resulting in a set of defined types of sound level related to averages over time. An example is shown in Figure 6. The sound level at each instant of time is the grey trace going from left to right. Over the total time it was measured (1 hour in the figure), the sound energy spends certain fractions of time near various levels, ranging from the minimum (about 27 dB in the figure) to the maximum (about 65 dB in the

[16] There is a third time response defined by standards, the “Impulse” response. This response was defined to enable use of older, analog meters when measuring very brief sounds; it is no longer in common use.

figure). The simplest descriptor is the average sound level, known as the Equivalent Continuous Sound Level. Statistical levels are used to determine for what percentage of time the sound is louder than any given level. These levels are described in the following sections.

Equivalent Continuous Sound Level - Leq

One straightforward, common way of describing sound levels is in terms of the Continuous Equivalent Sound Level, or L_{EQ}. The L_{EQ} is the average sound pressure level over a defined period of time, such as one hour or one day. L_{EQ} is the most commonly used descriptor in noise standards and regulations. L_{EQ} is representative of the overall sound to which a person is exposed. Because of the logarithmic calculation of decibels, L_{EQ} tends to favor higher sound levels: loud and infrequent sources have a larger impact on the resulting average sound level than quieter but more frequent sounds. For example, in Figure 6, even though the sound levels spends most of the time near about 34 dBA, the L_{EQ} is 41 dBA, having been “inflated” by the maximum level of 65 dBA and other occasional spikes over the course of the hour.

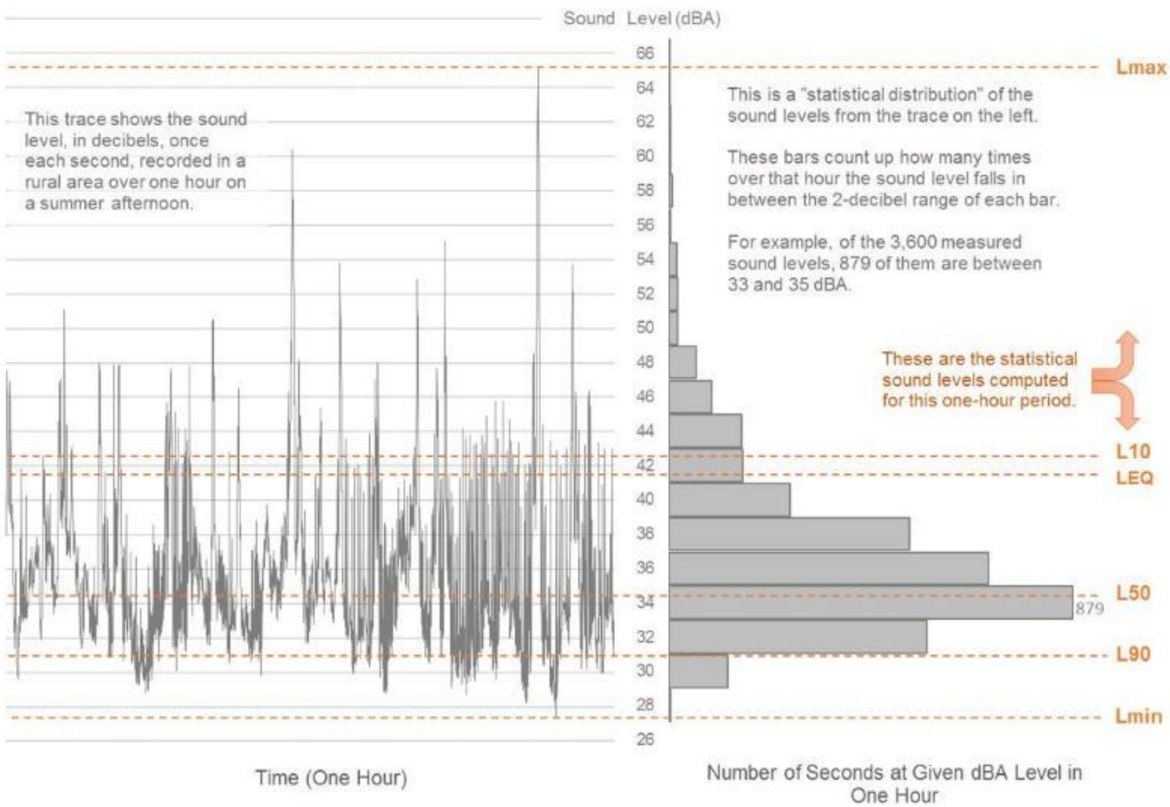

FIGURE 6: EXAMPLE OF DESCRIPTIVE TERMS OF SOUND MEASUREMENT OVER TIME

Percentile Sound Levels – Ln

Percentile sound levels describe the statistical distribution of sound levels over time. "L_N" is the level above which the sound spends "N" percent of the time. For example, L_{90} (sometimes called the "residual base level") is the sound level exceeded 90% of the time: the sound is louder than L_{90} most of the time. L_{10} is the sound level that is exceeded only 10% of the time. (the "median level") is exceeded 50% of the time: half of the time the sound is louder than , and half the time it is quieter than . Note that (median) and L_{EQ} (mean) are not always the same, for reasons described in the previous section.

L_{90} is often a good representation of the "ambient sound" in an area. This is the sound that persists for longer periods, and below which the overall sound level seldom falls. It tends to filter out other short-term environmental sounds that aren't part of the source being investigated. L_{10} represents the higher, but less frequent, sound levels. These could include such events as barking dogs, vehicles driving by and aircraft flying overhead, gusts of wind, and work operations. L_{90} represents the background sound that is present when these event sounds are excluded.

Note that if one sound source is very constant and dominates the soundscape in an area, all of the descriptive sound levels mentioned here tend toward the same value. It is when the sound is varying widely from one moment to the next that the statistical descriptors are useful.

APPENDIX B. WIND TURBINE ACOUSTICS – SPECIAL CONSIDERATIONS

Sources of Sound Generation by Wind Turbines

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

Aerodynamic sound is the primary source of sound associated with wind turbines. These acoustic emissions can be either tonal or broadband. Tonal sound occurs at discrete frequencies, whereas broadband sound is distributed with little peaking across the frequency spectrum. While unusual, tonal sound can also originate from unstable air flows over holes, slits, or blunt trailing edges on blades. The majority of audible aerodynamic sound from wind turbines is broadband at the middle frequencies, roughly between 200 Hz and 1,000 Hz.

Wind turbines emit aerodynamic broadband sound as the rotating blades interact with atmospheric turbulence and as air flows along their surfaces. This produces a characteristic "whooshing" sound through several mechanisms (Figure 7):

- Inflow turbulence sound 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 sound that varies across a wide range of frequencies but is most significant at frequencies below 500 Hz.
- Trailing edge sound is produced as boundary-layer turbulence as the air passes into the wake, or trailing edge, of the blade. This sound is distributed across a wide frequency range but is most notable at high frequencies between 700 Hz and 2 kHz.
- Tip vortex sound 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 sound further away.
- Stall or separation sound occurs due to the interaction of turbulence with the blade surface.

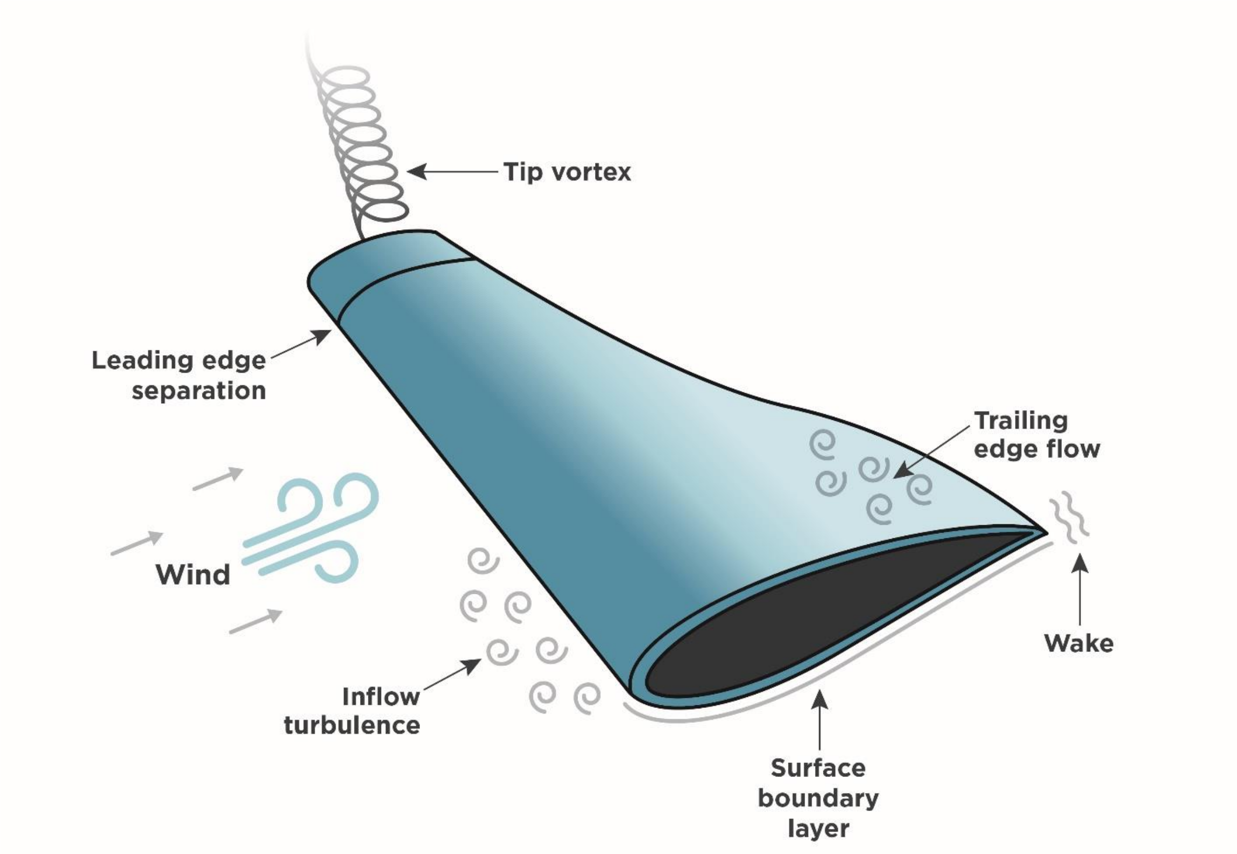

FIGURE 7: AIRFLOW AROUND A ROTOR BLADE

Mechanical sound from machinery inside the nacelle tends to be tonal in nature but can also have a broadband component. Potential sources of mechanical sound 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 sound. However modern wind turbines have nacelles that are designed to reduce the transmission of internal sound, and rarely is this a significant portion of the total wind turbine sound.

