Appendix B

Noise Analysis for the Proposed Plum Creek Wind Farm

Plum Creek Wind Farm, LLC
Docket No. IP6997 / WS-18-700
August 2020

the science of insight

GERONIMO ENERGY

PLUM CREEK WIND FARM

Noise Compliance Assessment | August 7, 2020

PREPARED FOR:
GERONIMO ENERGY, A National Grid Company

SUBMITTED BY:
RSG

IN COOPERATION WITH:
MERJENT

55 Railroad Row
White River Junction, VT 05001
802.295.4999
www.rsginc.com

CONTENTS

1.0 INTRODUCTION 1

2.0 PROJECT DESCRIPTION 2

3.0 SOUND LEVEL STANDARDS & GUIDELINES 5

3.1 LOCAL STANDARDS 5

3.2 STATE STANDARDS 5

4.0 WIND TURBINE ACOUSTICS – SPECIAL CONSIDERATIONS 7

4.1 SOURCES OF SOUND GENERATION BY WIND TURBINES 7

4.2 AMPLITUDE MODULATION 8

4.3 METEOROLOGY 9

4.4 MASKING 10

4.5 INFRASOUND AND LOW FREQUENCY SOUND 11

4.6 USE OF SOUND LEVEL WEIGHTING NETWORKS FOR WIND TURBINE SOUND 12

5.0 SOUND LEVEL MONITORING 14

5.1 MONITORING PROCEDURE 14

EQUIPMENT 15

DATA PROCESSING 15

5.2 LOCATION DESCRIPTIONS 16

MONITOR 1 16

MONITOR 2 18

MONITOR 3 20

MONITOR 4 22

MONITOR 5 24

NORTHWEST OFFSITE MONITOR 26
SOUTHEAST OFFSITE MONITOR 28
5.3 SOUND LEVEL MONITORING RESULTS 30
RESULTS SUMMARY 31
MONITOR 1 34
MONITOR 2 36
MONITOR 3 38
MONITOR 4 40
MONITOR 5 42
NORTHWEST OFFSITE MONITOR 44
SOUTHEAST OFFSITE MONITOR 46
6.0 SOUND PROPAGATION MODELING 48
6.1 MODELING PROCEDURE 48
6.2 MODELING RESULTS 49
OVERALL A-WEIGHTED MODEL RESULTS 49
MODEL RESULTS ADDED TO BACKGROUND 53
7.0 CONCLUSIONS 54
APPENDIX A. ACOUSTICS PRIMER 55
APPENDIX B. MODEL INPUT DATA 61
APPENDIX C. RECEIVER INFORMATION 68

LIST OF FIGURES

FIGURE 1: PLUM CREEK WIND FARM SITE MAP WITH VESTAS LAYOUT 3
FIGURE 2: PLUM CREEK WIND FARM SITE MAP WITH SIEMENS GAMESA LAYOUT 4
FIGURE 3: AIRFLOW AROUND A ROTOR BLADE 8
FIGURE 4: SCHEMATIC OF THE REFRACTION OF SOUND DUE TO VERTICAL WIND GRADIENT (WIND SHEAR) 10
FIGURE 5: COMPARISON OF NORMALIZED FREQUENCY SPECTRA FROM WIND AND THE GE VESTAS V162 AND SIEMENS GAMESA SG170 11
FIGURE 6: INFRASOUND FROM A WIND TURBINE AT 350 METERS (1,148 FEET) COMPARED WITH PERCEPTION THESHOLDS 12
FIGURE 7: MAP OF BACKGROUND SOUND MONITOR LOCATIONS 14
FIGURE 8: PHOTOGRAPH OF MONITOR 1, FACING EAST (9/3/2019) 16
FIGURE 9: AERIAL VIEW MONITOR 1 17
FIGURE 10: PHOTOGRAPH OF MONITOR 2, FACING NORTH (9/3/2019) 18
FIGURE 11: AERIAL VIEW OF MONITOR 2 19
FIGURE 12: PHOTOGRAPH OF MONITOR 3, FACING NORTHEAST (9/3/2019) 20
FIGURE 13: AERIAL VIEW OF MONITOR 3 21
FIGURE 14: PHOTOGRAPH OF MONITOR 4, FACING NORTHEAST (2019-09-03) 22
FIGURE 15: AERIAL PHOTO OF MONITOR 4 23
FIGURE 16: PHOTOGRAPH OF MONITOR 5, FACING EAST (9/3/2019) 24
FIGURE 17: AERIAL PHOTO OF MONITOR 5 25
FIGURE 18: PHOTOGRAPH OF THE NORTHWEST OFFSITE MONITOR LOCATION (9/3/2019) 26
FIGURE 19: AERIAL PHOTO OF NORTHWEST OFFSITE MONITOR 27
FIGURE 20: PHOTOGRAPH OF THE SOUTHEAST OFFSITE MONITORING LOCATION, FACING SOUTHEAST (9/3/2019) 28
FIGURE 21: AERIAL VIEW OF SOUTHEAST OFFSITE MONITOR 29
FIGURE 22: PRE-CONSTRUCTION MONITORING RESULTS AT MONITOR 1 35
FIGURE 23: PRE-CONSTRUCTION MONITORING RESULTS AT MONITOR 2 37
FIGURE 24: PRE-CONSTRUCTION MONITORING RESULTS AT MONITOR 3 39

FIGURE 25: 1/3 OCTAVE BAND AND OVERALL STATISTICAL SOUND LEVELS AT MONITOR 4 (FOR PERIODS WITH 10 M/S WIND SPEED AT 105-METER (345-FOOT) HEIGHT) ... 40
FIGURE 26: PRE-CONSTRUCTION MONITORING RESULTS AT MONITOR 4 ... 41
FIGURE 27: 1/3 OCTAVE BAND AND OVERALL STATISTICAL SOUND LEVELS AT MONITOR 5 (FOR PERIODS WITH 10 M/S WIND SPEED AT 105-METER (345-FOOT) HEIGHT) ... 42
FIGURE 28: PRE-CONSTRUCTION MONITORING RESULTS AT MONITOR 5 ... 43
FIGURE 29: 1/3 OCTAVE BAND AND OVERALL STATISTICAL SOUND LEVELS AT THE NORTHWEST OFFSITE MONITOR (FOR PERIODS WITH 10 M/S WIND SPEED AT 105-METER (345-FOOT) HEIGHT) ... 44
FIGURE 30: PRE-CONSTRUCTION MONITORING RESULTS AT THE NORTHWEST OFFSITE MONITOR ... 45
FIGURE 31: 1/3 OCTAVE BAND AND OVERALL STATISTICAL SOUND LEVELS AT THE SOUTHEAST OFFSITE MONITOR (FOR PERIODS WITH 10 M/S WIND SPEED AT 105-METER (345-FOOT) HEIGHT) ... 46
FIGURE 32: PRE-CONSTRUCTION MONITORING RESULTS AT THE OFFSITE SOUTHEAST MONITOR ... 47
FIGURE 33: SOUND PROPAGATION MODEL RESULTS (TURBINE-ONLY SOUND LEVEL) – VESTAS V162 ... 51
FIGURE 34: SOUND PROPAGATION MODEL RESULTS (TURBINE-ONLY SOUND LEVEL) – SIEMENS GAMESA SG170 ... 52
FIGURE 35: A SCALE OF SOUND PRESSURE LEVELS FOR TYPICAL SOUND SOURCES ... 56
FIGURE 36: EXAMPLE OF DESCRIPTIVE TERMS OF SOUND MEASUREMENT OVER TIME ... 59
FIGURE 37: MAP OF MODELED TURBINE LOCATIONS BY TURBINE ID FOR THE SG170 LAYOUT ... 66
FIGURE 38: MAP OF MODELED TURBINE LOCATIONS BY TURBINE ID FOR THE V162 LAYOUT ... 67
FIGURE 39: MAP OF MODELED RECEIVERS - NORTHEAST AREA ... 68
FIGURE 40: MAP OF MODELED RECEIVERS - NORTH-CENTRAL AREA ... 69
FIGURE 41: MAP OF MODELED RECEIVERS - SOUTH-CENTRAL AREA ... 70
FIGURE 42: MAP OF MODELED RECEIVERS - NORTHWEST AREA ... 71
FIGURE 43: MAP OF MODELED RECEIVERS - WESTERN AREA ... 72
FIGURE 44: MAP OF MODELED RECEIVERS - SOUTHWEST-CENTRAL AREA ... 73
FIGURE 45: MAP OF MODELED RECEIVERS - SOUTHWEST AREA ... 74
FIGURE 46: MAP OF MODELED RECEIVERS – DOVRAY ... 75

LIST OF TABLES

TABLE 1: TURBINE MODELS AND NUMBER OF TURBINES UNDER CONSIDERATION ... 2
TABLE 2: SOUND LEVEL LIMITS (dBA) FROM MN RULES 7030.0040 ... 6
TABLE 3: SOUND MONITOR SPECIFICATIONS BY SITE ... 15
TABLE 4: SUMMARY OF MEASURED 1.5 METER (5-FOOT) WIND SPEEDS ... 31
TABLE 5: SUMMARY OF EXCLUSION PERIODS AT EACH MONITOR ... 32
TABLE 6: PRECONSTRUCTION MONITORING SUMMARY (A-WEIGHTED RESULTS) ... 33
TABLE 7: PRECONSTRUCTION MONITORING SUMMARY (C-WEIGHTED RESULTS) ... 33
TABLE 8: PRECONSTRUCTION MONITORING SUMMARY (ANS-WEIGHTED RESULTS) ... 34
TABLE 9: MODEL RESULTS SUMMARY (dBA) ... 50
TABLE 10: MODEL RESULTS (dBA) SUMMED WITH MONITORED BACKGROUND SOUND LEVELS (L_{50}, dBA) ... 53
TABLE 11: SOUND PROPAGATION MODELING PARAMETERS ... 61
TABLE 12: TURBINE HUB HEIGHT AND 1/1 OCTAVE BAND MODELED SOURCE SPECTRA (dBZ UNLESS OTHERWISE INDICATED) ... 61
TABLE 13: MODELED TURBINE SOUND POWER LEVELS & LOCATIONS ... 61
TABLE 14: MODELED RECEIVER COORDINATES ... 76
TABLE 15: MODEL RESULTS FOR EACH RECEIVER, WITH AND WITHOUT BACKGROUND SOUND LEVELS (L_{50}, dBA) ... 83

1.0 INTRODUCTION

Geronimo Energy, a National Grid Company, has submitted Site Permit Application (SPA) to the Minnesota Public Utilities Commission (PUC) to build a wind power generation facility in Cottonwood, Murray, and Redwood Counties. Plum Creek Wind Farm (Project) will involve the construction of up to 110 turbines for a project rating of up to 414 MW. The Project area is located south of Walnut Grove and U.S. Route 14 (US-14), and generally north Westbrook and MN Route 30 (MN-30), although a portion of the Project is located southwest of Dovray.

For the SPA, RSG has conducted a preliminary noise compliance assessment of the Project based on the preliminary turbine layout. This noise compliance report is an updated version of the preliminary noise assessment with the most recent project information including an updated layout and turbine model options. Included in this report are:

- A description of the Project;
- A discussion of applicable sound level standards;
- A discussion of sound issues that are particular to wind farms;
- Background sound level monitoring procedure and results;
- 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.

2.0 PROJECT DESCRIPTION

Plum Creek Wind Farm is proposed to be located primarily in Cottonwood and Murray Counties, although a portion of the project will also be located in Redwood County. The northern extent of the Project area is US-14. The southern extent is near 121st Street in Murray County. The eastern extent of the Project area is 440th Avenue (County Highway 4) in Cottonwood County. The western extent is 225th Avenue in Murray County.

The area around the Project is composed primarily of agricultural land uses (primarily corn and soybean) with farm residences. Terrain in the area is mostly flat, but gradually increases by approximately 110 meters (360 feet) from the northwest corner of the Project area to the southwest corner of the Project area. There are rural, county roads through much of the project area, and major routes to the north (US-14) and south (MN-30). The closest cities to the project are Dovray to the southwest and Walnut Grove to the north.

The Project is currently considering two turbine models and two layout configurations as summarized in Table 1. A map of the proposed Project showing the turbine layout for the Vestas V162 is provided in Figure 1, and a map showing the turbine layout for the Siemens Gamesa SG170 is provided in Figure 2. Also shown in the Figures are the two project substations which will have one transformer each. Both substations are centrally located within the Project area with one located on the northwest corner of 340th Avenue and 220th Street in Cottonwood County the other located on the northwest corner of 300th Avenue and 240th Street on the Cottonwood/Murray County line.

TABLE 1: TURBINE MODELS AND NUMBER OF TURBINES UNDER CONSIDERATION

TURBINE MAKE/MODEL	TURBINE OUTPUT (MW)	HUB HEIGHT (m)	NUMBER OF TURBINES IN LAYOUT
Vestas V162 STE[1]	5.6	125	74
Siemens Gamesa SG170	6.2	115	67