Amplitude Modulation

Amplitude modulation (AM) is a fluctuation in sound level that occurs at the blade passage frequency. There is no consistent definition how much of a sound level fluctuation is necessary for blade swish to be considered AM. Fluctuations in individual 1/3 octave bands are typically greater. 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 amplitude modulation depth.[17] Most amplitude modulation is in the mid-frequencies and most overall A-weighted AM is less than 4.5 dB in depth.[18]

There are many confirmed and hypothesized causes of amplitude modulation including: blade passage in front of the tower, blade tip sound emission directivity, wind shear, inflow turbulence, transient blade stall, and turbine blade yaw error. It has recently been noted that although wind shear can contribute to the extent of amplitude modulation, wind shear does not contribute to the existence of amplitude modulation in and of itself. Instead, there needs to be detachment of airflow from the blades for wind shear to contribute to amplitude modulation.[19] 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. Amplitude modulation extent varies with the relative location of a receptor to the turbine. Amplitude Modulation 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.

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 8).

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[17] 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.
[18] RSG, et al., “Massachusetts Study on Wind Turbine Acoustics,” Massachusetts Clean Energy Center and Massachusetts Department of Environmental Protection, 2016
[19] “Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect.” *RenewableUK.* December 2013.

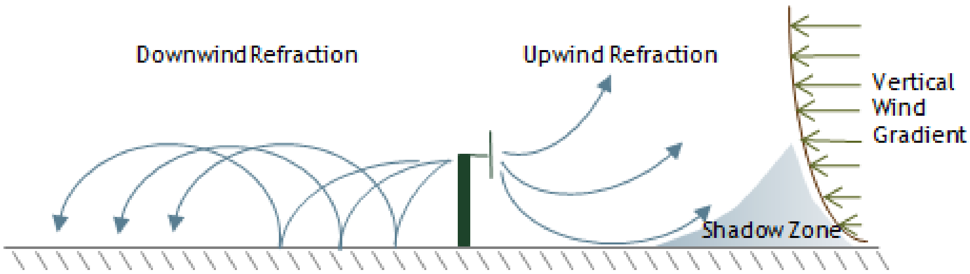


FIGURE 8: SCHEMATIC OF THE REFRACTION OF SOUND DUE TO VERTICAL WIND GRADIENT (WIND SHEAR)

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

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 sound at downwind receptors because the frequency spectrum from wind is very similar to the frequency spectrum from a wind turbine. Figure 9 compares the shape of the sound spectrum measured during a 5 m/s wind event to that of the GE 1.6-97 wind turbine. As shown, the shapes of the spectra are very similar. As a result, the masking of turbine sound occurs at higher wind speeds for some meteorological conditions. Masking will occur most, when ground wind speeds are relatively high, creating wind-caused sound such as wind blowing through the trees and interaction of wind with structures.

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 the ridge blocks the wind.

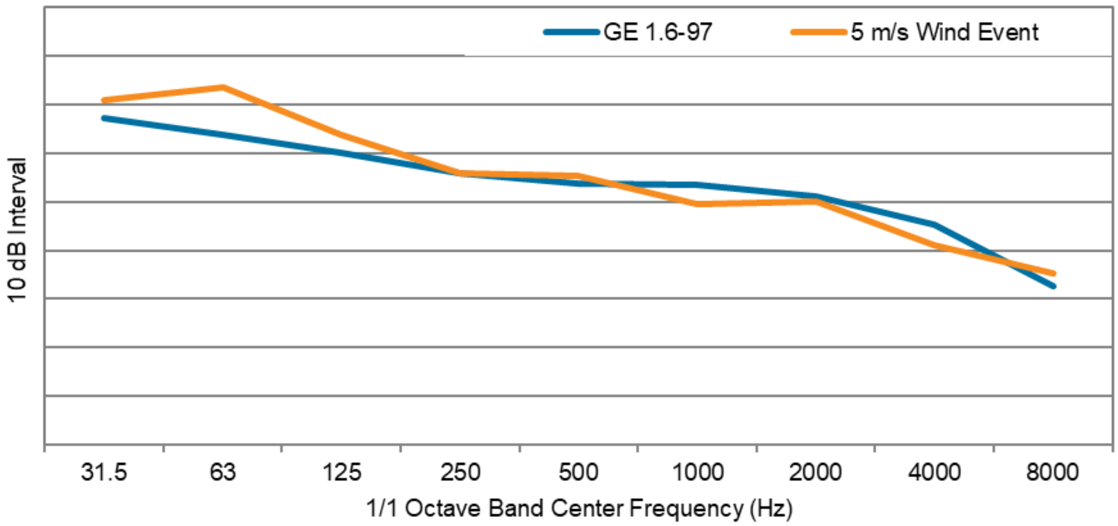


FIGURE 9: COMPARISON OF NORMALIZED FREQUENCY SPECTRA FROM WIND AND THE GE 1.6-97 TURBINE[20]

Infrasound and Low Frequency Sound

Infrasound is sound pressure fluctuations at frequencies below about 20 Hz. Sound below this frequency is only audible at very high magnitudes (90 dBG[21] and higher). 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 sound 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. Large modern wind turbines are "upwind", where the rotor plane is upwind of the tower. As a result, this type of low frequency sound is at a much lower magnitude with upwind turbines than downwind turbines, well below established infrasonic hearing thresholds.

Figure 10 shows the sound levels 350 meters (1,148 feet) 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

[20] 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.
[21] See Appendix A for additional information on frequency-weighted sound levels.

m/s. Measurements were made over approximately two weeks.[22] 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.

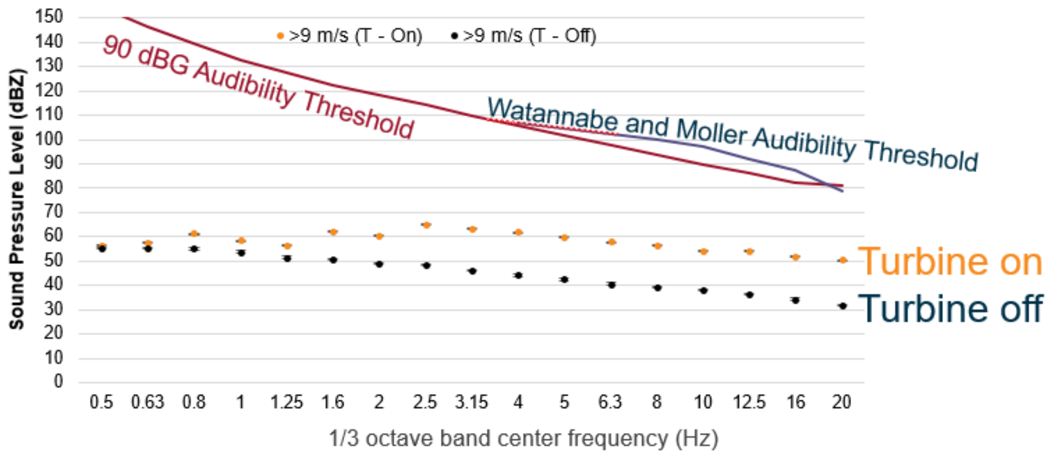


FIGURE 10: INFRASOUND FROM A WIND TURBINE AT 350 METERS (1,148 FEET) COMPARED WITH PERCEPTION THESHOLDS

Low frequency sound is primarily generated by the generator and mechanical components. Much of the mechanical sound 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 very turbulent. However, at these wind speeds, low frequency sound from the wind turbine blades is often masked by wind sound at the downwind receptors.

Finally, low frequency sound is absorbed less by the atmosphere and ground than higher frequency sound. This is taken into account in our modeling by using frequency-specific ground attenuation and atmospheric absorption factors.

Use of Sound Level Weighting Networks for Wind Turbine Sound

The human ear is not equally sensitive to sound pressure levels at all frequencies and magnitudes. Some frequencies, despite being the same decibel level (that is, magnitude), seem louder than others. For example, a 500 Hz tone at 80 dB will sound louder than a 63 Hz tone at the same level. In addition, the relative loudness of these tones will change with magnitude. For example, the perceived difference in loudness between those two tones is less when both are at 110 dB than when they are at 40 dB.

[22] 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

To account for the difference in the perceived loudness of a sound by frequency and magnitude, acousticians apply frequency weightings to sound levels. The most common weighting scale used in environmental noise analysis is the “A-weighting”, which represents the sensitivity of the human ear at lower sound pressure levels. The A-weighting is the most appropriate weighting when overall sound pressure levels are relatively low (up to about 70 dBA). The A-weighting de-emphasizes sounds at lower and very high frequencies, since the human ear is insensitive to sound at these frequencies at low magnitude. The A-weighting is indicated by “dBA” or “dB(A)”.

At higher sound pressure levels (greater than approximately 70 dBA), a different weighting must be used since human hearing sensitivity does not change as much with frequency. The “C-weighting” mimics the sensitivity of the human ear for these moderate to higher sound levels (greater than approximately 70 dBA, which is higher ground-based sound levels produced by wind power projects). C-weighted sound levels are indicated by “dBC” or “dB(C)”.

The “Z-weighting” does not emphasize or de-emphasize sound at any frequency. “Z” weighted sound levels are sometimes labeled as “Flat” or “Linear”. The difference is that the “Z-weighting” is defined as being unweighted in a specific range, whereas “Flat” or “Linear” indicate that no weighting has been used. Z-weighting or unweighted levels are typically used when reporting sound levels at individual octave bands.

The most appropriate weighting for wind turbine sound is A-weighting, for two reasons. The first is that sound pressure levels due to wind turbine sound are typically in the appropriate range for the A-weighting at typical receiver distances (50 dBA or less). The second is that various studies of wind turbine acoustics have shown that the potential effects of wind turbine noise on people are correlated with A-weighted sound level (i.e. Pedersen et al, 2008[23]) as well as to the perceived loudness of wind turbine sound.[24,25] Other researchers found that 51% of the energy making up a C-weighted measurement of wind turbine sound is not audible. Thus, it is more difficult to relate the level of C-weighted sound to human perception. That is, two sounds may be perceived exactly alike, but there could be significant variations in the C-weighted sound level depending on the content of inaudible sound in each.[18]

[23] 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.
[24] Yokoyama S., et al. “Perception of low frequency components in wind turbine noise.” Noise Control Engr. J. 62(5) 2014
[25] Yokoyama et al. “Loudness evaluation of general environmental noise containing low frequency components.” Proceedings of InterNoise2013, 2013

APPENDIX C. MODEL INPUT DATA

TABLE 3: SOUND PROPAGATION MODELING PARAMETERS

PARAMETER	SETTING
Ground Absorption	Spectral for all sources, mixed ground (G=0.7)
Atmospheric Attenuation	Based on 10˚ Celsius, 70% relative humidity
Structure Reflections	None
Receiver Height	4 meters for residences and isoline contours
Search Distance	10,000 meters

TABLE 4: TURBINE 1/1 OCTAVE BAND MODELED SPECTRA (dBZ UNLESS OTHERWISE INDICATED)

TURBINE	1/1 OCTAVE BAND CENTER FREQUENCY (Hz)									SUM (dBA)	SUM (dBZ)
	31.5	63	125	250	500	1000	2000	4000	8000		
GE 1.5 MW sl/sle		111	110	106	102	98	93	86	79	104	115
Senvion MM92		111	109	107	103	98	91	84	83	104	114
NEG Micron NM54	108	100	98	103	99	95	94	89	86	102	110
Vestas V82		111	108	105	102	96	94	87	73	103	114
GE 1.6-97 LNTE	116	112	109	104	102	102	100	94	81	108	120
GE 1.6-91 LNTE	117	114	110	105	102	100	97	90	76	105	119
Vestas V136 3.6MW STE	117	114	109	106	102	100	98	90	73	106	119
Vestas V110 2.2 MW STE	115	113	110	106	103	100	99	95	82	106	119

TABLE 5: MODELED TURBINE SOUND POWER LEVELS, NRO, & LOCATIONS

TURBINE	MODELED SOUND POWER LEVEL (dBA)		REPOWER TURBINE MODEL	NRO (dB)	HUB HEIGHT (m)	COORDINATES (UTM NAD83 Z15N)		GROUND ELEVATION + HUB HEIGHT (m)
	EXISTING	REPOWER				X (m)	Y (m)	
1	106.0	107.0	GE 1.6-97 LNTE	-1.5	80	269096	4846508	593
2	106.0	108.5	GE 1.6-97 LNTE	0.0	80	269575	4846480	595
3	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	269296	4845948	593
4	106.0	108.5	GE 1.6-97 LNTE	0.0	80	269893	4845630	599
5	106.0	108.5	GE 1.6-97 LNTE	0.0	80	270645	4846424	608
6	106.0	108.5	GE 1.6-97 LNTE	0.0	80	271139	4846553	607
7	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	271510	4845545	605
8	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	272263	4845367	611
9	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	272260	4844875	609
10	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	272242	4844457	607
11	106.0	108.5	GE 1.6-97 LNTE	0.0	80	269069	4843971	592
12	106.0	108.5	GE 1.6-97 LNTE	0.0	80	269453	4844237	590

TURBINE	MODELED SOUND POWER LEVEL (dBA)		REPOWER TURBINE MODEL	NRO (dB)	HUB HEIGHT (m)	COORDINATES (UTM NAD83 Z15N)		GROUND ELEVATION + HUB HEIGHT (m)
	EXISTING	REPOWER				X (m)	Y (m)	
13	106.0	106.5	GE 1.6-97 LNTE	-2.0	80	269766	4843891	603
14	106.0	107.0	GE 1.6-97 LNTE	-1.5	80	270512	4844008	607
15	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	270593	4843375	596
16	106.0	107.0	GE 1.6-97 LNTE	-1.5	80	271254	4843883	611
17	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	272096	4843887	609
18	106.0	108.5	GE 1.6-97 LNTE	0.0	80	270329	4842075	600
19	106.0	108.5	GE 1.6-97 LNTE	0.0	80	270407	4842544	601
20	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	270871	4842417	604
21	106.0	105.0	GE 1.6-91 LNTE	-2.0	80	271355	4842386	605
22	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	271054	4841642	595
23	106.0	103.0	GE 1.6-91 LNTE	-4.0	80	271489	4841801	602
24	106.0	103.0	GE 1.6-91 LNTE	-4.0	80	272146	4842080	600
25	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	272542	4842353	588
26	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	272945	4842353	598
27	106.0	104.0	GE 1.6-91 LNTE	-3.0	80	271832	4841472	602
28	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	272371	4841545	593
29	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	272862	4841685	591
30	106.0	108.5	GE 1.6-97 LNTE	0.0	80	269906	4840813	579
31	106.0	108.5	GE 1.6-97 LNTE	0.0	80	270271	4841090	583
32	106.0	104.0	GE 1.6-91 LNTE	-3.0	80	272176	4840889	591
33	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	272687	4840913	588
34	106.0	106.5	GE 1.6-97 LNTE	-2.0	80	271876	4840539	586
35	106.0	108.5	GE 1.6-97 LNTE	0.0	80	272115	4840011	580
36	106.0	107.0	GE 1.6-97 LNTE	-1.5	80	273262	4840471	588
37	106.0	108.5	GE 1.6-97 LNTE	0.0	80	273680	4840676	589
38	106.0	108.5	GE 1.6-97 LNTE	0.0	80	270660	4838567	571
39	106.0	108.5	GE 1.6-97 LNTE	0.0	80	271056	4838324	582
40	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	271874	4838637	578
41	106.0	108.5	GE 1.6-97 LNTE	0.0	80	272298	4838933	580
42	106.0	108.5	GE 1.6-97 LNTE	0.0	80	272633	4839341	578
43	106.0	108.5	GE 1.6-97 LNTE	0.0	80	272798	4838814	589
44	106.0	104.0	GE 1.6-91 LNTE	-3.0	80	271766	4838126	586
45	106.0	104.0	GE 1.6-91 LNTE	-3.0	80	272230	4838183	585
46	106.0	107.0	GE 1.6-97 LNTE	-1.5	80	272895	4838358	589

TURBINE	MODELED SOUND POWER LEVEL (dBA)		REPOWER TURBINE MODEL	NRO (dB)	HUB HEIGHT (m)	COORDINATES (UTM NAD83 Z15N)		GROUND ELEVATION + HUB HEIGHT (m)
	EXISTING	REPOWER				X (m)	Y (m)	
47[26]	106.0	107.5	V136_3p6_STE_PO1	0.0	82	273333	4838975	594
48	106.0	108.5	GE 1.6-97 LNTE	0.0	80	273621	4839347	587
49	106.0	108.5	GE 1.6-97 LNTE	0.0	80	273727	4838746	595
50	106.0	108.5	GE 1.6-97 LNTE	0.0	80	274060	4839087	592
51	106.0	105.0	GE 1.6-91 LNTE	-2.0	80	274389	4838711	594
52	106.0	108.5	GE 1.6-97 LNTE	0.0	80	273344	4838475	597
53	106.0	108.5	GE 1.6-97 LNTE	0.0	80	274035	4838392	596
54	106.0	105.0	GE 1.6-91 LNTE	-2.0	80	274418	4838128	594
55	106.0	105.0	GE 1.6-91 LNTE	-2.0	80	271353	4837892	584
56	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	271669	4837280	587
57	106.0	103.0	GE 1.6-91 LNTE	-4.0	80	272146	4837387	585
58	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	273262	4835726	592
59	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	273779	4835729	590
60	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	274031	4836122	595
61	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	275152	4837487	589
62	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	275892	4837622	584
63	106.0	108.5	GE 1.6-97 LNTE	0.0	80	274925	4836946	594
64	106.0	108.5	GE 1.6-97 LNTE	0.0	80	275417	4837010	591
65	106.0	108.5	GE 1.6-97 LNTE	0.0	80	276073	4837117	590
66	106.0	108.5	GE 1.6-97 LNTE	0.0	80	275125	4836487	593
67	106.0	108.5	GE 1.6-97 LNTE	0.0	80	275639	4836433	590
68	106.0	108.5	GE 1.6-97 LNTE	0.0	80	276136	4836469	598
69	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	276814	4837714	582
70	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	276521	4837344	584
71	106.0	108.5	GE 1.6-97 LNTE	0.0	80	276622	4836866	582
72	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	277543	4836438	587
73	106.0	108.5	GE 1.6-97 LNTE	0.0	80	276562	4836080	586
74	106.0	107.0	GE 1.6-97 LNTE	-1.5	80	277257	4836044	585
75	106.0	108.5	GE 1.6-97 LNTE	0.0	80	275922	4835665	591
76	106.0	108.5	GE 1.6-97 LNTE	0.0	80	276395	4835645	587
77	106.0	108.5	GE 1.6-97 LNTE	0.0	80	276910	4835739	584
78	106.0	105.0	GE 1.6-91 LNTE	-2.0	80	277523	4835617	583
79	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	278264	4835627	587
80	106.0	106.5	GE 1.6-97 LNTE	-2.0	80	278533	4836007	589