[1] STE: Serrated Trailing Edges

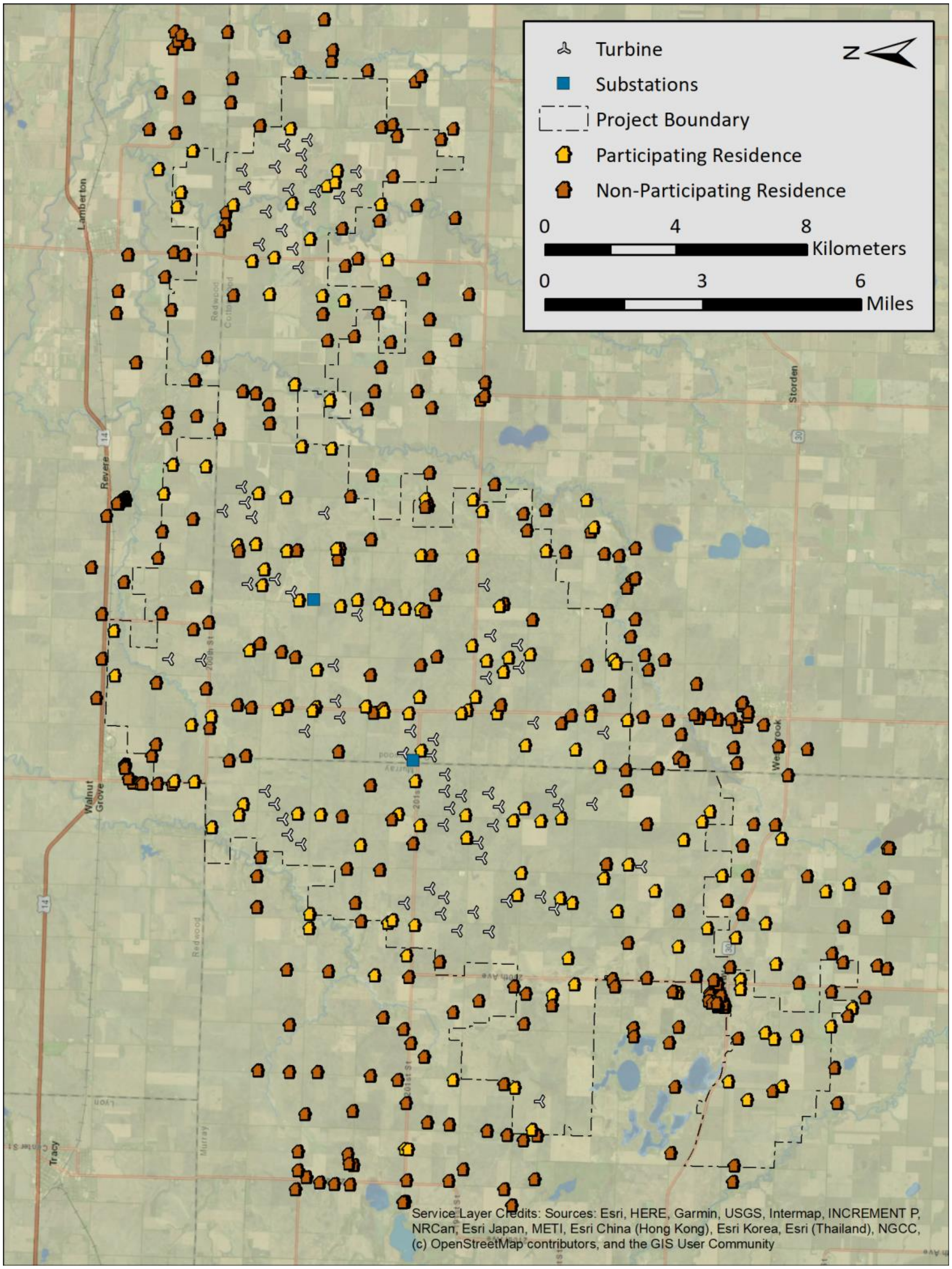

FIGURE 1: PLUM CREEK WIND FARM SITE MAP WITH VESTAS LAYOUT

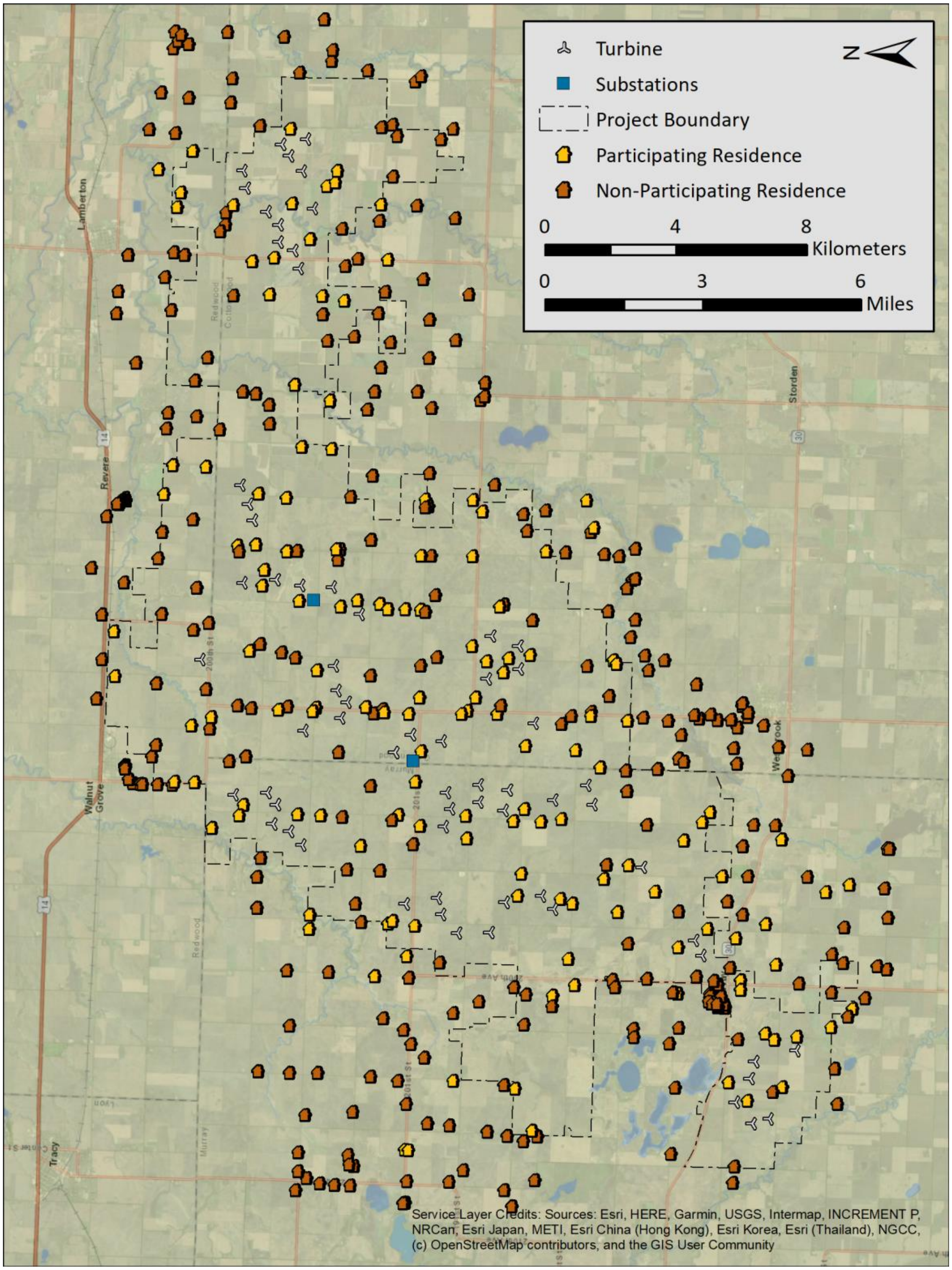

FIGURE 2: PLUM CREEK WIND FARM SITE MAP WITH SIEMENS GAMESA LAYOUT

3.0 SOUND LEVEL STANDARDS & GUIDELINES

3.1 LOCAL STANDARDS

All three counties in the Project area refer to the state noise standards for wind turbines. Specifically:

- Cottonwood County addresses noise from wind turbines in Subdivision 7 of their Renewable Energy Ordinance which states:

  Noise is regulated by the Minnesota Pollution Control Agency under Chapter 7030. These rules establish the maximum night time noise and day time noise levels that effectively limit wind turbine noise to 50 bD(A) at farm residences.

- Murray County addresses noise from wind turbines in Subdivision 4 of their Renewable Energy Ordinance which states:

  All WECS shall comply with Minnesota Rules 7030, as amended, governing noise.

- Redwood County addresses noise from wind turbines in Section 153.357 of Title XV of the County Code which states:

  Noise is regulated and the regulations are enforced by the state's Pollution Control Agency under Minn. Rules Ch. 7030. These rules establish the maximum nighttime and daytime noise levels.

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 2) for a variety of land uses, which are grouped into three categories identified by a Noise Area Classification. The sensitive land uses around the Project are primarily within Noise Area Classification 1 which includes residences (including farmhouses) and contains the most restrictive sound limits.

[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.

TABLE 2: 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."

[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 WIND TURBINE ACOUSTICS – SPECIAL CONSIDERATIONS

4.1 SOURCES OF SOUND GENERATION BY WIND TURBINES

Wind turbines generate two principle 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 3):

- 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.

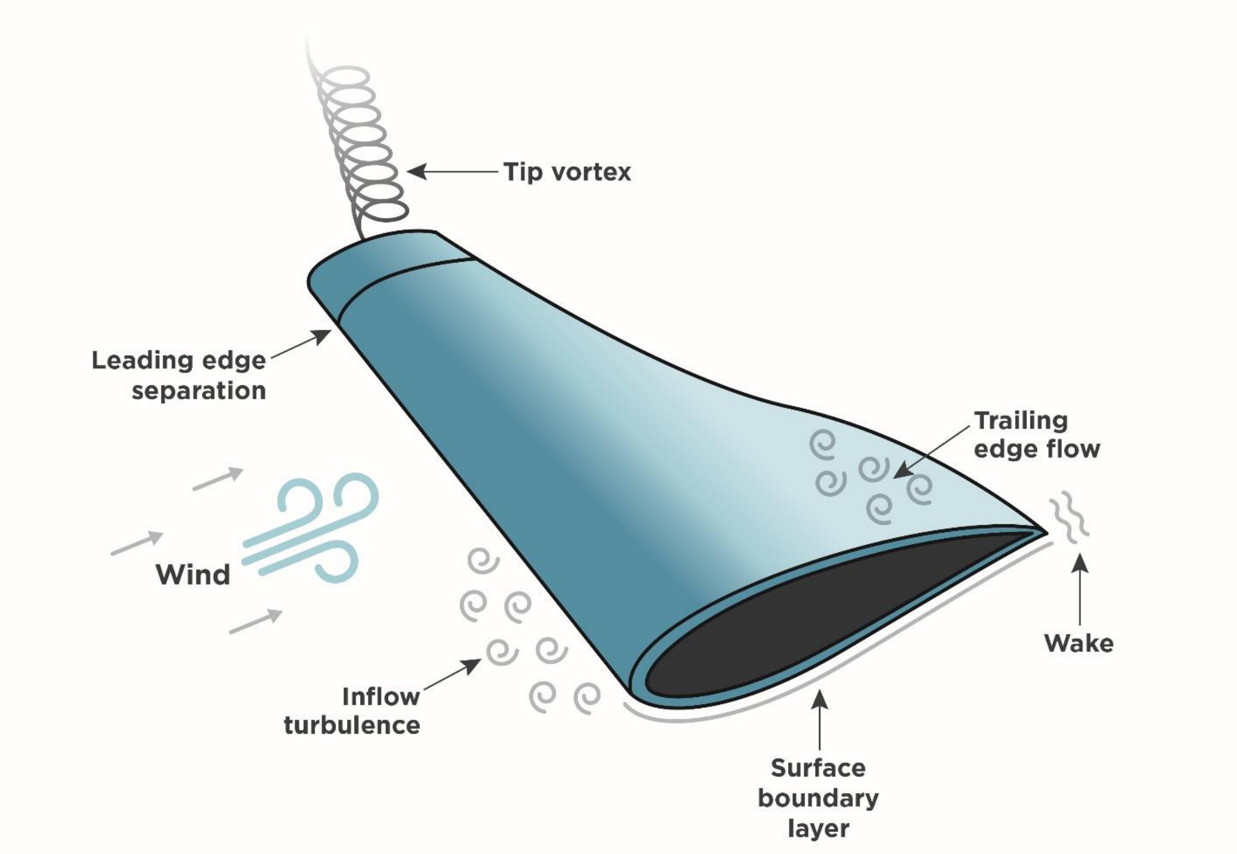

FIGURE 3: AIRFLOW AROUND A ROTOR BLADE

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.

4.2 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.[4] Most amplitude modulation is in the mid-frequencies and most overall A-weighted AM is less than 4.5 dB in depth.[5]

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.[6] 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.

4.3 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 4).

[4] 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.
[5] RSG, et al., "Massachusetts Study on Wind Turbine Acoustics," Massachusetts Clean Energy Center and Massachusetts Department of Environmental Protection, 2016
[6] "Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect." *RenewableUK.* December 2013.

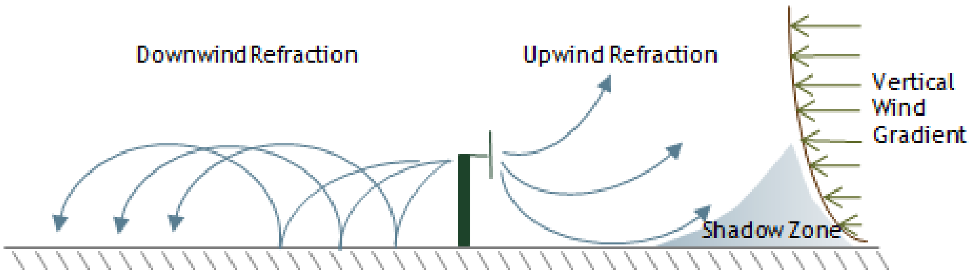

FIGURE 4: SCHEMATIC OF THE REFRACTION OF SOUND DUE TO VERTICAL WIND GRADIENT (WIND SHEAR)

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.

4.4 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 sound at downwind receptors because the frequency spectrum from wind is very similar to the frequency spectrum from a wind turbine. Figure 5 compares the shape of the sound spectrum measured during a 5 m/s wind event at the Project site to that of the V162 and SG170 wind turbines. As shown, the shapes of the spectra are very similar. At higher frequencies, the sounds from the masking wind sound are higher than the wind turbine. 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.

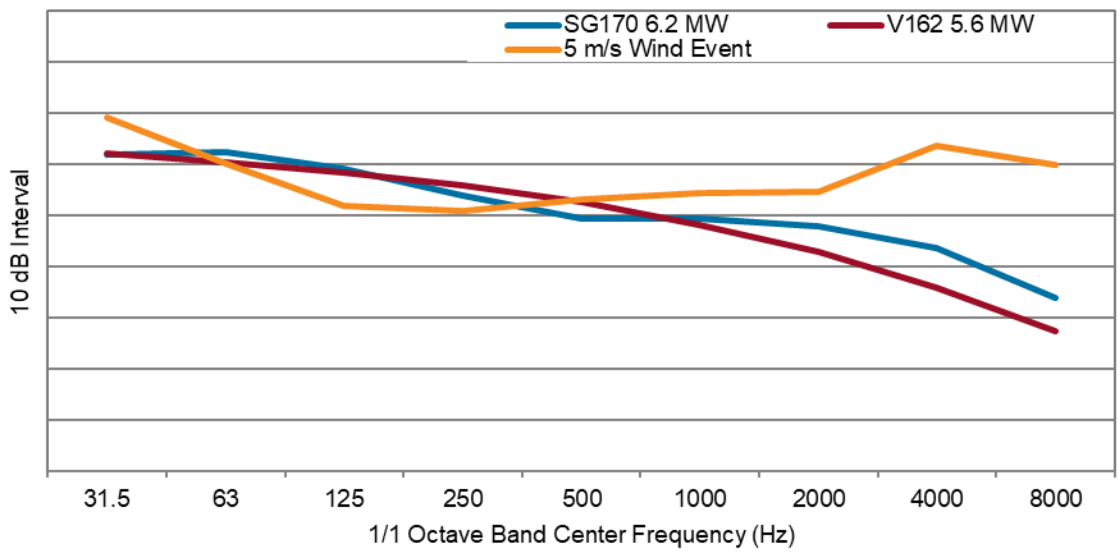

FIGURE 5: COMPARISON OF NORMALIZED FREQUENCY SPECTRA FROM WIND AND THE GE VESTAS V162 AND SIEMENS GAMESA SG170[7]

4.5 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[8] 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.

[7] 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.
[8] See Appendix A for additional information on frequency-weighted sound levels.

Figure 6 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 m/s. Measurements were made over approximately two weeks.[9] 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.

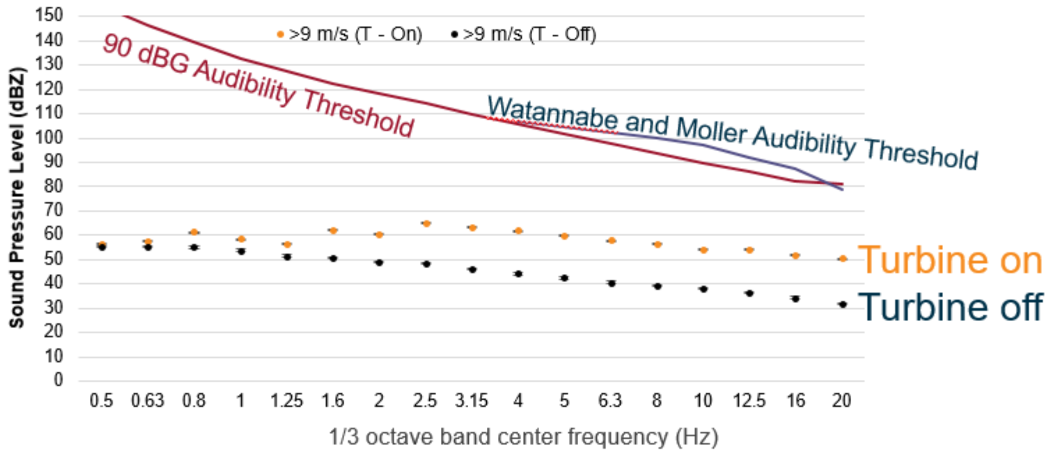

FIGURE 6: INFRASOUND FROM A WIND TURBINE AT 350 METERS (1,148 FEET) COMPARED WITH PERCEPTION THESHOLDS

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.

4.6 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

[9] 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

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.

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[10]) as well as to the perceived loudness of wind turbine sound.[11,12] 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.[5]

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[10] 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.
[11] Yokoyama S., et al. “Perception of low frequency components in wind turbine noise.” Noise Control Engr. J. 62(5) 2014
[12] Yokoyama et al. “Loudness evaluation of general environmental noise containing low frequency components.” Proceedings of InterNoise2013, 2013

5.0 SOUND LEVEL MONITORING

5.1 MONITORING PROCEDURE

Background sound level monitoring was conducted from August 27 to September 5, 2019 throughout the Project area to quantify the existing sound levels, including the nighttime L_{50}, and to identify existing sources of sound. Monitoring locations were selected per the guidance provided in the Department of Commerce's "Guidance for Large Wind Energy Conversion System Noise Study Protocol and Report," July 2019. The guidance recommends a minimum of three locations within the Project area. For this Project there were a total of five onsite and two offsite monitor locations. The guidance also recommends that one monitor location be in proximity to the worst-case modeled receptor. Monitors 4 and 5 represent the worst-case modeled areas. A map of the all the monitor locations is provided in Figure 7, and each monitor location is described further in Section 5.2.