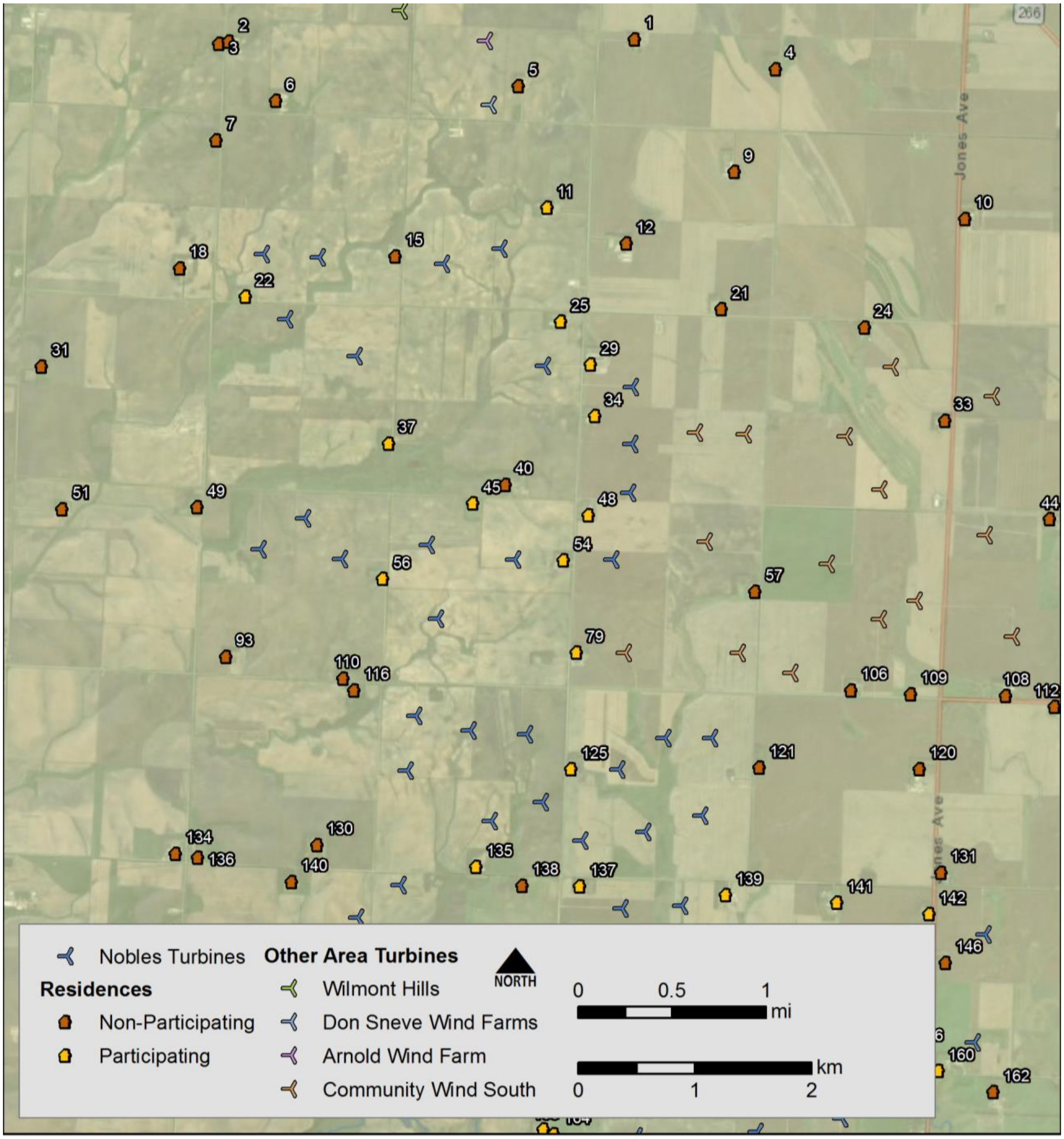
[26] Repower location shifted approximately 30 meters (98 feet) east-northeast of the existing locations. Coordinates shown in this table represent the repower location.

TURBINE	MODELED SOUND POWER LEVEL (dBA)		REPOWER TURBINE MODEL	NRO (dB)	HUB HEIGHT (m)	COORDINATES (UTM NAD83 Z15N)		GROUND ELEVATION + HUB HEIGHT (m)
	EXISTING	REPOWER				X (m)	Y (m)	
81	106.0	108.5	GE 1.6-97 LNTE	0.0	80	279007	4836022	591
82	106.0	106.5	GE 1.6-97 LNTE	-2.0	80	276073	4845488	590
83	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	276540	4845469	596
84	106.0	108.5	GE 1.6-97 LNTE	0.0	80	276387	4845006	593
85	106.0	104.0	GE 1.6-91 LNTE	-3.0	80	276385	4844406	594
86	106.0	108.5	GE 1.6-97 LNTE	0.0	80	277019	4845456	594
87	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	277089	4844983	596
88	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	277483	4844413	593
89	106.0	107.0	GE 1.6-97 LNTE	-1.5	80	277967	4844376	591
90	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	276908	4843818	596
91	106.0	108.5	GE 1.6-97 LNTE	0.0	80	277236	4843473	595
92	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	277797	4843830	594
93	106.0	108.5	GE 1.6-97 LNTE	0.0	80	276785	4842866	586
94	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	277191	4843008	593
95	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	277948	4843305	595
96	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	278036	4842819	596
97	106.0	105.0	GE 1.6-91 LNTE	-2.0	80	278496	4842948	590
98	106.0	103.5	GE 1.6-91 LNTE	-2.0	80	278963	4842939	591
99	106.0	107.0	GE 1.6-97 LNTE	-1.5	80	279445	4843027	592
100	106.0	107.0	GE 1.6-97 LNTE	-1.5	80	279179	4842424	593
101	106.0	107.0	GE 1.6-97 LNTE	-1.5	80	279227	4841952	595
102	106.0	105.0	GE 1.6-91 LNTE	-2.0	80	280069	4842136	594
103	106.0	107.0	GE 1.6-97 LNTE	-1.5	80	280217	4841634	597
104	106.0	108.5	GE 1.6-97 LNTE	0.0	80	280692	4841803	597
105	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	279161	4841102	593
106	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	280366	4841135	595
107	106.0	108.5	GE 1.6-97 LNTE	0.0	80	280809	4841271	600
108	106.0	108.5	GE 1.6-97 LNTE	0.0	80	275291	4840667	599
109	106.0	108.5	GE 1.6-97 LNTE	0.0	80	271775	4836601	588
110	106.0	108.5	GE 1.6-97 LNTE	0.0	80	275196	4839742	596
111	106.0	108.5	GE 1.6-97 LNTE	0.0	80	276809	4840628	594
112	106.0	108.5	GE 1.6-97 LNTE	0.0	80	277345	4840574	597
113	106.0	108.5	GE 1.6-97 LNTE	0.0	80	276871	4839792	590
114	106.0	107.0	GE 1.6-97 LNTE	-1.5	80	277407	4840040	590
115	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	277904	4840040	590
116	106.0	106.5	GE 1.6-97 LNTE	-2.0	80	277316	4839627	591

TURBINE	MODELED SOUND POWER LEVEL (dBA)		REPOWER TURBINE MODEL	NRO (dB)	HUB HEIGHT (m)	COORDINATES (UTM NAD83 Z15N)		GROUND ELEVATION + HUB HEIGHT (m)
	EXISTING	REPOWER				X (m)	Y (m)	
117	106.0	104.0	GE 1.6-91 LNTE	-3.0	80	277725	4839611	589
118	106.0	104.0	GE 1.6-91 LNTE	-3.0	80	278713	4840314	592
119	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	279104	4840512	591
120	106.0	103.0	GE 1.6-91 LNTE	-4.0	80	278355	4839855	593
121	106.0	103.0	GE 1.6-91 LNTE	-4.0	80	278787	4839848	592
122	106.0	104.0	GE 1.6-91 LNTE	-3.0	80	279292	4839996	592
123	106.0	108.5	GE 1.6-97 LNTE	0.0	80	280609	4840458	593
124	106.0	108.5	GE 1.6-97 LNTE	0.0	80	280945	4840742	593
125	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	280778	4840079	595
126	106.0	108.5	GE 1.6-97 LNTE	0.0	80	280298	4839571	595
127	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	280776	4839533	598
128	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	278428	4838749	588
129	106.0	104.0	GE 1.6-91 LNTE	-3.0	80	279290	4839231	590
130	106.0	106.0	GE 1.6-97 LNTE	-2.5	80	279058	4838821	590
131	106.0	106.5	GE 1.6-97 LNTE	-2.0	80	279523	4838814	593
132	106.0	108.5	GE 1.6-97 LNTE	0.0	80	280077	4839041	599
133	106.0	107.5	GE 1.6-97 LNTE	-1.0	80	280048	4838540	597
134	106.0	107.0	GE 1.6-97 LNTE	-1.5	80	280014	4838069	600
CWS	106.2	108.1	Vestas V110 STE		100	273179	4843082	621
CWS	106.2	108.1	Vestas V110 STE		100	274700	4843529	616
CWS	106.2	108.1	Vestas V110 STE		100	272816	4844973	630
CWS	106.2	108.1	Vestas V110 STE		100	275302	4844096	616
CWS	106.2	108.1	Vestas V110 STE		100	272897	4844037	620
CWS	106.2	108.1	Vestas V110 STE		100	275531	4843225	609
CWS	106.2	108.1	Vestas V110 STE		100	274396	4844486	622
CWS	106.2	108.1	Vestas V110 STE		100	274497	4845539	624
CWS	106.2	108.1	Vestas V110 STE		100	272203	4843082	631
CWS	106.2	108.1	Vestas V110 STE		100	273633	4842911	624
CWS	106.2	108.1	Vestas V110 STE		100	273947	4843845	626
CWS	106.2	108.1	Vestas V110 STE		100	275359	4845288	612
CWS	106.2	108.1	Vestas V110 STE		100	273235	4844959	627
CWS	106.2	108.1	Vestas V110 STE		100	274391	4843374	618
CWS	106.2	108.1	Vestas V110 STE		100	274097	4844941	623
Arnold Wind Farm	105.3				70	271012	4848338	607