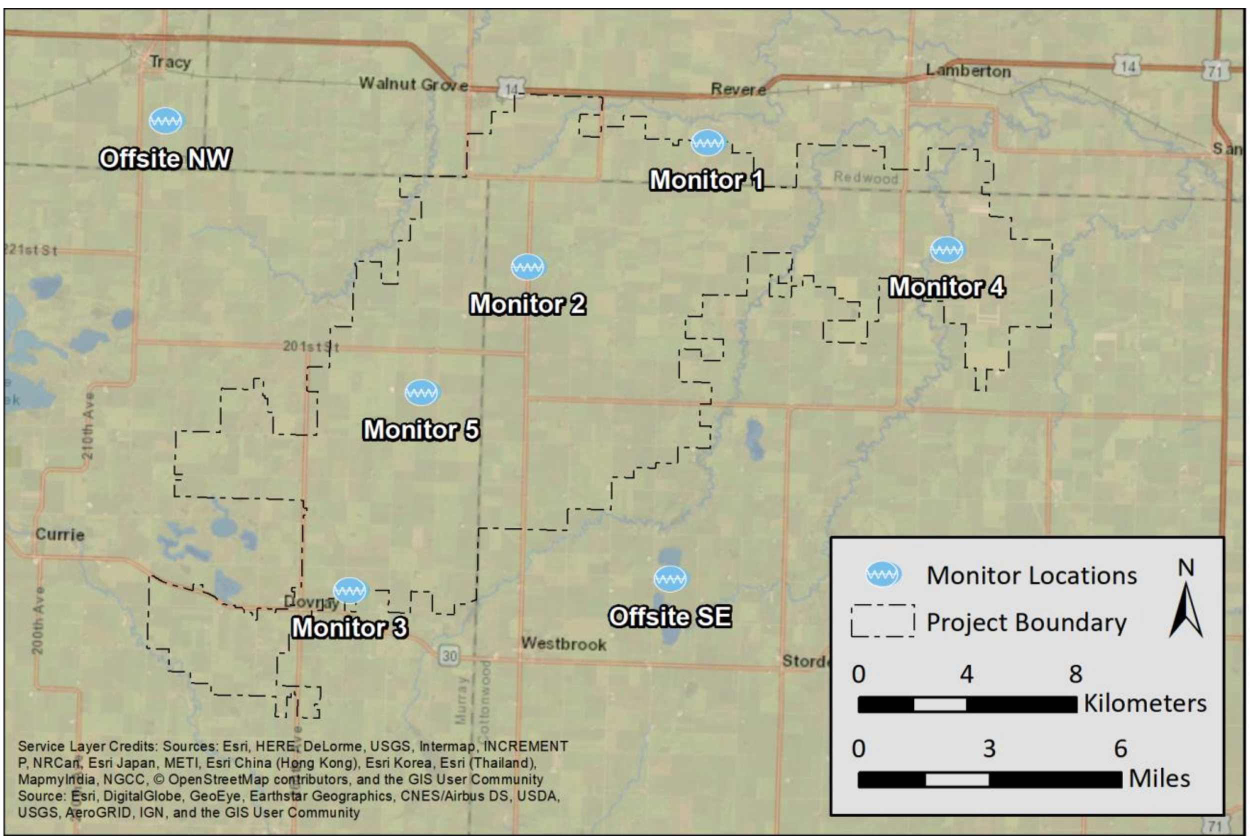

FIGURE 7: MAP OF BACKGROUND SOUND MONITOR LOCATIONS

Equipment

Background sound level monitoring was performed with ANSI/IEC Class 1 Cesva SC-310 and Svantek SV979 sound level meters. Each meter logged at a minimum A-weighted and 1/3 octave band equivalent continuous sound levels once per second for the entire measurement period. Sound level meter microphones were mounted on stakes at an approximate height of 1.5 meters (5 feet) and covered with 180 mm (7 inch) windscreens to minimize the impact of wind-caused distortion on measurements. Sound level meters were calibrated before and after the measurement period. Each Cesva was attached to a Roland external audio recorder, while the Svanteks recorded audio internally.

Each location had an ONSET anemometer logging wind data once per minute at a height of 1.5 meters (5 feet). The Offsite Northwest Monitor also logged temperature and relative humidity. Additional meteorological data was obtained from the ASOS station in Tracy, Minnesota (TKC). A list of the equipment used at each monitor location is provided in Table 3.

TABLE 3: SOUND MONITOR SPECIFICATIONS BY SITE

MONITOR LOCATION	SOUND LEVEL METER[13]	1/3 OCTAVE BAND FREQUENCY RANGE	AUDIO RECORDER	WEATHER STATION
1	Cesva SC310	10 Hz - 20 kHz	Edirol	ONSET HOBO Wind Speed
2	Cesva SC310	10 Hz - 20 kHz	Edirol	ONSET HOBO Wind Speed
3	Cesva SC310	20 Hz - 10 kHz	Edirol	ONSET HOBO Wind Speed
4	Svantek SV979	3.15 Hz – 20 kHz	Internal	ONSET HOBO Wind Speed
5	Cesva SC310	10 Hz - 10 kHz	Edirol	ONSET HOBO Wind Speed
Offsite NW	Cesva SC310	10 Hz - 20 kHz	Edirol	ONSET HOBO Wind Speed
Offsite SW	Svantek SV979	3.15 Hz - 20 kHz	Internal	ONSET HOBO Wind Speed

Data Processing

Upon completion of the monitoring period, data was downloaded, processed, and summarized into 10-minute periods. An equivalent average (L_{EQ}) was calculated for A-, C-, and Z-weightings. For A- and C- weightings, the statistical sound levels L_{10}, L_{50}, and L_{90} were also calculated.

A second set of data was also generated with periods removed from the data that either contained anomalous sound events or periods during weather conditions that could lead to inaccurate sound level readings.

Periods that were removed from the sound level data included:

- Wind speeds above 5 m/s (11 mph),

[13] The frequency range for the Cesva SC-310 sound level meters is limited by the instrument and the range for the Svantek SV979 sound level meters is limited by the microphone.

- Precipitation, and
- Personnel and animal interaction with equipment.

5.2 LOCATION DESCRIPTIONS

Monitor 1

Monitor 1 was located near the northern extent of the Project area in Redwood County, MN. It was approximately 60 meters (200 feet) south of 110th Street, and 710 meters (1,850 feet) west of Frontier Avenue in Revere, Minnesota. The monitor was situated between a cornfield and a row of spruce trees. A nearby residence with agricultural buildings was located west of the monitor, with the nearest building being the residence approximately 35 meters (115 feet) to the west. The location is approximately 1,670 meters (5,500 feet) south of US Route 14, a parallel railway, and the town of Revere. The surrounding area is largely agricultural with scattered rural residences.

A photograph of the monitor setup is shown in Figure 8, and a map indicating the monitor location within the surrounding area is displayed in Figure 9.

FIGURE 8: PHOTOGRAPH OF MONITOR 1, FACING EAST (9/3/2019)

FIGURE 9: AERIAL VIEW MONITOR 1

Monitor 2

Monitor 2 was located centrally within the Project area in Walnut Grove, which is in Cottonwood County, MN. It was situated 25 meters (80 feet) south of 220th Street, and 43 meters (140 feet) west of County Road 7. The setup was fastened to a tree in the yard of a residence, approximately 25 meters (85 feet) from the house. While the broader area was predominantly agricultural, three residences with associated agricultural buildings and infrastructure were in the immediate vicinity of the monitor. A photograph of the monitor setup is shown in Figure 10, and a map of the monitor location is provided in Figure 11.

FIGURE 10: PHOTOGRAPH OF MONITOR 2, FACING NORTH (9/3/2019)

FIGURE 11: AERIAL VIEW OF MONITOR 2

Monitor 3

Monitor 3 was placed in the southwest portion of the Project area in Murray County, MN. It was located 170 meters (550 feet) from 270th Avenue, and 775 meters (2,550 feet) north of 141st Street in Dorvay. This location is 6.9 kilometers (4.3 miles) northeast of the City of Westbrook. The Monitor was positioned along a tree line bordering an agricultural field to the east, which was under soybean production. A patch of woods separated the monitor from 270th Avenue. An agricultural operation and associated residence are situated approximately 120 meters (400 feet) to the southwest. A photograph of the monitor setup is shown in Figure 12, and a map of the monitor location is provided in Figure 13.

FIGURE 12: PHOTOGRAPH OF MONITOR 3, FACING NORTHEAST (9/3/2019)

FIGURE 13: AERIAL VIEW OF MONITOR 3

Monitor 4

Monitor 4 was located in the northeastern section of the Project area in Cottonwood County, MN. The monitor was set up in a mowed field at a homestead situated next to a stream and riparian area. The monitor was placed 300 meters (1000 feet) north of 215th Street and 750 meters (2500 feet) west of 420th Avenue (Country Road 54). A photograph of the monitor setup is shown in Figure 14, and a map of the monitor location is shown in Figure 15.

FIGURE 14: PHOTOGRAPH OF MONITOR 4, FACING NORTHEAST (2019-09-03)

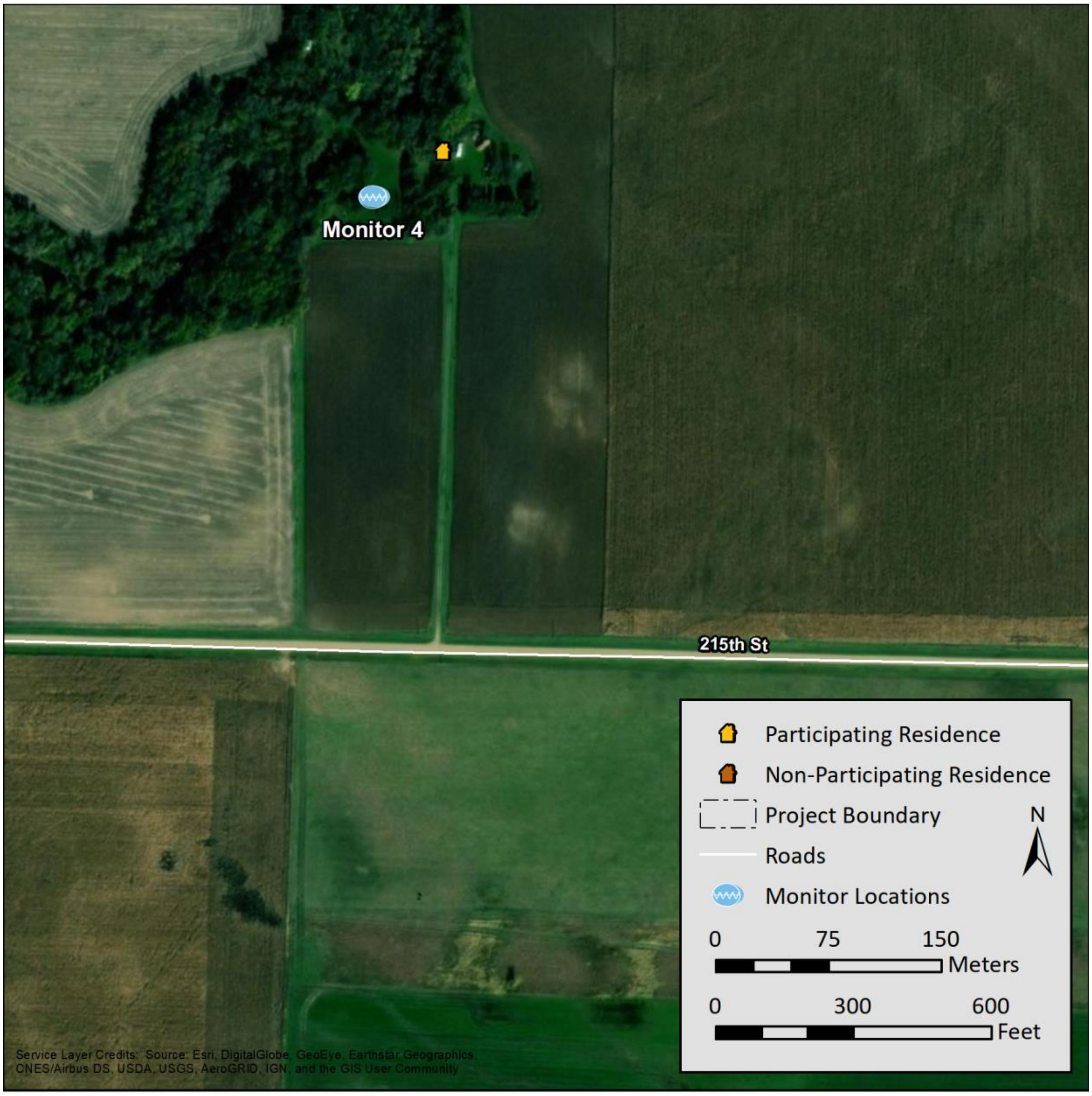

FIGURE 15: AERIAL PHOTO OF MONITOR 4

Monitor 5

Monitor 5 was located on a parcel bordered by agricultural fields under active corn production in Murray County, MN. During the monitoring period, the home on the parcel was not inhabited, but a horse was fenced into the homestead area. The monitor was located at the rear of the homestead, about 100 meters (330 feet) from 191st Street and 600 meters west of 290th Avenue (County Road 45). A photograph of the monitor setup is shown in Figure 16, and a map of the monitor location is shown in Figure 17. Note that the crop line has since moved to the south from what is shown in Figure 17 (aerial imagery from 2015).

FIGURE 16: PHOTOGRAPH OF MONITOR 5, FACING EAST (9/3/2019)

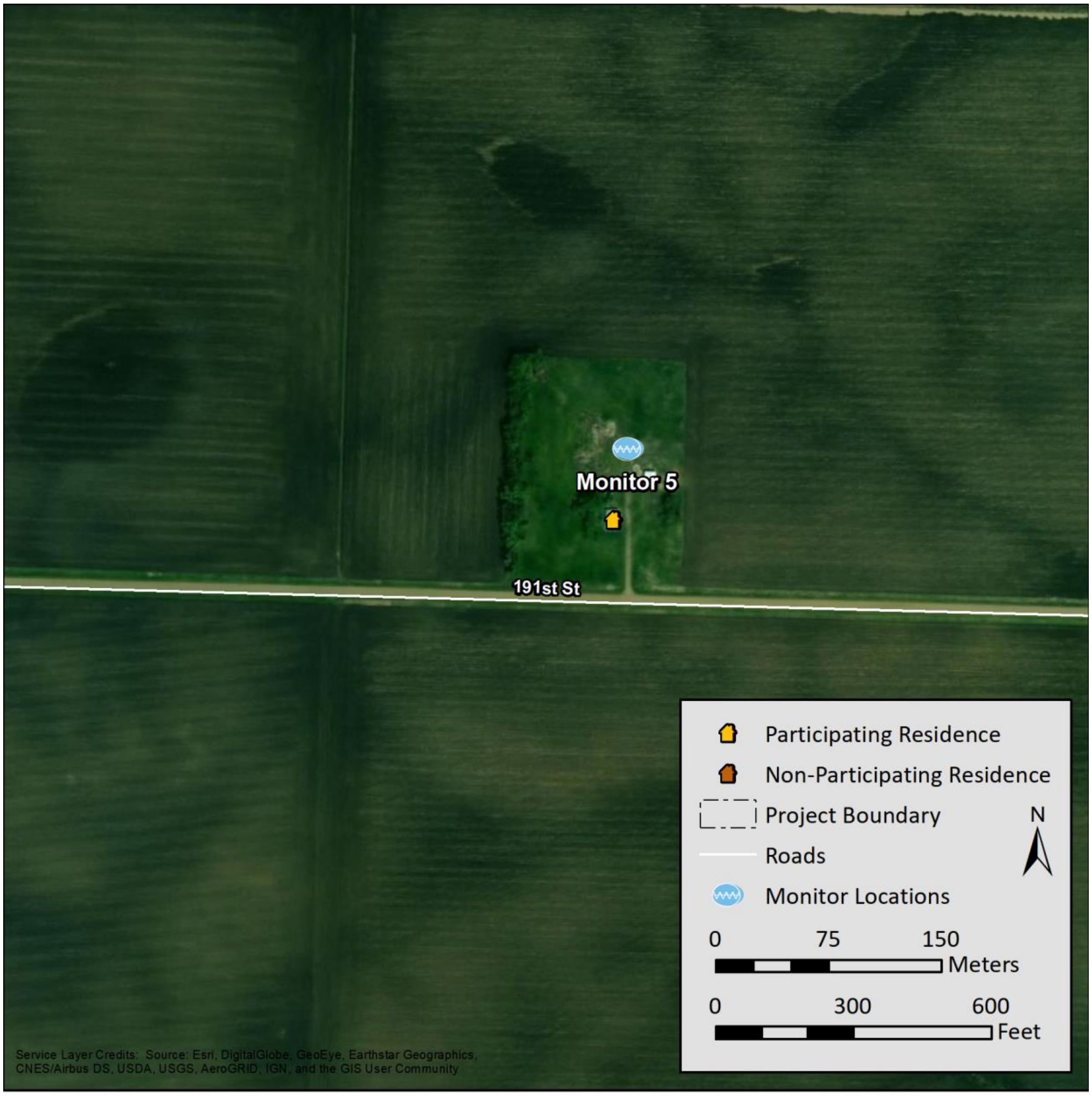

FIGURE 17: AERIAL PHOTO OF MONITOR 5

Northwest Offsite Monitor

The Northwest Offsite Monitor location was the Tracy Community Cemetery in Tracy, MN, which is located in Lyon County. The sound monitor was placed 120 meters (400 feet) east of 340th Avenue (County Road 73) and 170 meters (560 feet) north of 110th Street. This location is 1.8 kilometers (1.1 miles) south of the rail line and the town of Tracy and is surrounded by agricultural fields. The monitor was over 10 kilometers (6.2 miles) from the nearest proposed turbine location. A photograph of the monitor setup is shown in Figure 18, and a map of the monitoring location is shown in Figure 19.

FIGURE 18: PHOTOGRAPH OF THE NORTHWEST OFFSITE MONITOR LOCATION (9/3/2019)

FIGURE 19: AERIAL PHOTO OF NORTHWEST OFFSITE MONITOR

Southeast Offsite Monitor

The Southeast Offsite Monitor was located on a homestead site with various outbuildings to the southeast of the proposed project area in Cottonwood County, MN. The monitor was placed 35 meters (115 feet) south of 290th Street and 620 meters (2040 feet) east of 350th Avenue. This location is about 250 meters (820 feet) south of Bean Lake. Additionally, the Jeffers Wind Energy Center (JWEC) in Cottonwood County, MN was operating to the east of the monitoring location. The closest JWEC turbine to the monitor was 7.5 kilometers (4.7 miles) away. The monitor was over 6 kilometers (3.7 miles) from the nearest proposed Project turbine location. A photograph of the monitor setup is shown in Figure 20, and a map of the monitor area is shown in Figure 21.

FIGURE 20: PHOTOGRAPH OF THE SOUTHEAST OFFSITE MONITORING LOCATION, FACING SOUTHEAST (9/3/2019)

FIGURE 21: AERIAL VIEW OF SOUTHEAST OFFSITE MONITOR

5.3 SOUND LEVEL MONITORING RESULTS

For each monitor site, sound level monitoring results are presented in a single chart in this report section. Each chart contains hourly sound levels, gust wind speed measured adjacent to each microphone, “hub height” average wind speed, precipitation events, and indications of data exclusions in conformance with LWECS Guidance. Points on the sound level graph represent data summarized for a single one-hour interval. The top portion of the chart displays A-weighted sound levels, the middle portion presents C-weighted levels, and the bottom portion shows wind speeds and times when there were data exclusions. All portions of the chart exhibit day/night shading: night is defined as 22:00 to 07:00 and is shaded in grey.

The specific sound level metrics reported are L_{EQ}, L_{90}, L_{50}, and L_{10}. Equivalent continuous sound levels (L_{EQ}) are the energy-average level over one hour. Tenth-percentile sound levels (L_{90}) are the statistical value above which 90% of the sound levels occurred during one hour. Fiftieth-percentile sound levels (L_{50}) represent the median sound level of that one-hour period. Ninetieth-percentile sound levels (L_{10}) are the statistical value above which 10% of the sound levels occurred during one hour. Data that were excluded from processing (e.g., due to high wind and rain periods) are included in the graphs but shown in lighter colors. Furthermore, rectangular markers on the lower portion of the chart indicate periods for which data was excluded and designate if the period was eliminated as a result of rain, wind gusts over 11 mph, or anomalous events.

Sound level data and wind gust data presented in the charts are those measured at each corresponding site. Wind data from the monitoring location, measured at the microphone height of 1.5 meters (5 feet), are presented as the maximum gust speed occurring at any time over a 10-minute interval; they are not averaged. The average 10-minute wind speed measured at the project met-tower closest to the monitoring location is also displayed on the chart.

Lastly, one-third octave band statistical sound level results are also presented for periods when a representative wind speed (10 m/s) existed at a representative hub height of 105 meters (344 feet). This condition reflects wind conditions that would result in turbines producing maximum sound power. Only periods with this representative wind speed were used for the unweighted statistical one-third octave band metrics in the figures, providing a baseline for direct comparison with post-construction measurements. Each vertical orange and grey bar shows the Lower 10th, median, and Upper 10th percentile (L_{90}, L_{50}, and L_{10}) sound level for a single 1/3 octave band. The top of the orange bar is the Upper 10th percentile sound pressure level (L_{10}), the white dot is the median (L_{50}), and the bottom of the grey bar is the lower 10th percentile sound level (L_{90}). The entire length of the bar indicates the middle 80th percentile of sound pressure levels. The blue dots indicate the equivalent average sound pressure level (L_{EQ}) for that 1/3 octave band. At the far right of the chart are the A-, C-, and Z-weighted overall levels.

Results Summary

Meteorology

Wind speed was collected at all monitor locations by Onset anemometers mounted at 1.5 meters. Other meteorological data was obtained from the Tracy, Minnesota airport (TKC). This data showed that temperatures during the monitoring period ranged from 10º C (50º F) to 28º C (82º F).

A summary of 1.5-meter (5-foot) wind speeds for each monitoring location is shown in Table 4.

TABLE 4: SUMMARY OF MEASURED 1.5 METER (5-FOOT) WIND SPEEDS

Location	Measured 1.5-meter Wind (mph)			
	10-min Wind Speed		10-min Gust Speed	
	Average	Maximum	Average	Maximum
Onsite 1	1.4	12.4	4.1	18.6
Onsite 2	0.8	4.8	3.5	13.0
Onsite 3	0.6	7.2	2.3	13.5
Onsite 4	0.3	2.7	1.9	9.6
Onsite 5	1.6	8.4	5.3	19.1
Offsite NW	3.7	11.8	7.7	20.8
Offsite SE	0.6	5.9	2.5	12.4

Exclusion Periods

Periods of data were excluded from each monitor by automated processing and manual identification. Manual processing consisted of analyzing the spectrogram created from one-second 1/3 octave band data, verifying noise appropriate for exclusion with the assistance of audio recordings, and excluding it from the data set. Automated processing was performed to eliminate gust speeds in excess of 11 mph recorded at a monitoring location. Rain periods were identified from weather station data and verified in the spectrogram and with audio recordings.

A summary of each location’s monitor runtime and exclusion statistics for rain, wind, and anomalies are shown in Table 5.

TABLE 5: SUMMARY OF EXCLUSION PERIODS AT EACH MONITOR

Location	Run-Time	Exclusion Statistics							
		Rain		Wind		Anomalies		Total	
	(hr)	(hr)	(%)	(hr)	(%)	(hr)	(%)	(hr)	(%)
Onsite 1	210	4.3	2.1	8.2	3.9	5.6	2.7	16.7	8.0
Onsite 2	211	2.3	1.1	0.2	0.1	7.0	3.3	9.5	4.5
Onsite 3	213	3.8	1.8	0.7	0.3	1.1	0.5	5.2	2.4
Onsite 4	213	0.0	0.0	0.0	0.0	17.7[14]	8.3	17.7	8.3
Onsite 5	212	3.3	1.6	13.9	6.6	0.5	0.2	17.5	8.3
Offsite NW	208	2.0	1.0	28.4	13.7	0.2	0.1	29.0	13.9
Offsite SE	215	2.8	1.3	0.1	0.0	0.3	0.1	3.0	1.4

Overall Sound Levels

The A-weighted sound level summary levels are listed in Table 6, and the C-weighted summary levels are listed in Table 7. As shown in Table 6, the average nighttime L50 across all the onsite monitors was 42 dBA. The nighttime A-weighted sound levels shown in Table 6 were notably affected by biogenic sounds, primarily insects. At times during the year, the biogenic sound would not be present. To account for this, high frequency tonal sounds such as insect sounds can be filtered out of the dataset using an ANS weighting[15]. ANS weighting is the same as A-weighting accept that it simply discounts sound levels above the 1 kHz 1/1 octave band, the frequency range in which the biogenic sounds occur. To represent the background sound levels in the area for times when biogenic sounds are not a major source of sound, such as late fall through early spring, Table 8 provides the ANS-weighted sound levels. Comparing the nighttime sound levels in Table 8 with those shown in Table 6, shows that the background sound levels would generally be at least 10 dB less when nighttime biogenic sounds are not present. This is helpful in understanding seasonal variations in background sound levels. The average nighttime ANS-weighted L50 across all the onsite monitors was 25 dBA (see Table 8).

[14] Monitor 4 had more anomaly exclusions than the other monitors due to extended periods of mowing in close proximity to the monitor and a social event/celebration held at the property where monitoring was taking place.
[15] ANSI S12.100, "Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential Areas"

TABLE 6: PRECONSTRUCTION MONITORING SUMMARY (A-WEIGHTED RESULTS)

Location	Sound Levels (dBA)											
	Overall				Day				Night			
	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}
Onsite 1	43	36	41	45	44	38	42	46	40	34	39	43
Onsite 2	50	42	46	51	51	41	45	52	48	42	46	50
Onsite 3	42	32	38	46	42	31	37	46	42	35	39	47
Onsite 4	52	34	43	53	52	34	42	55	51	34	43	51
Onsite 5	43	38	42	46	43	38	41	45	44	37	43	47
Onsite Average	*46*	*36*	*42*	*48*	*46*	*36*	*41*	*49*	*45*	*36*	***42***	*48*
Offsite NW	44	38	43	46	45	38	43	47	44	37	44	46
Offsite SE	46	37	45	49	46	36	43	49	47	41	46	49

TABLE 7: PRECONSTRUCTION MONITORING SUMMARY (C-WEIGHTED RESULTS)

Location	Sound Levels (dBC)											
	Overall				Day				Night			
	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}
Onsite 1	52	40	45	52	53	41	47	53	51	40	42	43
Onsite 2	56	43	46	55	58	43	48	58	51	43	46	50
Onsite 3	48	39	43	51	49	39	44	52	44	39	42	47
Onsite 4	60	40	46	60	59	41	48	63	60	38	44	51
Onsite 5	53	41	45	51	55	42	45	53	48	40	44	47
Onsite Average	*54*	*40*	*45*	*54*	*55*	*41*	*46*	*56*	*51*	*40*	*44*	*48*
Offsite NW	54	43	47	54	55	43	47	56	50	43	46	46
Offsite SE	50	42	46	53	51	42	46	53	48	44	46	49

TABLE 8: PRECONSTRUCTION MONITORING SUMMARY (ANS-WEIGHTED RESULTS[16])

Location	Sound Levels (ANS-Weighted)											
	Overall				Day				Night			
	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}
Onsite 1	40	17	31	43	41	22	36	44	33	15	23	35
Onsite 2	47	19	32	46	49	22	35	49	41	16	26	39
Onsite 3	40	20	30	43	41	22	32	45	31	17	26	34
Onsite 4	51	21	33	52	52	24	38	55	50	19	27	44
Onsite 5	35	18	26	36	37	21	28	39	28	16	23	32
Onsite Average	*42*	*19*	*30*	*44*	*44*	*22*	*34*	*46*	*37*	*17*	*25*	*37*
Offsite NW	37	20	30	39	38	23	31	41	33	17	29	37
Offsite SE	40	21	30	43	41	22	33	45	34	19	26	36

Monitor 1

Monitor 1 was acoustically characterized by insect sounds, vehicle traffic, aircraft overflights, and distant dog barking. A radio playing at the residence could often be detected during daytime hours. This was not excluded, as the contribution to sound levels was insignificant, and it did not play at night. Exclusions at this site were made for idling vehicles adjacent to the monitor, lawn mowing, wind, and rain periods.

The location had one of the lowest nighttime sound levels on an A-weighted L_{50} basis, at 39 dBA. This was likely due to the nearby road being used infrequently, as well as little sound originating at the nearby residence. Time-history monitoring results for Monitor 1 are provided Figure 22.

[16] Sound levels were only ANS-weighted for periods when high frequency tonal sounds were present.

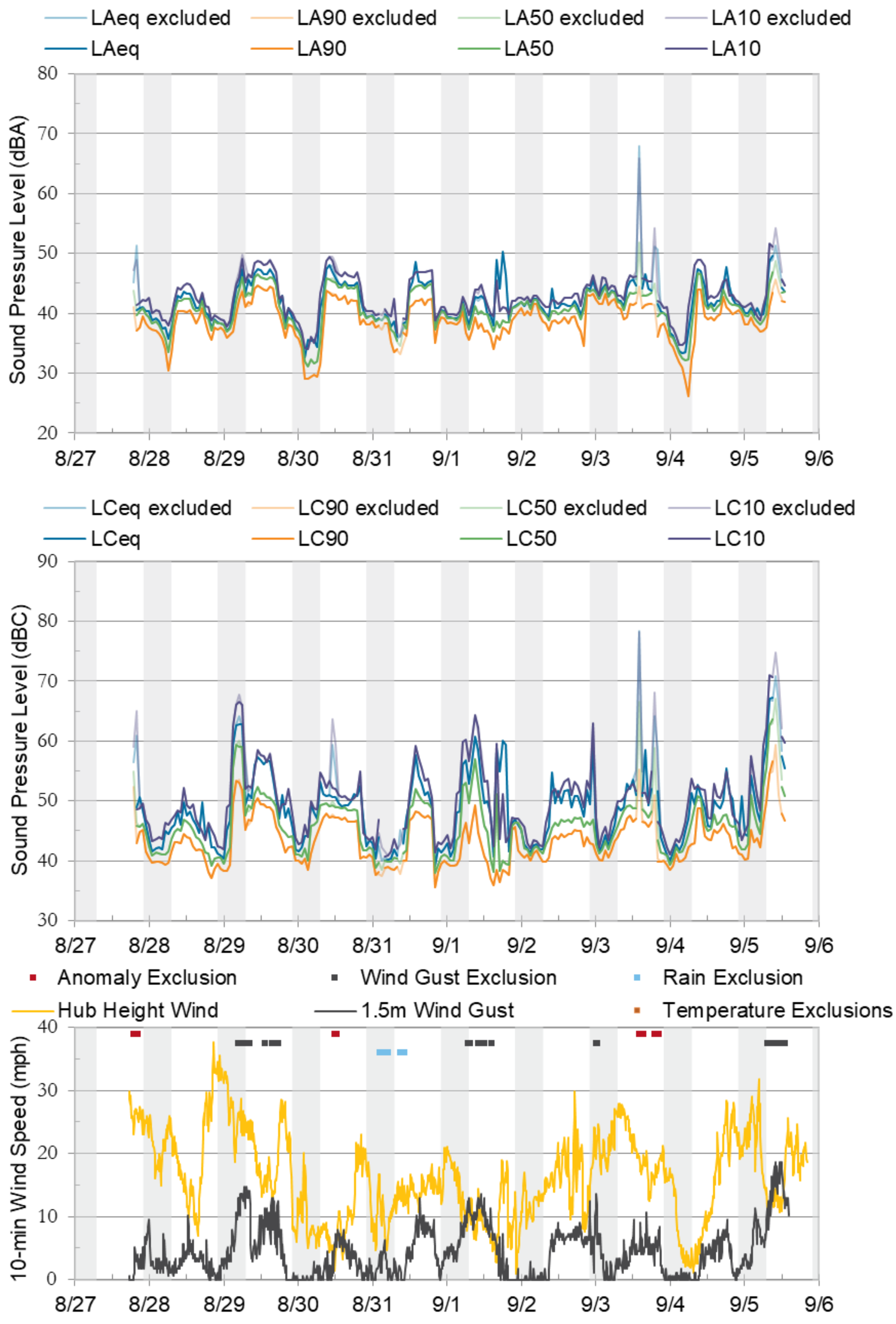

FIGURE 22: PRE-CONSTRUCTION MONITORING RESULTS AT MONITOR 1

Monitor 2

Monitor 2 was situated near the intersection of two roads, and thus experienced a notable amount of traffic noise compared to the other monitor locations. Biogenic sound from insects and birds was present throughout the monitoring. Other sources included aircraft overflights and distant agricultural operations. Data exclusions were made for lawn mowing and nearby agricultural activities.

The site had the highest (along with Offsite Southeast) nighttime L_{50} of any location monitored, at 46 dBA. This may have been due to stronger nighttime insect sound at this location than other locations. Time-history monitoring results for Monitor 2 are provided Figure 23.

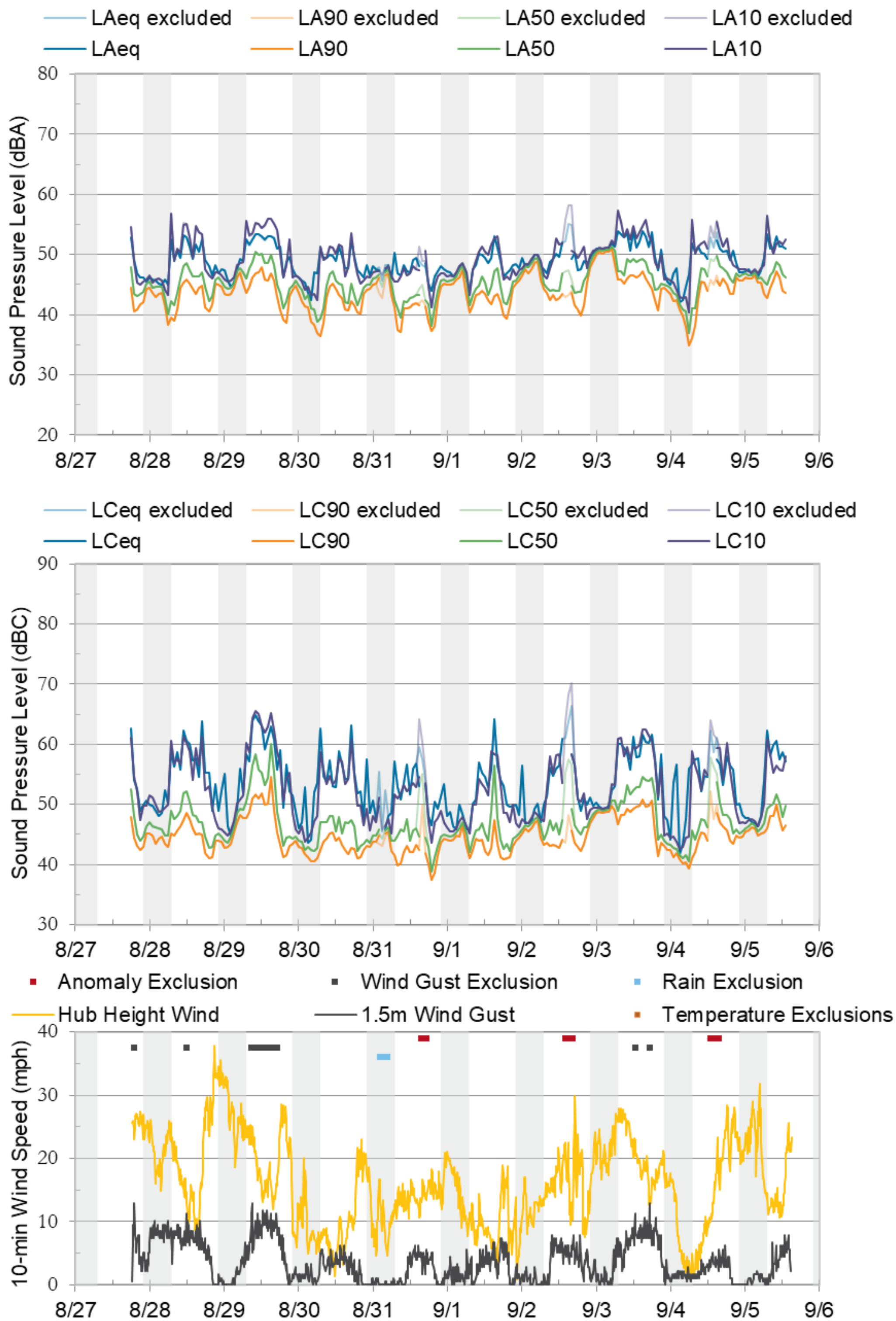

FIGURE 23: PRE-CONSTRUCTION MONITORING RESULTS AT MONITOR 2

Monitor 3

Monitor 3 was adjacent to a soybean field, with a wooded area on the other side, and not especially close to the road or residence. The soundscape at this location was primarily biogenic, with bird and insect sound being the dominant source. Other sources included aircraft overlfights and distant equipment noise. Wind exclusions were few at this location due in part to shielding from the wooded area. The only anomalous exclusion (other than setup and pickup of the equipment) was the presence of an ATV near the monitor on 8/30/2019 for less than an hour.