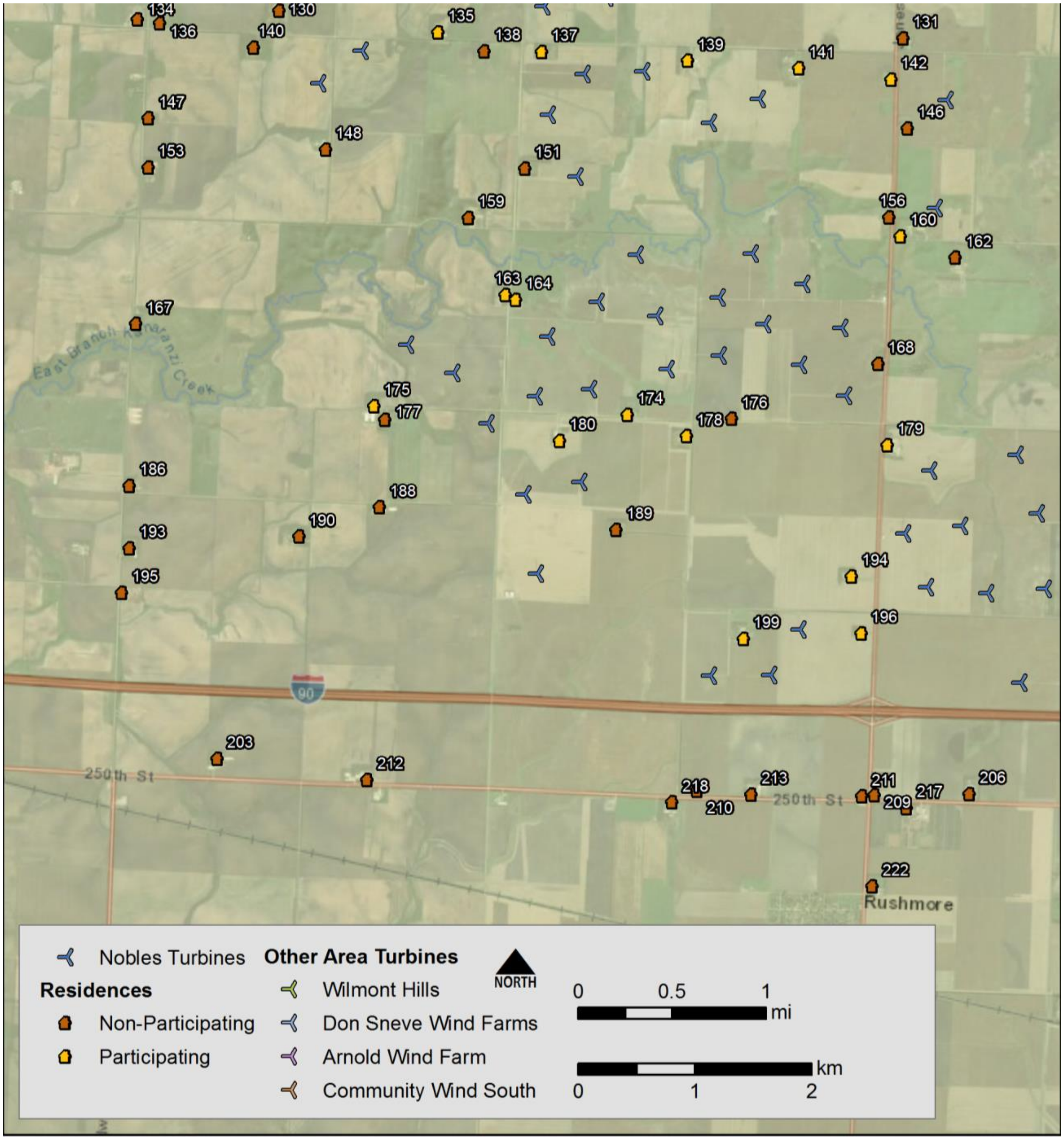
TURBINE	MODELED SOUND POWER LEVEL (dBA)		REPOWER TURBINE MODEL	NRO (dB)	HUB HEIGHT (m)	COORDINATES (UTM NAD83 Z15N)		GROUND ELEVATION + HUB HEIGHT (m)
	EXISTING	REPOWER				X (m)	Y (m)	
Don Sneve Wind Farm	103.6				70	271044	4847787	606
Wilmont Hills	103.6				70	270279	4848596	607

APPENDIX D. RECEIVER INFORMATION



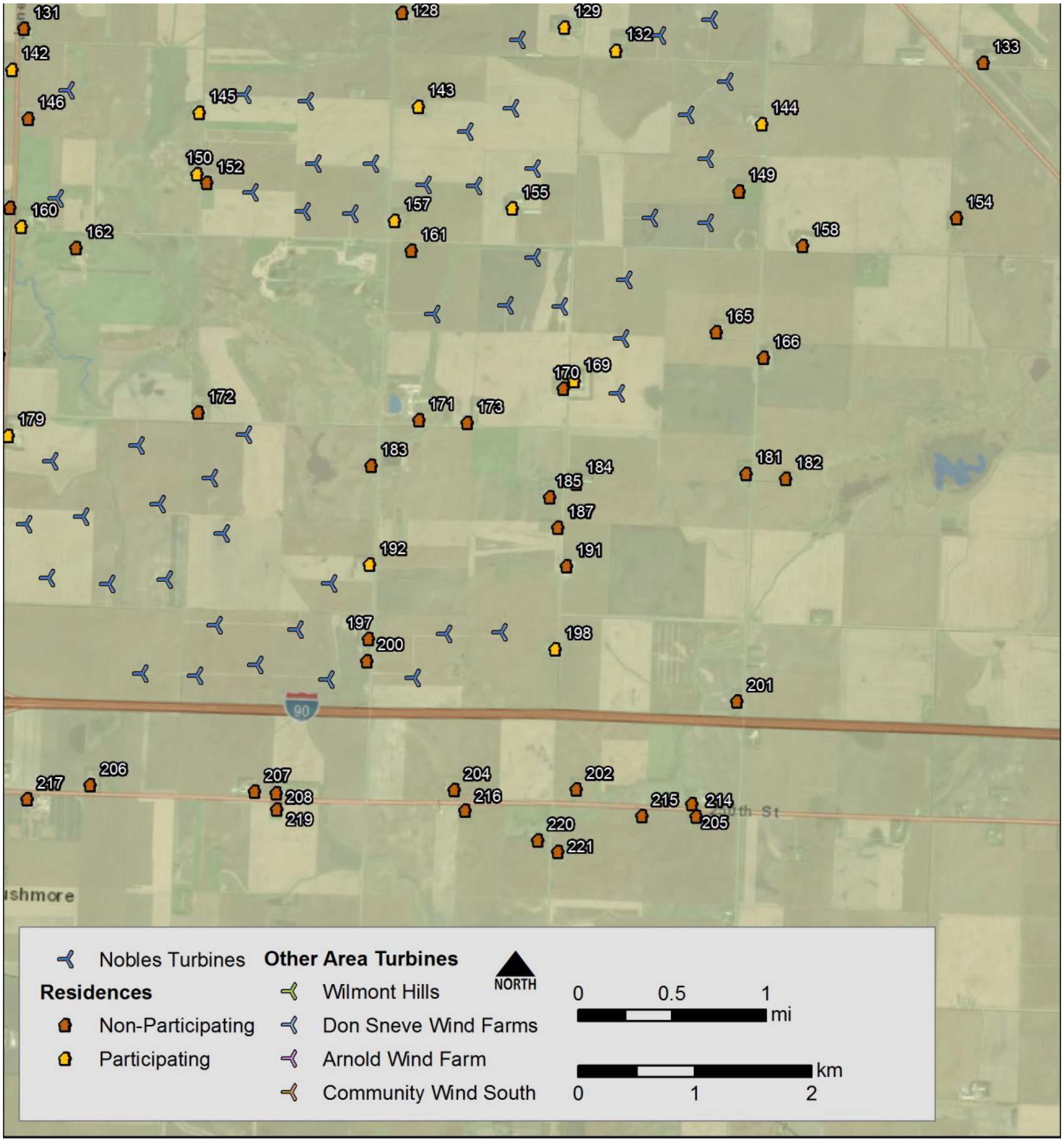
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