Monitor 3 (along with Monitor 1) had the lowest nighttime L_{50}, at 39 dBA. It also had the lowest L_{eq} of any location for overall, day and night at 42 dBA for each metric, indicating the site was not subject to a strong diurnal pattern. Time-history monitoring results for Monitor 3 are provided Figure 24.

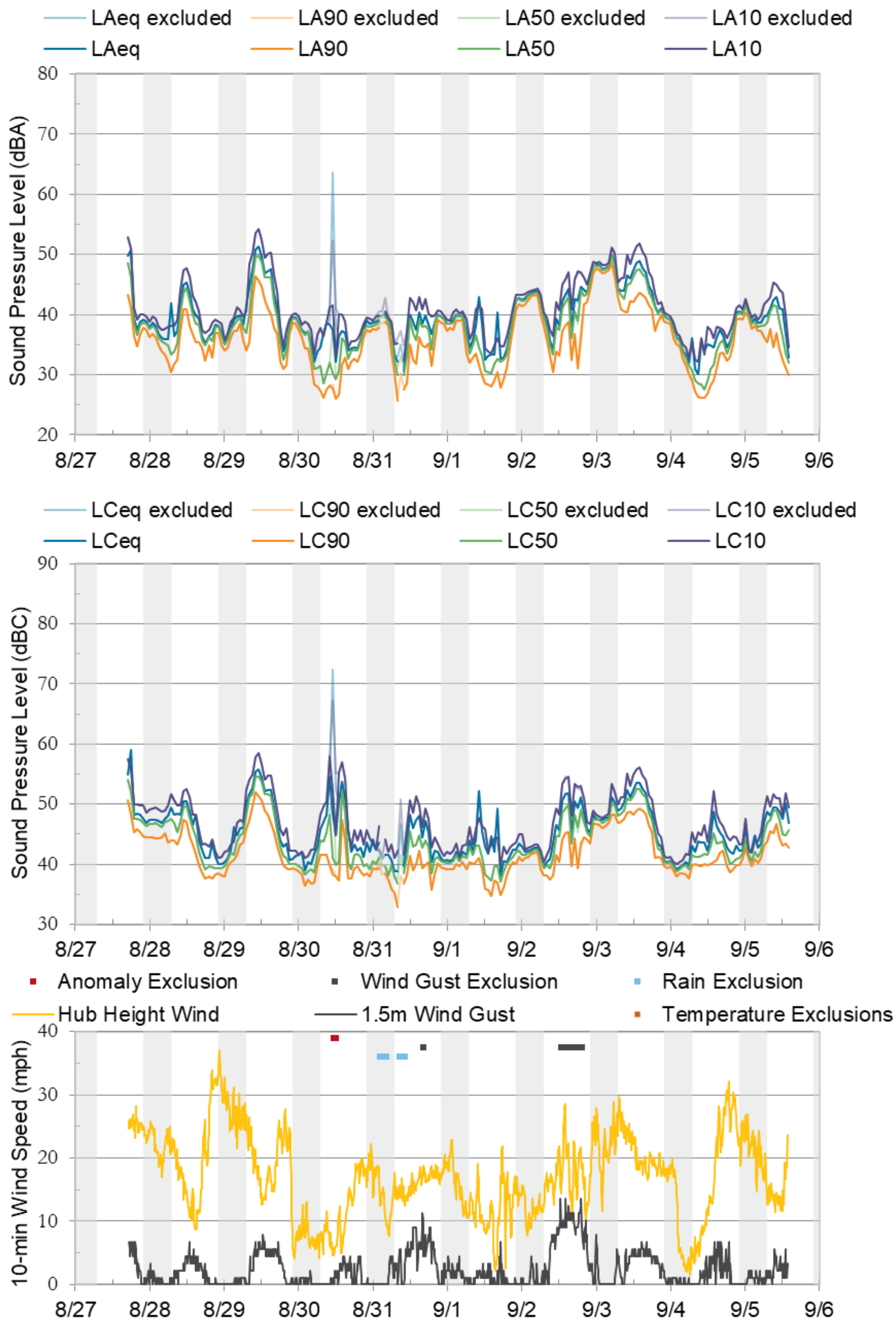

FIGURE 24: PRE-CONSTRUCTION MONITORING RESULTS AT MONITOR 3

Monitor 4

Monitor 4 was in the yard section of a homestead. Though vacant much of the time, the location was host to social event/celebration in the general vicinity of the monitor for a period of time on August 29 and periodically throughout the monitoring period. While close activity warranted exclusion, activity further away was retained, as it represented a significant portion of the monitoring period. Other contributors of sound at the location included biogenic sources and aircraft overflights. Because of the sheltered nature of the site, there were no wind exclusions. The location did have the greatest amount of anomalous exclusions (8.3%) as a result of the anthropogenic activity near the monitor.

The nighttime L_{50} at the location was 43 dBA, which was greater than the daytime level, likely because of the recreational activities taking place some evenings.

Monitor 4 represents one of the worst-case areas projected by the pre-construction sound propagation model, so the statistical spectral levels for a representative wind speed (10 m/s) at a representative hub height (105 meters) are presented in Figure 25. The higher sound levels in the 4,000 and 5,000 Hz bands are due to biogenic sounds. Time-history monitoring results for Monitor 4 are provided Figure 26.

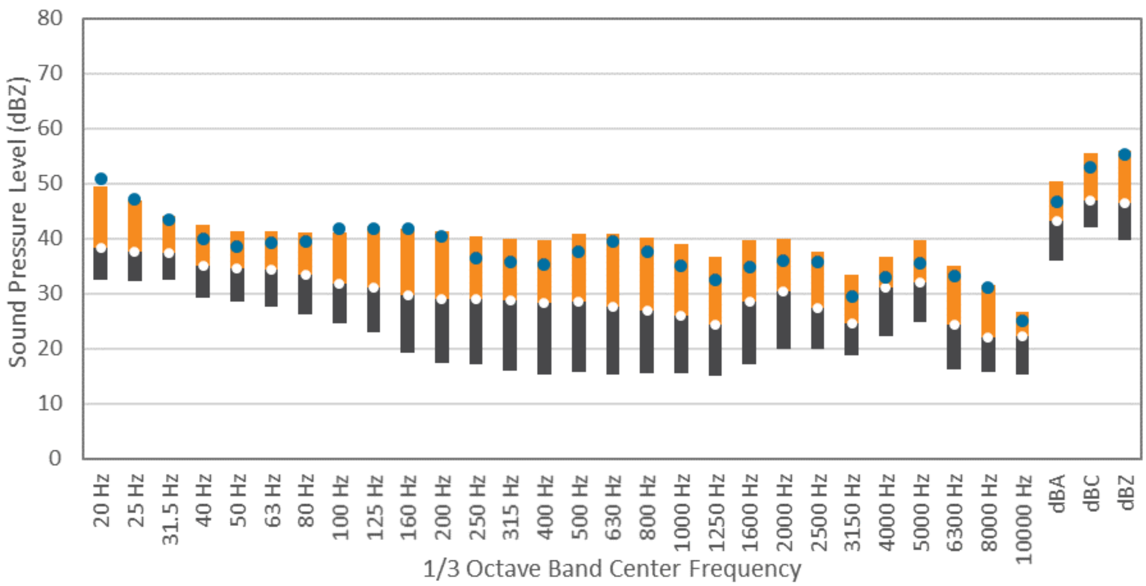

FIGURE 25: 1/3 OCTAVE BAND AND OVERALL STATISTICAL SOUND LEVELS AT MONITOR 4 (FOR PERIODS WITH 10 m/s WIND SPEED AT 105-METER (345-FOOT) HEIGHT)

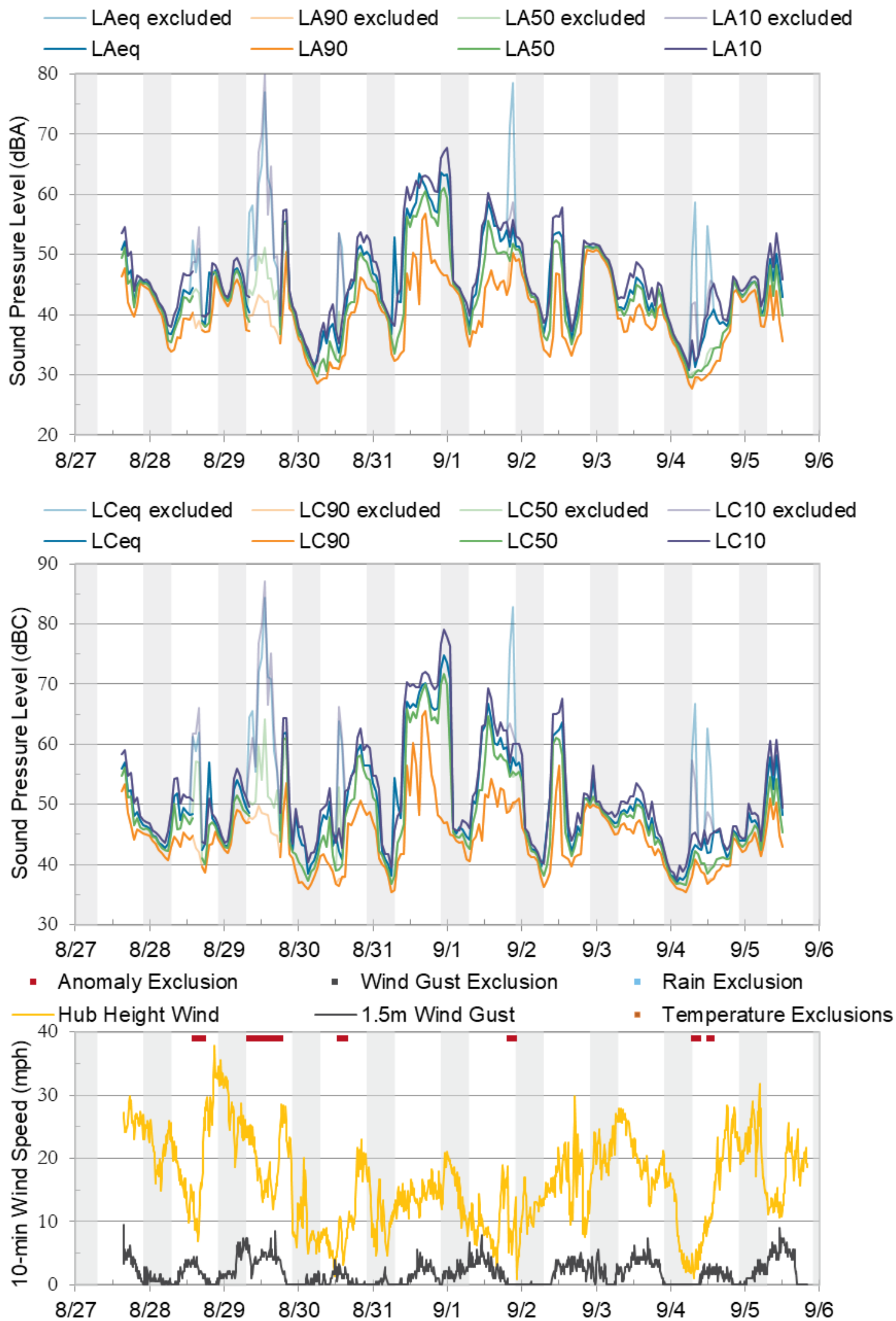

FIGURE 26: PRE-CONSTRUCTION MONITORING RESULTS AT MONITOR 4

Monitor 5

Monitor 5 was located between a horse pasture and a corn field. Sound at this location was characterized by biogenic sources, as it was not located near an active residence or a busy roadway. Insect and bird sounds were dominant sources. Aircraft overflights were apparent in the spectrograms. Anomalous exclusions were made at the site due to animals interacting with the microphone, namely birds and deer. The nighttime L50 at this location was 43 dBA.

Monitor 5 represents one of the worst-case areas projected by the pre-construction sound propagation model, so the statistical spectral levels for a representative wind speed (10 m/s) at a representative hub height (105 meters) are presented in Figure 27. The higher sound levels in the 4,000 and 5,000 Hz bands are due to biogenic sounds. Time-history monitoring results for Monitor 5 are provided Figure 28.

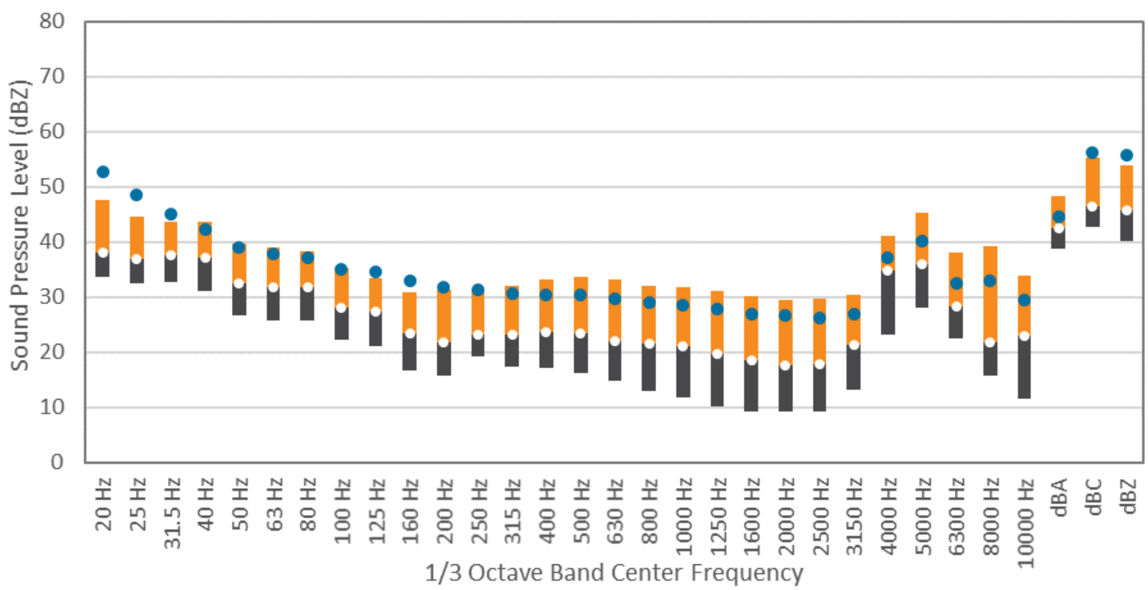

FIGURE 27: 1/3 OCTAVE BAND AND OVERALL STATISTICAL SOUND LEVELS AT MONITOR 5 (FOR PERIODS WITH 10 m/s WIND SPEED AT 105-METER (345-FOOT) HEIGHT)

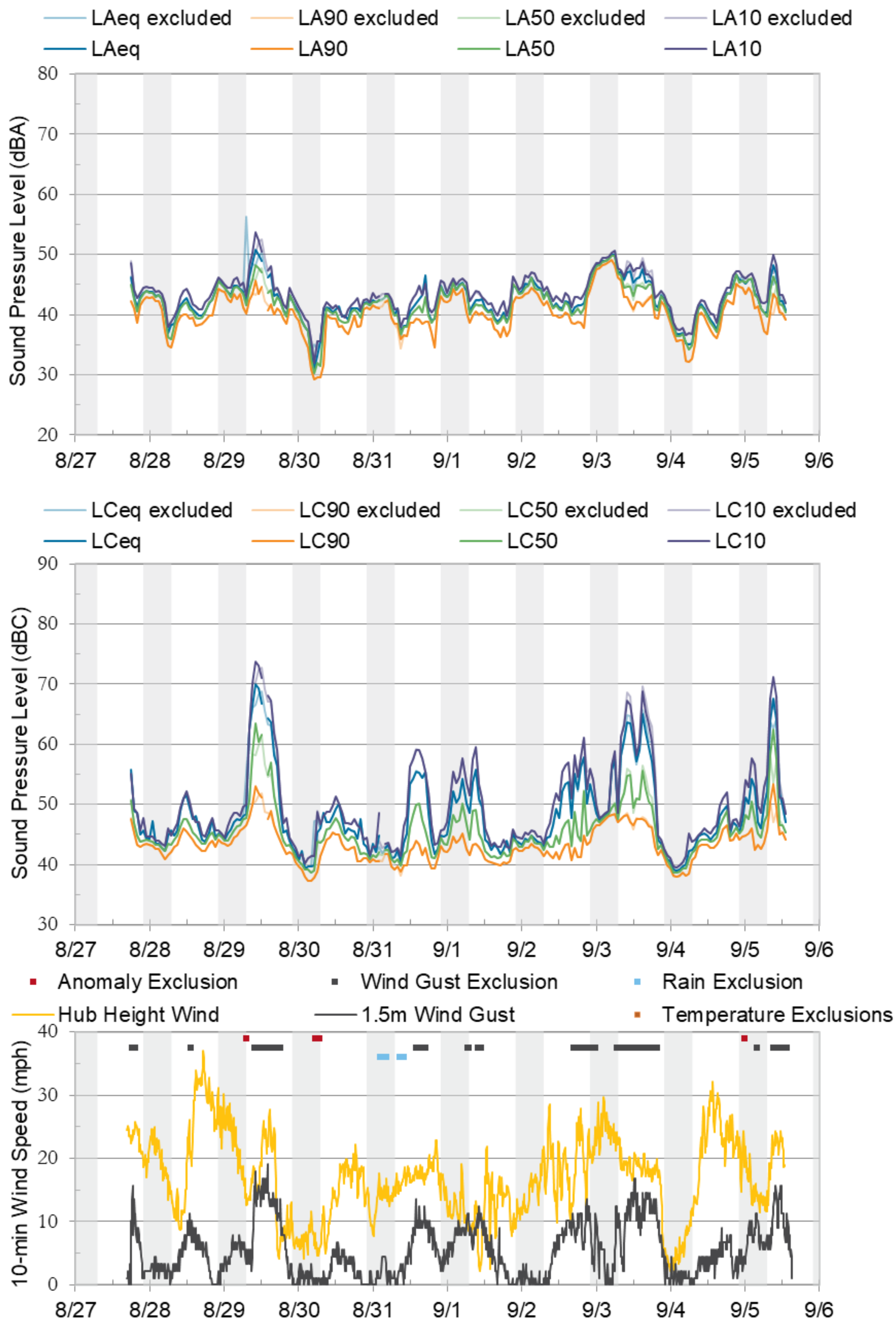

FIGURE 28: PRE-CONSTRUCTION MONITORING RESULTS AT MONITOR 5

Northwest Offsite Monitor

The Northwest Offsite Monitor was situated on the periphery of a cemetery. The location was fairly open, and this site had the greatest amount of wind exclusions, with 13.7% of time excluded due to wind. The average wind speed was nearly 2 m/s greater than the next highest site. The sound sources at this site were biogenic sounds, aircraft overflights, distant trains, and periodic activity in the cemetery. Additionally, wind-induced sound was a factor (when not great enough to warrant exclusion). The nighttime L_{50} at this location was 44 dBA, 2 dB greater than the average onsite nighttime L_{50}.

Statistical spectral levels for a representative wind speed (10 m/s) at a representative hub height (105 meters) are presented in Figure 30. The higher sound levels in the 4,000 and 5,000 Hz bands are due to biogenic sounds. Time-history monitoring results for the Northwest Offsite Monitor are provided Figure 30.

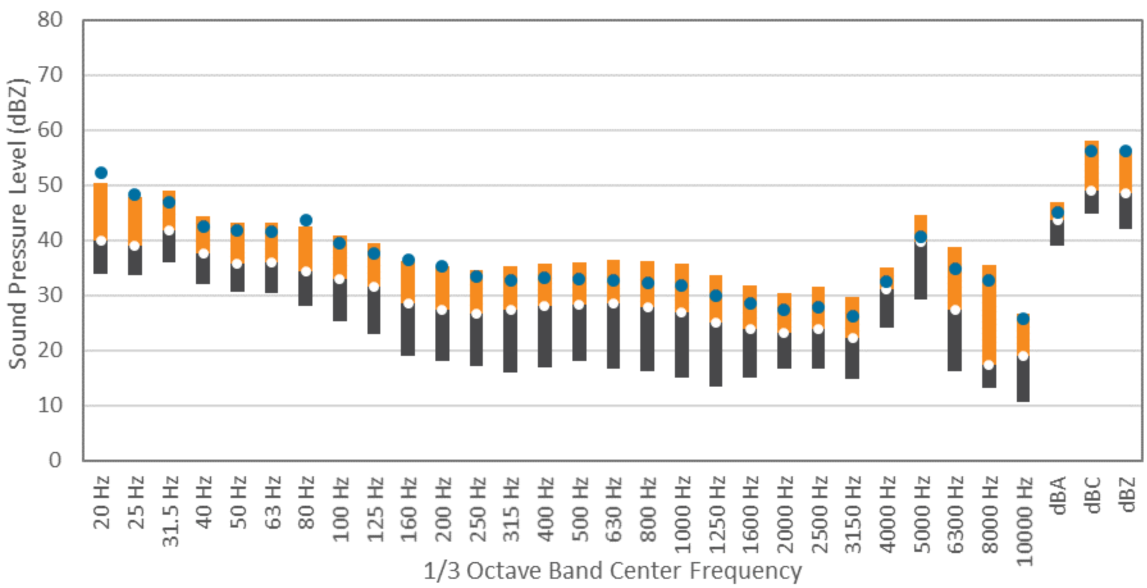

FIGURE 29: 1/3 OCTAVE BAND AND OVERALL STATISTICAL SOUND LEVELS AT THE NORTHWEST OFFSITE MONITOR (FOR PERIODS WITH 10 m/s WIND SPEED AT 105-METER (345-FOOT) HEIGHT)

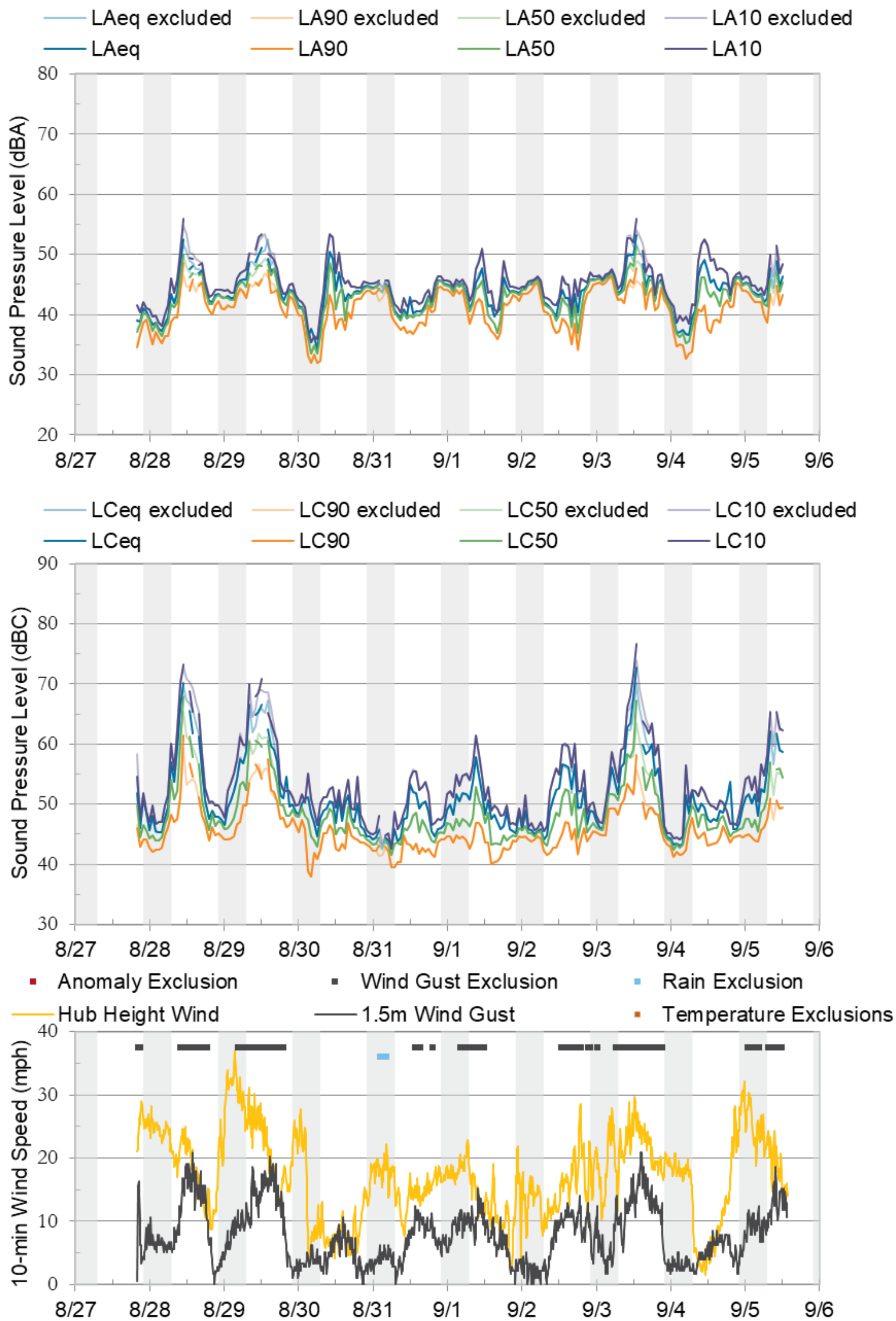

FIGURE 30: PRE-CONSTRUCTION MONITORING RESULTS AT THE NORTHWEST OFFSITE MONITOR

Southeast Offsite Monitor

The Southeast Offsite Monitor was in the yard of a residence surrounded by trees. Due to the sheltered nature of the site, there were very few windy periods to exclude from this location. Sound at this location was driven by biogenic sound, including a dog at the residence barking occasionally. Other sources included occasional car passes, aircraft overflight, and stationary mechanical equipment, likely HVAC, at the residence periodically cycling on and off. The nighttime L_{50} at this location was 46 dBA, 4 dB greater than the average onsite nighttime L_{50}.

Statistical spectral levels for a representative wind speed (10 m/s) at a representative hub height (105 meters) are presented in Figure 31. The higher sound levels in the 4,000 and 5,000 Hz bands are due to biogenic sounds. Time-history monitoring results for the Southeast Offsite Monitor are provided Figure 32.

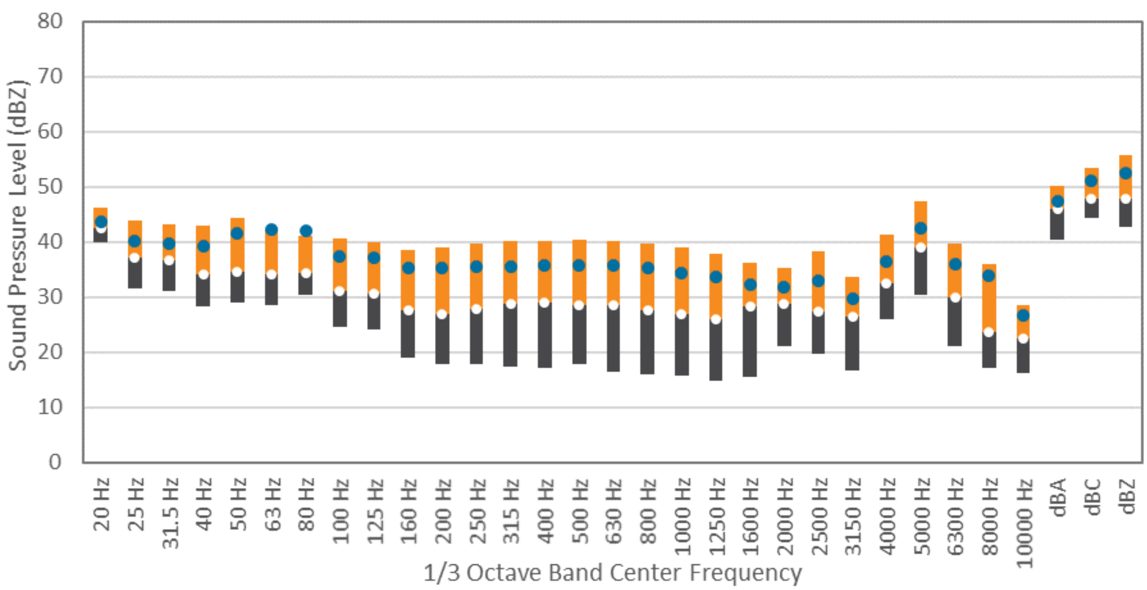

FIGURE 31: 1/3 OCTAVE BAND AND OVERALL STATISTICAL SOUND LEVELS AT THE SOUTHEAST OFFSITE MONITOR (FOR PERIODS WITH 10 M/S WIND SPEED AT 105-METER (345-FOOT) HEIGHT)

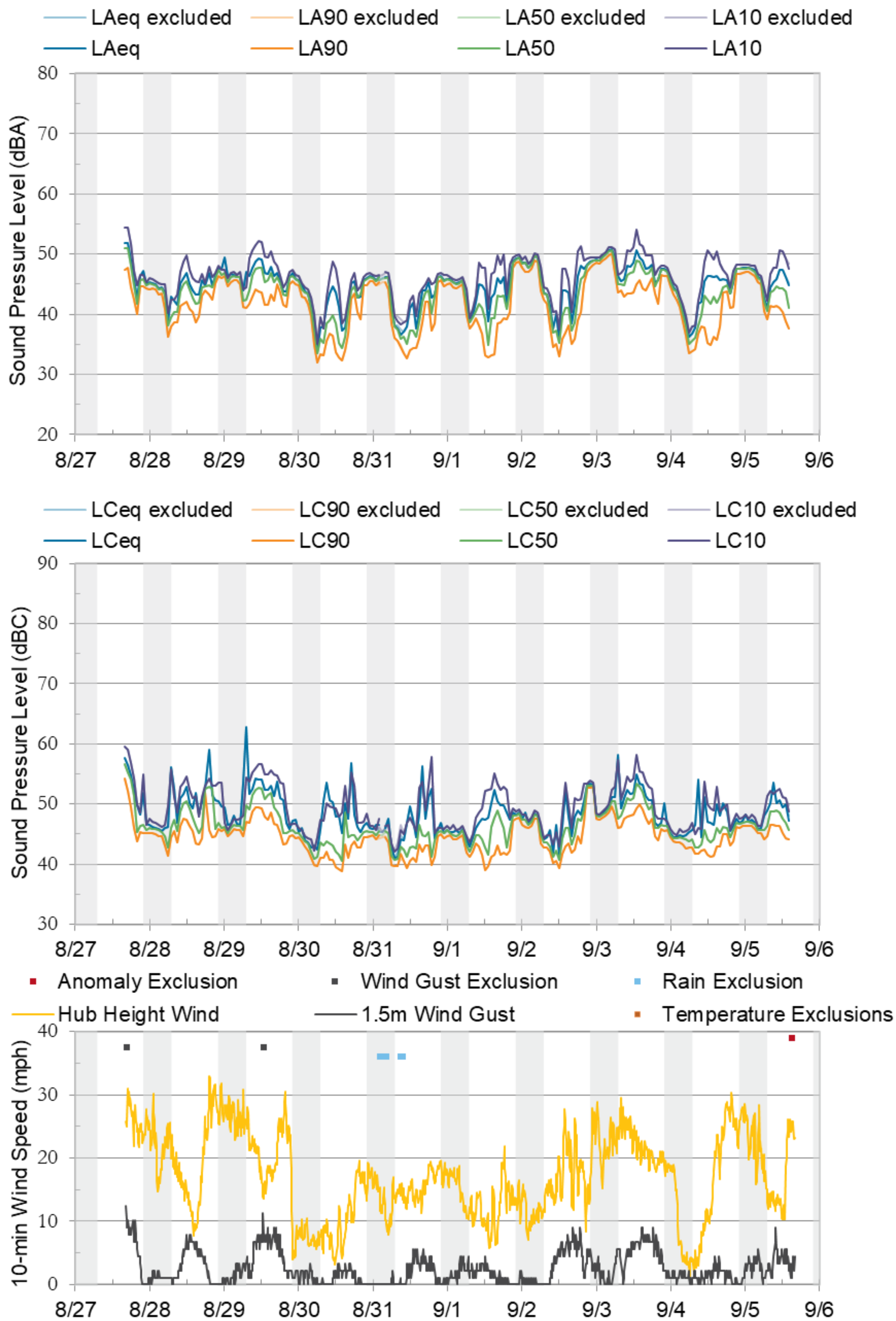

FIGURE 32: PRE-CONSTRUCTION MONITORING RESULTS AT THE OFFSITE SOUTHEAST MONITOR

6.0 SOUND PROPAGATION MODELING

6.1 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 also 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 B including the modeled sound power spectra for each turbine model. The Vestas V162 turbines incorporate mitigation in the form of Serrated Trailing Edges or STE. In addition, two of the V162s (T-36 & T-37) use Noise Reduced Operations (NRO). The sound power levels used in the model and detailed in Appendix B include STE and NRO on the turbines for which it applies. The transformer at each substation was also included in the model, and the modeled sound power level of each transformer is listed in Appendix B.

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 monitored L_{50} levels.[17] A 2-dB uncertainty factor was added to the turbine sound power per typical manufacturer warranty confidence interval specifications.

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[17] 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 $L_{EQ(1-}$

Two distinct receiver heights are included in the analysis; different receiver heights result in different sound levels as a result of source proximity and relative exposure. Residences are modeled as discrete receivers at 4 meters (13 feet) above ground level. A total of 461 residences were modeled throughout and around the Project area. The grid, represented in the results maps by sound pressure level contours, is calculated at a height of 1.5 meters (5 feet), to represent one's average listening height when standing outside. The sound pressure level contours represent turbine-only sound levels.