FIGURE 11: RECEIVER ID MAP, NORTHWESTERN AREA



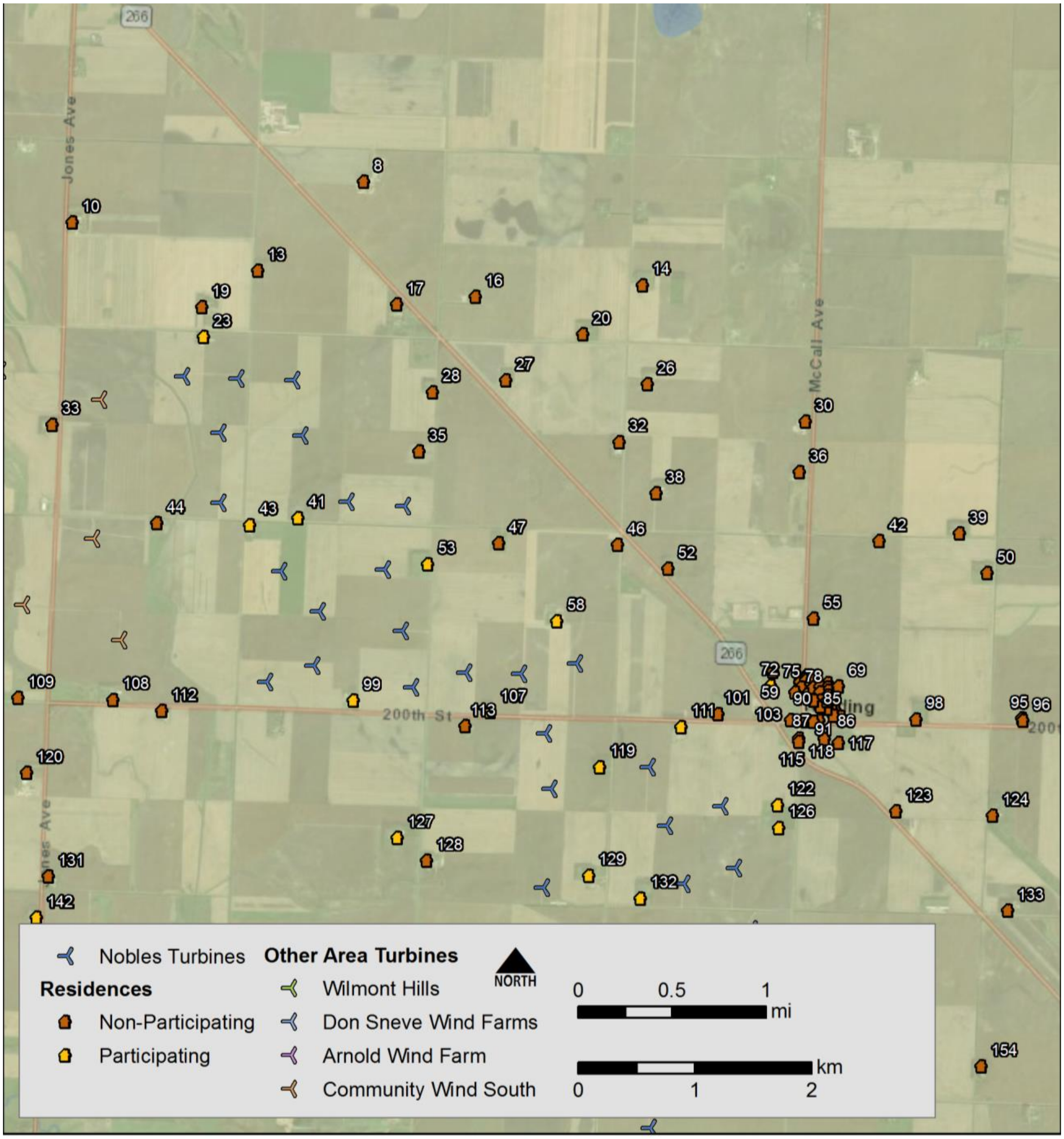
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

FIGURE 12: RECEIVER ID MAP, SOUTHWESTERN AREA



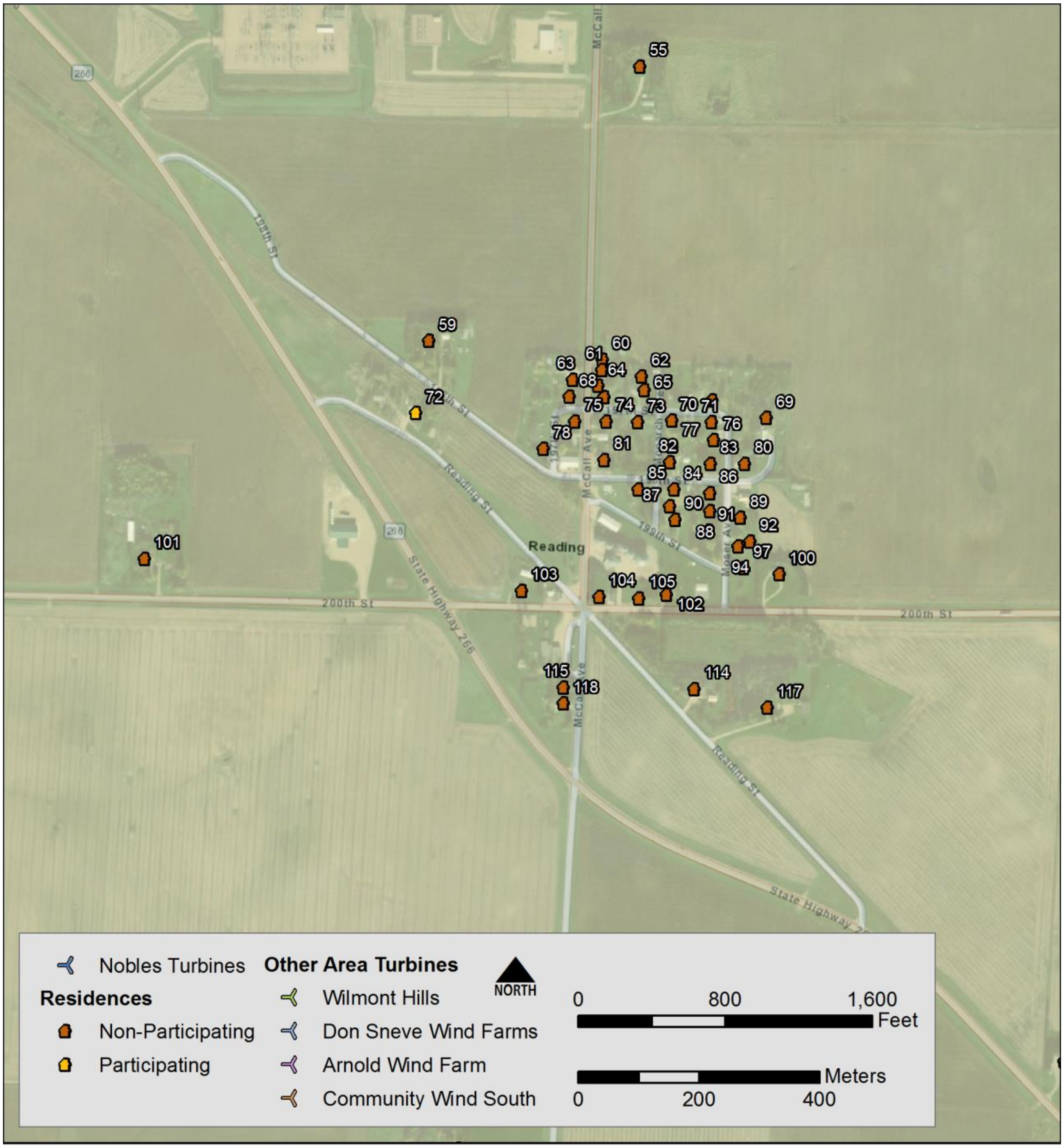
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

FIGURE 13: RECEIVER ID MAP, SOUTHEASTERN AREA



Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

FIGURE 14: RECEIVER ID MAP, NORTHEASTERN AREA



Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

FIGURE 15: RECEIVER ID MAP, READING AREA

TABLE 6: MODEL RESULTS AND COORDINATES FOR EACH MODELED RECEIVER

ID	STATUS[27]	MODELED TURBINE ONLY SOUND LEVEL (L_{50}, dBA)			DIFFERENCE BETWEEN SCENARIO 3 & 1[28]	TOTAL SOUND LEVEL, SCENARIO 3 COMBINED WITH BACKGROUND				COORDINATES (UTM NAD 83 Z15N)		
		SCENARIO 1	SCENARIO 2	SCENARIO 3		30 dBA BACKGROUND	35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	X(m)	Y(m)	Z (m)
1	NP	36	35	35	0	36	38	41	45	272292	4848350	533
2	NP	33	33	33	0	35	37	41	45	268810	4848330	530
3	NP	33	33	33	0	35	37	41	45	268726	4848315	530
4	NP	34	33	34	-1	35	37	41	45	273501	4848094	527
5	NP	45	45	45	0	45	45	46	48	271297	4847948	540
6	NP	37	37	37	0	38	39	42	46	269212	4847823	533
7	NP	37	37	37	0	38	39	42	46	268703	4847486	534
8	NP	35	35	35	-1	36	38	41	45	277630	4847161	522
9	NP	37	36	36	0	37	39	41	46	273149	4847213	531
10	NP	38	37	38	0	38	40	42	46	275126	4846811	519
11	P	42	43	43	1	43	44	45	47	271541	4846905	533
12	NP	40	40	40	0	40	41	43	46	272220	4846599	533
13	NP	40	40	41	0	41	42	43	46	276718	4846398	521
14	NP	33	32	32	-1	34	37	41	45	280021	4846273	527
15	NP	45	46	46	2	46	47	47	49	270239	4846487	527
16	NP	36	36	36	-1	37	38	41	45	278586	4846171	522
17	NP	39	38	38	0	39	40	42	46	277912	4846109	519
18	NP	40	40	40	0	41	41	43	46	268389	4846386	521

[27] NP: Non-Participating, P: Participating

[28] The sound levels and the difference between Scenario 3 and Scenario 1 are rounded to the nearest whole decibel. In some cases, the sound levels the reported sound level for Scenario 1 and Scenario 3 are the same, but a difference of 1 or -1 is reported. This is due to rounding. For example the modeled sound level under Scenario 1 may be 34.3 dBA, and the modeled sound level under Scenario 3 may be 33.6 dBA. Both sound levels would be reported as 34 dBA, but a difference of -1 dB would be reported because the difference of 0.7 dB is rounded to the nearest whole number.