A search distance up to 10,000 meters (6.2 miles) allows for the contributions of distant turbines to be considered at receivers. The contribution of distant turbines will depend on the geometry and geography of the Project.

6.2 MODELING RESULTS

Overall A-weighted Model Results

A summary of the sound propagation model results is presented in Table 9. For each turbine model, results are presented as turbine-only sound levels from the sound propagation model, and total sound levels, which is a calculation summing (logarithmically)[18] the modeled turbine-only sound levels to the average monitored nighttime background L_{50} across all monitor locations. The highest modeled turbine-only sound level (L_{50}) at a non-participating residence is 41 dBA for the V162, and the average sound level (L_{50}) across all non-participating residences is 26 to 27 dBA depending on which turbine model is selected. The highest modeled turbine-only sound level at a participating residence is 47 dBA for the V162, and the average sound level (L_{50}) across all participating residences is 33 to 35 dBA depending on which turbine model is selected. For all turbine models, when added with the average monitored nighttime background L_{50} across all monitor locations, 42 dBA in Table 6, the total sound level is less than 50 dBA.

Maps of model results for each turbine model are shown in Figure 33 and 34. Results are presented as contour lines representing 5-dB increments of calculated A-weighted sound pressure levels. Appendix C provides a list of the calculated sound pressure levels at each receiver in tabular format and a map showing all receiver identification numbers for reference in the appendix table.

hr). In this case, the state limit utilizes an L_{50} metric instead of maximum $L_{EQ(1\text{-}hr)}$, which means a ground factor of G=0.7 can be used.

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

TABLE 9: MODEL RESULTS SUMMARY (dBA)

TURBINE MODEL	NOISE SOURCE	STATISTICAL L_{50} METRIC	RESIDENCE CLASSIFICATION		
			All Residences	Participating Residences	Non-Participating Residences
V162	Turbine-Only Noise	Avg	28	33	26
		Max	47	47	40
		Min	1	8	1
	Total Sound (Background + Turbine)	Avg	42	43	42
		Max	48	48	44
		Min	42	42	42
SG170	Turbine-Only Noise	Avg	30	35	27
		Max	46	46	41
		Min	11	17	11
	Total Sound (Background + Turbine)	Avg	42	43	42
		Max	47	47	45
		Min	42	42	42

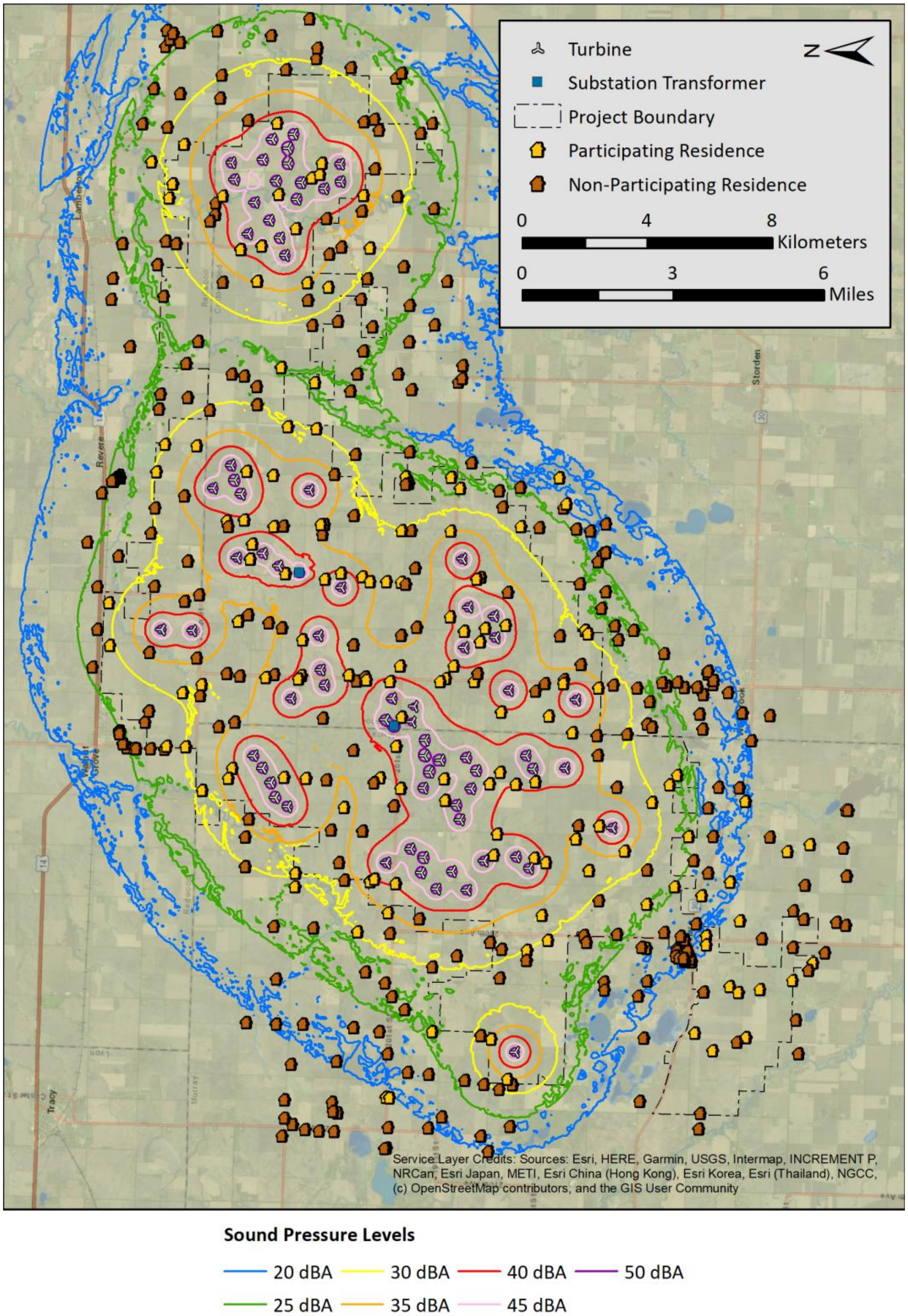

FIGURE 33: SOUND PROPAGATION MODEL RESULTS (TURBINE-ONLY SOUND LEVEL) – VESTAS V162

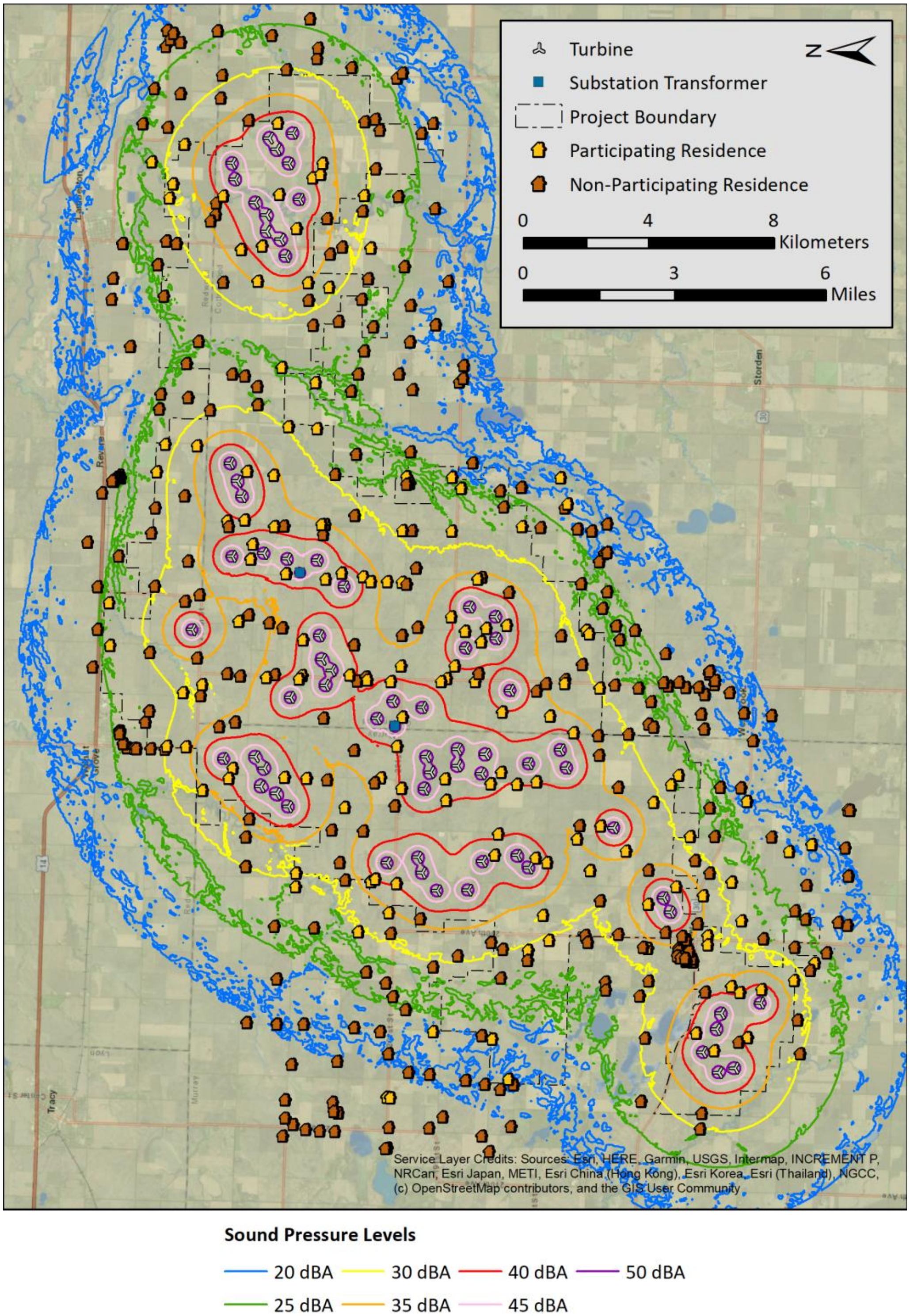

FIGURE 34: SOUND PROPAGATION MODEL RESULTS (TURBINE-ONLY SOUND LEVEL) – SIEMENS GAMESA SG170

Model Results Added to Background

To assess compliance with state noise regulations, the model results must be summed with the monitored nighttime results to determine the projected cumulative sound level that could occur when the Project is operating. An analysis of this is presented in Table 10 for each monitor location. As shown in the table, the model results summed with the overall nighttime for each background monitor location are less than 50 dBA.

TABLE 10: MODEL RESULTS (dBA) SUMMED WITH MONITORED BACKGROUND SOUND LEVELS (L_{50}, dBA)

SCENARIO	METRIC	MONITOR LOCATION				
		Monitor 1	Monitor 2	Monitor 3	Monitor 4	Monitor 5
Background Monitor Results	Overall Nighttime	39	46	39	43	43
	Maximum 1-hr Nighttime	46	51	50	61[19]	50
	Minimum 1-hr Nighttime	31	37	31	30	30
V162	Modeled Sound Level	28	39	24	44	43
	Summed with Overall Nighttime	39	47	39	47	46
SG170	Modeled Sound Level	27	41	40	42	40
	Summed with Overall Nighttime	39	47	43	46	45

The background sound level does and will vary from hour to hour, as shown in the monitor results in Section 5.3. The average overall nighttime L_{50} across all monitor sites was 42 dBA (see Table 6), but there were some nighttime hours during the monitoring period when the L_{50} was above 45 dBA and as high as 61 dBA[19]. Thus, in Appendix C, the model results are summed with a range of potential background values ranging from 35 dBA to 50 dBA in 5 dB increments.

[19] The 61 dBA nighttime L50 was due to a social event/celebration occurring at the property where the monitoring was taking place.

7.0 CONCLUSIONS

Plum Creek Wind Farm is a proposed wind power generation facility in Cottonwood, Murray, and Redwood Counties. The Project will include up to 74 turbines for a project rating of up to 414 MW. For the SPA, RSG performed a preliminary noise compliance assessment of the Project based on the preliminary turbine layout and turbine models under consideration. This noise compliance assessment is an updated version of the preliminary noise compliance assessment with the most recent project information.

Conclusions of the assessment are as follows:

1. Background sound levels vary around the Project site during the day and night. The overall nighttime L_{50} across the Project area ranged from 39 dBA at Monitors 1 and 3 to 46 dBA at Monitor 2. The average overall nighttime L_{50} across the site was 42 dBA. During the day, the overall L50 across the Project area ranged from 37 at Monitor 3 to 45 at Monitor 2 with an average overall daytime L_{50} of 41 dBA.
2. Minimum 1-hour nighttime L_{50}s were between 30 and 37 dBA across the Project area, while maximum 1-hour nighttime L_{50}s were between 46 and 61 dBA.
3. Elevated background sound levels at night were due primarily to biogenic sources such as insect sounds. When weighted to exclude insect sounds as discussed in Section 5.3, nighttime sound levels (L_{50}) are generally at least 10 dB lower.
4. 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.
5. Sound propagation modeling was performed in accordance with ISO 9613-2 at a total of 461 discrete receivers with spectral ground attenuation and a ground factor of G=0.7. These modeling parameters are meant to represent the L_{50} of the proposed facility.
6. Modeling was completed for two turbine models and two potential layouts. The V162 with a hub height of 125 meters was modeled with a layout of 74 turbines. The SG170, with a hub height of 115 meters was modeled with a 67 turbine layout.
7. Projected turbine-only sound levels from the Project are less than 50 dBA at all residences with the highest projected sound level (L_{50}) at a non-participating residence of 41 dBA. The average turbine-only sound level (L_{50}) across all modeled residences is 28 to 30 dBA depending on which turbine model is selected.
8. When added to the average overall nighttime L_{50} across the monitored sites, sound levels remain below 50 dBA, but the background L_{50} does and will vary from hour to hour, as shown in the monitor results.

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”).[20] 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 35.

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.

[20] 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 35: 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.[21] 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 36. 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

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[21] 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 36, 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.

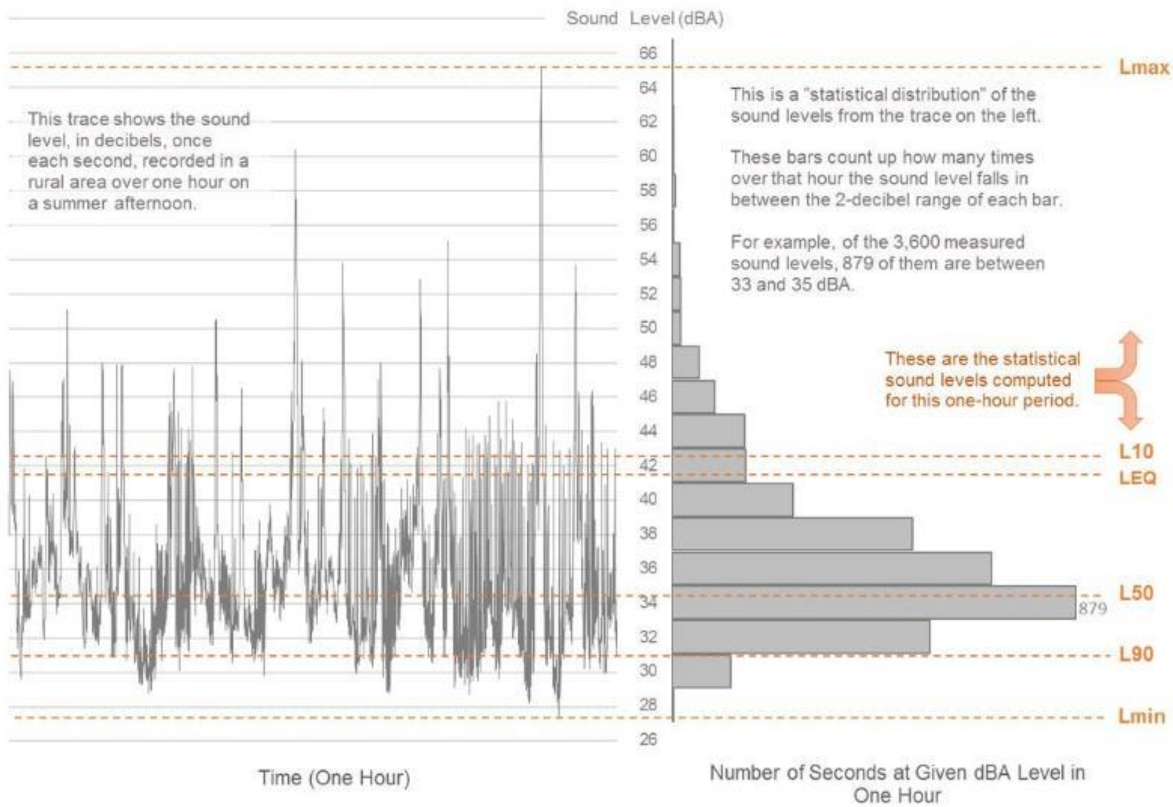

FIGURE 36: EXAMPLE OF DESCRIPTIVE TERMS OF SOUND MEASUREMENT OVER TIME

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. MODEL INPUT DATA

TABLE 11: SOUND PROPAGATION MODELING PARAMETERS

PARAMETER	SETTING
Ground Absorption	Spectral for all sources, Mixed Ground (G=0.7)
Atmospheric Attenuation	Based on 10 Degrees Celsius, 70% Relative Humidity
Reflections	None
Receiver Height	4 meters for residences, 1.5 meters for grid
Search Distance	10,000 meters

TABLE 12: TURBINE HUB HEIGHT AND 1/1 OCTAVE BAND MODELED SOURCE SPECTRA (dBZ UNLESS OTHERWISE INDICATED)

SOUND SOURCE	MODE	HUB HEIGHT	1/1 OCTAVE BAND CENTER FREQUENCY (HZ)									SUM (dBA)	SUM (dBZ)
			31.5	*63*	*125*	*250*	*500*	*1000*	*2000*	*4000*	*8000*		
Siemens Gamesa SG170	None	115 m	112	112	109	104	99	99	98	94	84	104.7	116.6
Vestas V162 STE	None	125 m	112	110	108	106	103	98	93	86	77	104.0	116.1
	NRO SO2[22]		110	108	106	104	101	96	91	84	75	102.0	114.3
Sub Transformer	ONAF[23]	NA	96	95	107	106	105	98	93	88	81	105.1	111.4

TABLE 13: MODELED TURBINE SOUND POWER LEVELS & LOCATIONS[24]

TURBINE ID	TURBINE/SOURCE	MODE	MODELED SOUND POWER LEVEL (dBA)	SOURCE HEIGHT (m)	COORDINATES (UTM NAD 83 Z15N)	
					X (m)	Y (m)
1	SG170		108	115	294265	4878606
2	SG170		108	115	292185	4879422
3	SG170		108	115	293937	4879860
4	SG170		108	115	292045	4879941
5	SG170		108	115	293425	4879999
6	SG170		108	115	292697	4880441

[22] SO2 is a Noise Reduced Operation mode.
[23] Transformer cooling fans operating represents worst-case sound emissions.
[24] Maps showing the locations of the turbines by Turbine ID are provided after this Table.