ID	STATUS[27]	MODELED TURBINE ONLY SOUND LEVEL (L_{50}, dBA)			DIFFERENCE BETWEEN SCENARIO 3 & 1[28]	TOTAL SOUND LEVEL, SCENARIO 3 COMBINED WITH BACKGROUND				COORDINATES (UTM NAD 83 Z15N)		
		SCENARIO 1	SCENARIO 2	SCENARIO 3		30 dBA BACKGROUND	35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	X(m)	Y(m)	Z (m)
19	NP	43	43	44	0	44	44	45	47	276240	4846083	522
20	NP	35	34	34	-1	35	37	41	45	279508	4845850	526
21	NP	41	41	41	0	41	42	44	46	273039	4846035	530
22	P	46	47	47	1	47	47	48	49	268953	4846144	515
23	P	46	47	47	1	47	47	48	49	276253	4845827	523
24	NP	44	44	45	1	45	46	46	48	274265	4845878	525
25	P	45	45	45	0	45	45	46	48	271658	4845930	536
26	NP	34	33	33	-1	35	37	41	45	280063	4845422	524
27	NP	38	37	37	-1	38	39	42	46	278848	4845457	520
28	NP	41	40	40	0	41	41	43	46	278219	4845355	520
29	P	47	46	46	0	46	47	47	49	271917	4845561	537
30	NP	32	30	30	-2	33	36	40	45	281418	4845100	532
31	NP	32	32	32	0	34	37	41	45	267203	4845542	506
32	NP	36	35	35	-1	36	38	41	45	279820	4844927	521
33	NP	46	46	46	1	46	47	47	49	274955	4845076	521
34	P	48	47	47	-1	47	47	48	49	271950	4845118	536
35	NP	44	44	44	0	44	45	45	48	278102	4844847	519
36	NP	33	31	31	-1	34	37	41	45	281370	4844669	531
37	P	43	43	43	0	43	43	45	47	270182	4844883	512
38	NP	37	36	36	-1	37	38	41	45	280140	4844486	524
39	NP	30	29	29	-1	33	36	40	45	282742	4844143	523
40	NP	44	43	43	0	44	44	45	47	271183	4844527	524
41	P	47	47	47	0	47	47	48	49	277066	4844273	523
42	NP	33	32	32	-1	34	37	41	45	282051	4844078	531
43	P	48	47	47	-1	47	47	48	49	276650	4844213	523
44	NP	45	45	45	0	45	46	46	48	275854	4844232	513
45	P	45	45	45	0	45	45	46	48	270906	4844368	523

ID	STATUS[27]	MODELED TURBINE ONLY SOUND LEVEL (L_{50}, dBA)			DIFFERENCE BETWEEN SCENARIO 3 & 1[28]	TOTAL SOUND LEVEL, SCENARIO 3 COMBINED WITH BACKGROUND				COORDINATES (UTM NAD 83 Z15N)		
		SCENARIO 1	SCENARIO 2	SCENARIO 3		30 dBA BACKGROUND	35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	X(m)	Y(m)	Z (m)
46	NP	39	38	38	-1	39	40	42	46	279808	4844044	519
47	NP	42	42	42	-1	42	42	44	47	278790	4844060	518
48	P	47	47	47	0	47	47	48	49	271897	4844265	538
49	NP	41	42	42	1	42	43	44	47	268540	4844334	502
50	NP	29	27	27	-1	32	36	40	45	282977	4843802	523
51	NP	34	34	34	0	35	37	41	45	267380	4844319	495
52	NP	39	38	38	-1	38	40	42	46	280241	4843839	520
53	P	47	47	47	0	47	47	48	49	278178	4843878	518
54	P	47	47	47	0	47	47	48	49	271682	4843879	535
55	NP	36	35	35	-1	36	38	41	45	281491	4843411	530
56	P	47	47	47	0	47	47	48	49	270131	4843721	528
57	NP	46	46	47	1	47	47	48	49	273326	4843611	520
58	P	46	45	45	-1	45	46	46	48	279288	4843390	521
59	NP	39	38	38	-1	39	40	42	46	281141	4842956	526
60	NP	38	37	37	-1	38	39	42	46	281429	4842924	526
61	NP	38	37	37	-1	38	39	42	46	281428	4842908	527
62	NP	37	37	37	-1	38	39	42	46	281493	4842897	527
63	NP	38	38	38	-1	38	39	42	46	281379	4842891	526
64	NP	38	37	37	-1	38	39	42	46	281422	4842881	527
65	NP	37	37	37	-1	38	39	42	46	281498	4842874	528
66	NP	37	37	37	-1	38	39	42	46	281610	4842857	529
67	NP	38	37	37	-1	38	39	42	46	281432	4842862	528
68	NP	38	38	38	-1	38	40	42	46	281374	4842863	526
69	NP	37	36	36	-1	37	38	41	46	281701	4842828	529
70	NP	38	37	37	-1	38	39	42	46	281544	4842823	529
71	NP	37	37	37	-1	38	39	42	46	281610	4842820	529
72	P	39	39	39	0	39	40	42	46	281119	4842836	523

ID	STATUS[27]	MODELED TURBINE ONLY SOUND LEVEL (L_{50}, dBA)			DIFFERENCE BETWEEN SCENARIO 3 & 1[28]	TOTAL SOUND LEVEL, SCENARIO 3 COMBINED WITH BACKGROUND				COORDINATES (UTM NAD 83 Z15N)		
		SCENARIO 1	SCENARIO 2	SCENARIO 3		30 dBA BACKGROUND	35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	X(m)	Y(m)	Z (m)
73	NP	38	37	37	-1	38	39	42	46	281488	4842820	528
74	NP	38	38	38	0	38	40	42	46	281435	4842822	527
75	NP	38	38	38	0	38	40	42	46	281383	4842822	526
76	NP	38	37	37	-1	38	39	42	46	281614	4842791	529
77	NP	38	37	37	-1	38	39	42	46	281544	4842780	528
78	NP	39	38	38	0	39	40	42	46	281331	4842776	524
79	P	46	46	46	0	46	47	47	49	271792	4843089	533
80	NP	37	37	37	-1	38	39	42	46	281665	4842751	530
81	NP	38	38	38	0	39	40	42	46	281432	4842758	526
82	NP	38	37	37	0	38	39	42	46	281541	4842754	528
83	NP	38	37	37	-1	38	39	42	46	281608	4842752	528
84	NP	38	38	38	0	38	40	42	46	281548	4842709	527
85	NP	38	38	38	0	38	40	42	46	281488	4842709	526
86	NP	38	37	37	-1	38	39	42	46	281607	4842703	528
87	NP	38	38	38	0	38	40	42	46	281540	4842682	527
88	NP	38	37	37	-1	38	39	42	46	281607	4842673	527
89	NP	38	37	37	-1	38	39	42	46	281658	4842662	528
90	NP	38	38	38	0	38	40	42	46	281550	4842659	527
91	NP	38	38	38	0	38	40	42	46	281605	4842641	527
92	NP	38	37	37	0	38	39	42	46	281674	4842623	528
93	NP	39	40	40	0	40	41	43	46	268785	4843053	512
94	NP	38	37	38	0	38	39	42	46	281654	4842615	527
95	NP	31	30	30	-1	33	36	40	45	283278	4842553	524
96	NP	31	30	30	-1	33	36	40	45	283285	4842535	524
97	NP	38	38	38	0	38	39	42	46	281663	4842579	527
98	NP	35	34	34	-1	36	38	41	45	282368	4842548	535
99	P	47	47	47	0	47	47	48	49	277539	4842707	519

ID	STATUS[27]	MODELED TURBINE ONLY SOUND LEVEL (L_{50}, dBA)			DIFFERENCE BETWEEN SCENARIO 3 & 1[28]	TOTAL SOUND LEVEL, SCENARIO 3 COMBINED WITH BACKGROUND				COORDINATES (UTM NAD 83 Z15N)		
		SCENARIO 1	SCENARIO 2	SCENARIO 3		30 dBA BACKGROUND	35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	X(m)	Y(m)	Z (m)
100	NP	38	37	37	0	38	39	42	46	281722	4842568	530
101	NP	42	42	42	0	42	43	44	47	280669	4842594	522
102	NP	39	38	38	0	39	40	42	46	281535	4842534	526
103	NP	40	40	40	0	40	41	43	46	281294	4842541	523
104	NP	39	39	39	0	40	40	43	46	281424	4842531	525
105	NP	39	39	39	0	39	40	42	46	281490	4842528	525
106	NP	45	45	46	1	46	46	47	48	274150	4842763	525
107	P	48	47	47	-1	47	47	48	49	278716	4842610	518
108	NP	44	44	44	0	44	45	46	48	275478	4842715	514
109	NP	44	43	44	0	44	45	45	48	274662	4842730	519
110	NP	43	43	43	0	43	44	45	47	269789	4842864	515
111	P	45	44	44	-1	45	45	46	48	280353	4842480	520
112	NP	43	43	43	0	43	44	45	47	275896	4842621	512
113	NP	47	46	46	-1	46	46	47	48	278501	4842488	520
114	NP	39	39	39	0	39	40	42	46	281581	4842378	525
115	NP	40	40	40	0	40	41	43	46	281364	4842381	524
116	NP	44	44	44	1	45	45	46	48	269885	4842764	515
117	NP	39	38	38	0	39	40	42	46	281703	4842347	528
118	NP	40	40	40	0	41	41	43	46	281364	4842354	524
119	P	47	47	47	0	47	47	48	49	279656	4842137	519
120	NP	41	41	41	0	41	42	44	46	274738	4842088	523
121	NP	46	45	45	-1	45	46	46	48	273363	4842099	524
122	P	44	45	45	1	45	46	46	48	281183	4841811	525
123	NP	37	37	37	0	38	39	42	46	282195	4841760	522
124	NP	34	33	33	-1	35	37	41	45	283026	4841722	530
125	P	49	47	47	-2	47	47	48	49	271749	4842086	529
126	P	45	46	46	1	46	46	47	48	281190	4841615	526

ID	STATUS[27]	MODELED TURBINE ONLY SOUND LEVEL (L_{50}, dBA)			DIFFERENCE BETWEEN SCENARIO 3 & 1[28]	TOTAL SOUND LEVEL, SCENARIO 3 COMBINED WITH BACKGROUND				COORDINATES (UTM NAD 83 Z15N)		
		SCENARIO 1	SCENARIO 2	SCENARIO 3		30 dBA BACKGROUND	35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	X(m)	Y(m)	Z (m)
127	P	43	42	42	-1	42	43	44	47	277917	4841529	519
128	NP	43	42	42	-1	43	43	44	47	278170	4841335	516
129	P	46	47	47	0	47	47	47	49	279559	4841207	525
130	NP	42	43	43	1	43	43	45	47	269566	4841436	513
131	NP	42	43	43	1	43	43	45	47	274922	4841199	525
132	P	47	47	47	0	47	47	48	49	280003	4841009	522
133	NP	34	33	33	-1	35	37	41	45	283157	4840905	523
134	NP	36	35	35	0	37	38	41	45	268352	4841363	509
135	P	46	46	46	0	46	46	47	48	270933	4841249	512
136	NP	37	36	36	0	37	39	42	46	268542	4841327	510
137	P	48	47	47	-1	47	47	48	49	271822	4841082	522
138	NP	46	45	45	-1	45	45	46	48	271329	4841086	516
139	P	47	47	47	0	47	47	48	49	273075	4841006	515
140	NP	41	42	42	1	42	43	44	47	269348	4841119	508
141	P	45	45	45	1	45	46	46	48	274028	4840940	522
142	P	43	44	44	1	44	45	46	48	274822	4840844	522
143	P	47	45	45	-1	46	46	47	48	278307	4840528	517
144	P	46	46	46	1	46	47	47	49	281254	4840378	521
145	P	45	46	46	1	46	47	47	49	276429	4840478	510
146	NP	45	46	46	1	46	46	47	49	274962	4840426	522
147	NP	35	35	35	0	36	38	41	45	268446	4840511	503
148	NP	42	43	43	1	43	43	45	47	269967	4840243	503
149	NP	47	47	47	0	47	47	48	49	281059	4839802	524
150	P	45	45	45	1	46	46	47	48	276410	4839952	512
151	NP	46	46	46	0	46	47	47	49	271676	4840080	509
152	NP	46	47	47	1	47	47	48	49	276492	4839875	515
153	NP	35	34	34	-1	36	38	41	45	268444	4840091	493

ID	STATUS[27]	MODELED TURBINE ONLY SOUND LEVEL (L_{50}, dBA)			DIFFERENCE BETWEEN SCENARIO 3 & 1[28]	TOTAL SOUND LEVEL, SCENARIO 3 COMBINED WITH BACKGROUND				COORDINATES (UTM NAD 83 Z15N)		
		SCENARIO 1	SCENARIO 2	SCENARIO 3		30 dBA BACKGROUND	35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	X(m)	Y(m)	Z (m)
154	NP	34	33	33	-1	35	37	41	45	282927	4839571	518
155	P	49	47	47	-2	47	47	48	49	279114	4839655	521
156	NP	45	46	46	1	46	47	47	49	274800	4839663	517
157	P	49	47	47	-2	47	47	48	49	278102	4839549	522
158	NP	41	40	40	-1	40	41	43	46	281603	4839336	523
159	NP	42	42	42	0	42	43	44	47	271192	4839657	492
160	P	45	47	47	1	47	47	47	49	274898	4839499	517
161	NP	47	45	45	-1	46	46	47	48	278247	4839294	518
162	NP	44	45	45	1	45	45	46	48	275370	4839314	518
163	P	45	46	46	0	46	46	47	48	271508	4838995	497
164	P	46	47	47	1	47	47	48	49	271599	4838955	499
165	NP	42	42	42	0	43	43	44	47	280864	4838594	525
166	NP	39	39	39	-1	39	40	42	46	281271	4838376	518
167	NP	32	31	31	-1	34	36	41	45	268338	4838747	485
168	NP	47	47	47	0	47	47	48	49	274707	4838404	516
169	P	47	47	47	0	47	47	47	49	279645	4838174	523
170	NP	45	45	45	0	45	46	46	48	279554	4838109	522
171	NP	42	41	41	-1	41	42	44	46	278312	4837841	513
172	NP	46	47	47	1	47	47	48	49	276417	4837903	506
173	NP	42	41	41	-1	41	42	44	46	278729	4837816	516
174	P	47	47	47	-1	47	47	48	49	272556	4837967	517
175	P	43	43	43	1	44	44	45	47	270381	4838040	502
176	NP	46	46	46	1	46	47	47	49	273450	4837932	522
177	NP	43	43	43	1	43	44	45	47	270478	4837923	503
178	P	45	45	45	0	45	46	46	48	273066	4837782	518
179	P	47	47	47	0	47	47	48	49	274788	4837704	517
180	P	48	47	47	-1	47	47	48	49	271973	4837744	513

ID	STATUS[27]	MODELED TURBINE ONLY SOUND LEVEL (L50, dBA)			DIFFERENCE BETWEEN SCENARIO 3 & 1[28]	TOTAL SOUND LEVEL, SCENARIO 3 COMBINED WITH BACKGROUND				COORDINATES (UTM NAD 83 Z15N)		
		SCENARIO 1	SCENARIO 2	SCENARIO 3		30 dBA BACKGROUND	35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	X(m)	Y(m)	Z (m)
181	NP	37	36	36	-1	37	39	41	46	281120	4837381	520
182	NP	36	35	35	-1	36	38	41	45	281460	4837337	515
183	NP	42	41	41	0	42	42	44	47	277902	4837448	514
184	NP	41	40	40	-1	41	41	43	46	279662	4837297	521
185	NP	40	40	40	-1	40	41	43	46	279434	4837177	522
186	NP	32	31	31	-1	33	36	40	45	268283	4837356	491
187	NP	40	40	40	0	40	41	43	46	279506	4836919	520
188	NP	39	39	39	-1	39	40	42	46	270429	4837173	505
189	NP	44	43	43	-1	43	44	45	47	272460	4836980	516
190	NP	36	35	35	-1	36	38	41	45	269739	4836921	501
191	NP	40	40	40	0	41	41	43	46	279579	4836587	518
192	P	46	46	46	1	46	46	47	49	277891	4836601	511
193	NP	32	31	31	-1	33	36	40	45	268284	4836822	489
194	P	45	46	46	1	46	46	47	49	274482	4836578	517
195	NP	28	27	27	-1	32	36	40	45	268219	4836440	488
196	P	45	45	45	1	45	46	46	48	274565	4836090	519
197	NP	47	47	47	0	47	47	47	49	277878	4835962	514
198	P	42	43	43	1	43	44	45	47	279482	4835874	519
199	P	47	47	47	0	47	47	48	49	273555	4836044	518
200	NP	47	47	47	0	47	47	48	49	277867	4835775	510
201	NP	33	32	32	-1	34	37	41	45	281044	4835427	522
202	NP	35	35	35	-1	36	38	41	45	279662	4834675	513
203	NP	31	29	30	-1	33	36	40	45	269036	4835015	494
204	NP	39	38	38	-1	39	40	42	46	278614	4834667	520
205	NP	33	32	32	-1	34	37	41	45	280657	4834550	518
206	NP	40	40	40	0	40	41	43	46	275493	4834711	515
207	NP	40	41	41	0	41	42	43	46	276901	4834656	519

ID	STATUS[27]	MODELED TURBINE ONLY SOUND LEVEL (L50, dBA)			DIFFERENCE BETWEEN SCENARIO 3 & 1[28]	TOTAL SOUND LEVEL, SCENARIO 3 COMBINED WITH BACKGROUND				COORDINATES (UTM NAD 83 Z15N)		
		SCENARIO 1	SCENARIO 2	SCENARIO 3		30 dBA BACKGROUND	35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	X(m)	Y(m)	Z (m)
208	NP	40	40	40	0	41	41	43	46	277086	4834640	519
209	NP	38	38	38	0	39	40	42	46	274677	4834702	518
210	NP	38	37	37	-1	38	39	42	46	273152	4834741	512
211	NP	38	38	38	0	39	40	42	46	274568	4834690	517
212	NP	33	32	32	-1	34	37	41	45	270322	4834834	504
213	NP	38	37	37	-1	38	39	42	46	273620	4834706	513
214	NP	32	31	31	-1	33	36	40	45	280691	4834439	521
215	NP	33	33	33	-1	34	37	41	45	280226	4834447	517
216	NP	37	36	36	-1	37	39	42	46	278707	4834492	516
217	NP	38	38	38	0	39	40	42	46	274952	4834591	518
218	NP	37	36	36	-1	37	39	42	46	272941	4834640	512
219	NP	39	39	39	0	40	41	43	46	277093	4834499	519
220	NP	35	34	34	-1	35	37	41	45	279332	4834237	508
221	NP	34	33	33	-1	35	37	41	45	279506	4834137	511
222	NP	36	35	35	-1	36	38	41	45	274657	4833918	516

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