TURBINE ID	TURBINE/SOURCE	MODE	MODELED SOUND POWER LEVEL (dBA)	SOURCE HEIGHT (m)	COORDINATES (UTM NAD 83 Z15N) X (m)	Y (m)
7	SG170		108	115	297170	4881469
8	SG170		108	115	297637	4881702
9	SG170		108	115	299874	4883282
10	SG170		108	115	301790	4884796
11	SG170		108	115	302373	4884995
12	SG170		108	115	298590	4886004
13	SG170		108	115	301925	4886010
14	SG170		108	115	298984	4886379
15	SG170		108	115	304268	4886603
16	SG170		108	115	305931	4887046
17	SG170		108	115	306633	4887062
18	SG170		108	115	302231	4887391
19	SG170		108	115	298790	4887485
20	SG170		108	115	301600	4887512
23	SG170		108	115	306941	4887892
24	SG170		108	115	297883	4887951
25	SG170		108	115	305628	4888022
28	SG170		108	115	302397	4888279
29	SG170		108	115	301862	4888285
31	SG170		108	115	297865	4888943
32	SG170		108	115	301658	4889156
33	SG170		108	115	302154	4889283
34	SG170		108	115	301113	4889348
35	SG170		108	115	303723	4889412
36	SG170		108	115	298430	4889416
37	SG170		108	115	298928	4889546
38	SG170		108	115	303926	4890332
39	SG170		108	115	298751	4890535
40	SG170		108	115	303367	4890855
41	SG170		108	115	307598	4891913
44	SG170		108	115	304918	4892309
45	SG170		108	115	304432	4892501
46	SG170		108	115	305270	4892621
47	SG170		108	115	306028	4892693
48	SG170		108	115	308432	4892765

TURBINE ID	TURBINE/SOURCE	MODE	MODELED SOUND POWER LEVEL (dBA)	SOURCE HEIGHT (m)	COORDINATES (UTM NAD 83 Z15N) X (m)	Y (m)
49	SG170		108	115	319987	4893345
50	SG170		108	115	322109	4893549
51	SG170		108	115	304044	4893632
52	SG170		108	115	321133	4893673
53	SG170		108	115	300548	4893695
54	SG170		108	115	308477	4893730
55	SG170		108	115	318161	4893779
56	SG170		108	115	318710	4893928
57	SG170		108	115	321587	4894058
58	SG170		108	115	300960	4894061
60	SG170		108	115	321956	4894297
61	SG170		108	115	318964	4894380
62	SG170		108	115	319485	4894387
63	SG170		108	115	301789	4894460
64	SG170		108	115	308661	4894478
66	SG170		108	115	301197	4894576
67	SG170		108	115	319890	4894746
68	SG170		108	115	302152	4894754
69	SG170		108	115	310471	4895165
70	SG170		108	115	310974	4895314
71	SG170		108	115	320619	4895389
72	SG170		108	115	321153	4895493
73	SG170		108	115	308557	4895498
74	SG170		108	115	311541	4895547
75	SG170		108	115	302089	4895761
77	SG170		108	115	306214	4896768
7	V162 STE		106.1	125	299874.8	4883282
8	V162 STE		106.1	125	303966.6	4884442
9	V162 STE		106.1	125	301787.6	4884796
10	V162 STE		106.1	125	302188.4	4886054
11	V162 STE		106.1	125	301755.9	4885826
12	V162 STE		106.1	125	298570.8	4885956
13	V162 STE		106.1	125	298940.5	4886364
14	V162 STE		106.1	125	292699	4886411
15	V162 STE		106.1	125	304269.4	4886600

TURBINE ID	TURBINE/SOURCE	MODE	MODELED SOUND POWER LEVEL (dBA)	SOURCE HEIGHT (m)	COORDINATES (UTM NAD 83 Z15N)	
					X (m)	Y (m)
16	V162 STE		106.1	125	305962.6	4887034
17	V162 STE		106.1	125	298811.6	4887402
18	V162 STE		106.1	125	306931.7	4887899
19	V162 STE		106.1	125	306644.6	4887073
20	V162 STE		106.1	125	301697.7	4887635
21	V162 STE		106.1	125	301118	4887810
22	V162 STE		106.1	125	302122.8	4887963
23	V162 STE		106.1	125	297882.5	4887951
24	V162 STE		106.1	125	305631.2	4888023
25	V162 STE		106.1	125	308471.4	4888091
26	V162 STE		106.1	125	300603.7	4888284
27	V162 STE		106.1	125	298477.7	4888421
28	V162 STE		106.1	125	302044.6	4888801
29	V162 STE		106.1	125	297917.7	4888929
30	V162 STE		106.1	125	301657.8	4889155
31	V162 STE		106.1	125	302685.4	4889295
32	V162 STE		106.1	125	302192.9	4889317
33	V162 STE		106.1	125	298928.6	4889330
34	V162 STE		106.1	125	301137.1	4889348
35	V162 STE		106.1	125	298429.8	4889416
36	V162 STE	SO2	104.1	125	303755.9	4889643
37	V162 STE	SO2	104.1	125	303255.3	4889712
38	V162 STE		106.1	125	299202.5	4889759
39	V162 STE		106.1	125	304015.3	4890343
40	V162 STE		106.1	125	298751	4890532
41	V162 STE		106.1	125	303329.3	4890562
42	V162 STE		106.1	125	307569.8	4891973
43	V162 STE		106.1	125	320544.1	4891990
44	V162 STE		106.1	125	321117.6	4892011
45	V162 STE		106.1	125	306024.2	4892697
46	V162 STE		106.1	125	304433.2	4892500
47	V162 STE		106.1	125	320323.9	4892526
48	V162 STE		106.1	125	304933.7	4892630
49	V162 STE		106.1	125	310680.4	4892993
50	V162 STE		106.1	125	320525.8	4893255

TURBINE ID	TURBINE/SOURCE	MODE	MODELED SOUND POWER LEVEL (dBA)	SOURCE HEIGHT (m)	COORDINATES (UTM NAD 83 Z15N)	
					X (m)	Y (m)
51	V162 STE		106.1	125	319988.5	4893400
52	V162 STE		106.1	125	322082.3	4893495
53	V162 STE		106.1	125	304008.1	4893576
54	V162 STE		106.1	125	321134.2	4893674
55	V162 STE		106.1	125	321626.8	4893682
56	V162 STE		106.1	125	300548.9	4893692
57	V162 STE		106.1	125	318189.3	4893775
58	V162 STE		106.1	125	318746.2	4893941
59	V162 STE		106.1	125	308249	4893974
60	V162 STE		106.1	125	300842.7	4894091
61	V162 STE		106.1	125	320570.5	4894059
62	V162 STE		106.1	125	321910.6	4894192
63	V162 STE		106.1	125	301310.4	4894232
64	V162 STE		106.1	125	319321.2	4894272
65	V162 STE		106.1	125	321249.7	4894485
66	V162 STE		106.1	125	308657	4894477
67	V162 STE		106.1	125	301789.2	4894495
68	V162 STE		106.1	125	319889.6	4894746
69	V162 STE		106.1	125	302187.7	4894781
70	V162 STE		106.1	125	318882.1	4894958
71	V162 STE		106.1	125	320618.9	4895388
72	V162 STE		106.1	125	310555.7	4895181
73	V162 STE		106.1	125	308518.3	4895309
74	V162 STE		106.1	125	310995	4895399
75	V162 STE		106.1	125	321163.6	4895492
76	V162 STE		106.1	125	311479.5	4895505
77	V162 STE		106.1	125	310737.3	4896080
78	V162 STE		106.1	125	306183.2	4896745
79	V162 STE		106.1	125	306219.7	4897736
80	V162 STE		106.1	125	300133.5	4888168
Trans	Transformer	ONAF	105.1	2.75	303112.9	4890265
Trans	Transformer	ONAF	105.1	2.75	308032.2	4893302

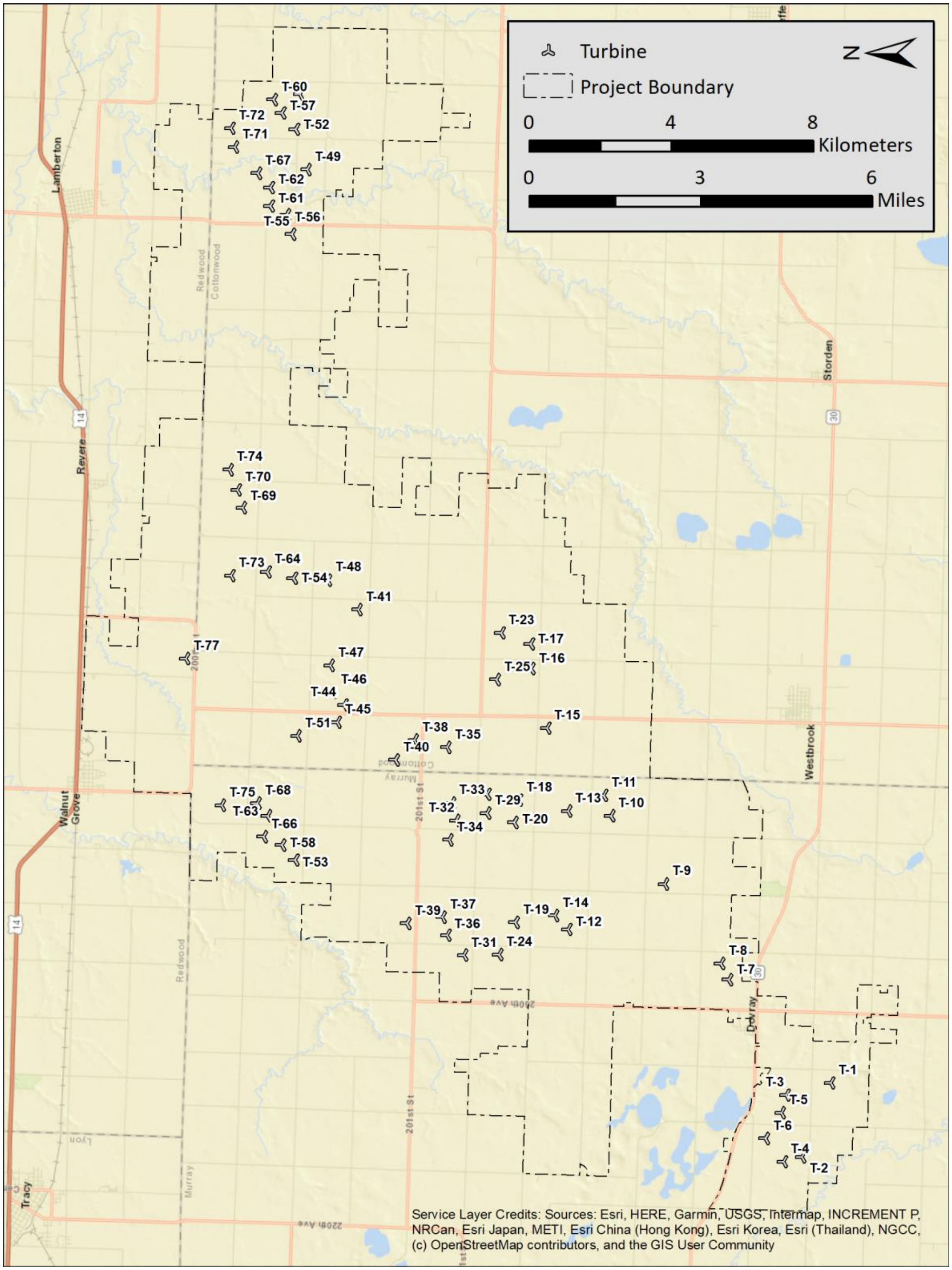

FIGURE 37: MAP OF MODELED TURBINE LOCATIONS BY TURBINE ID FOR THE SG170 LAYOUT

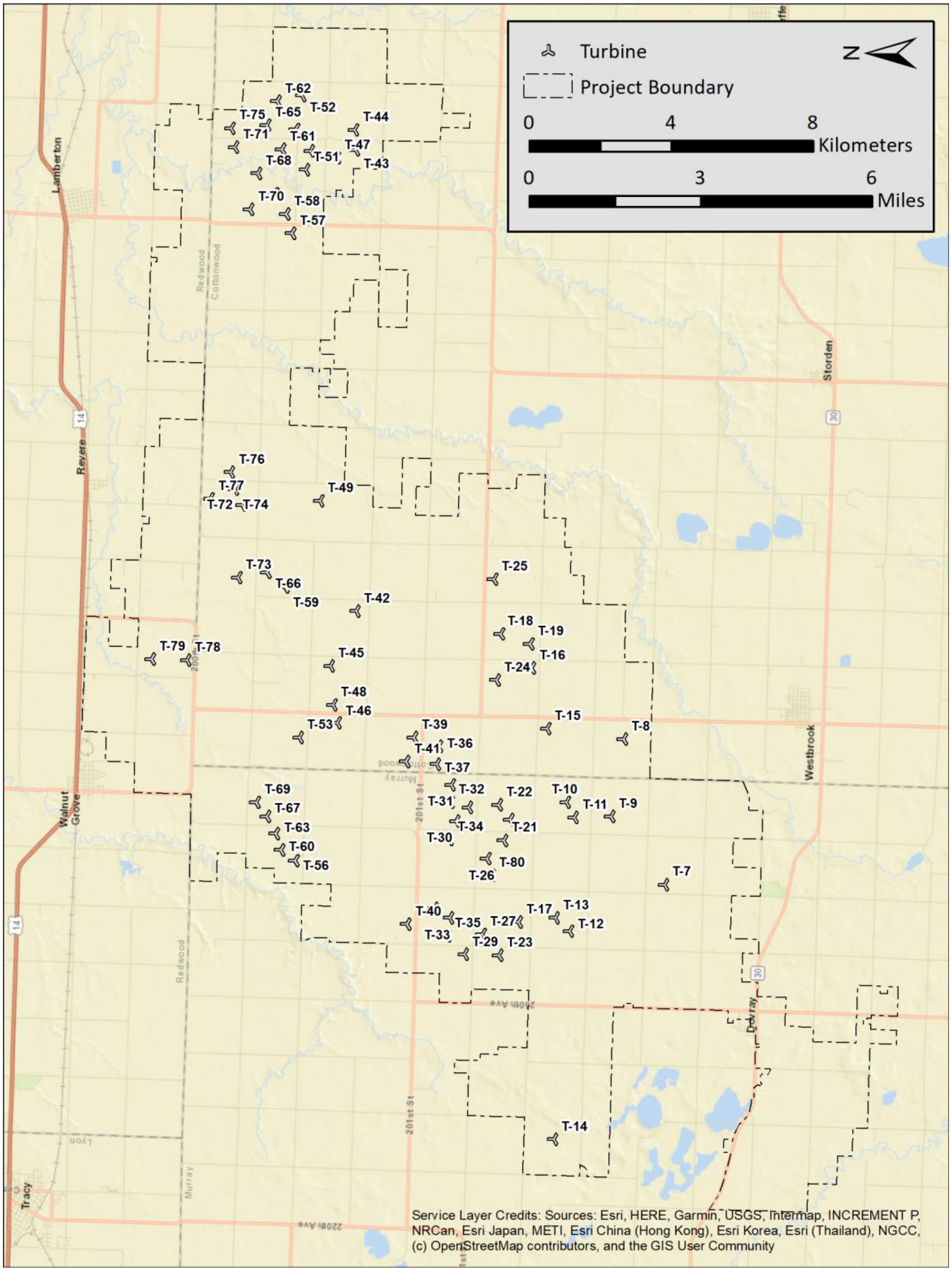

FIGURE 38: MAP OF MODELED TURBINE LOCATIONS BY TURBINE ID FOR THE V162 LAYOUT

APPENDIX C. RECEIVER INFORMATION

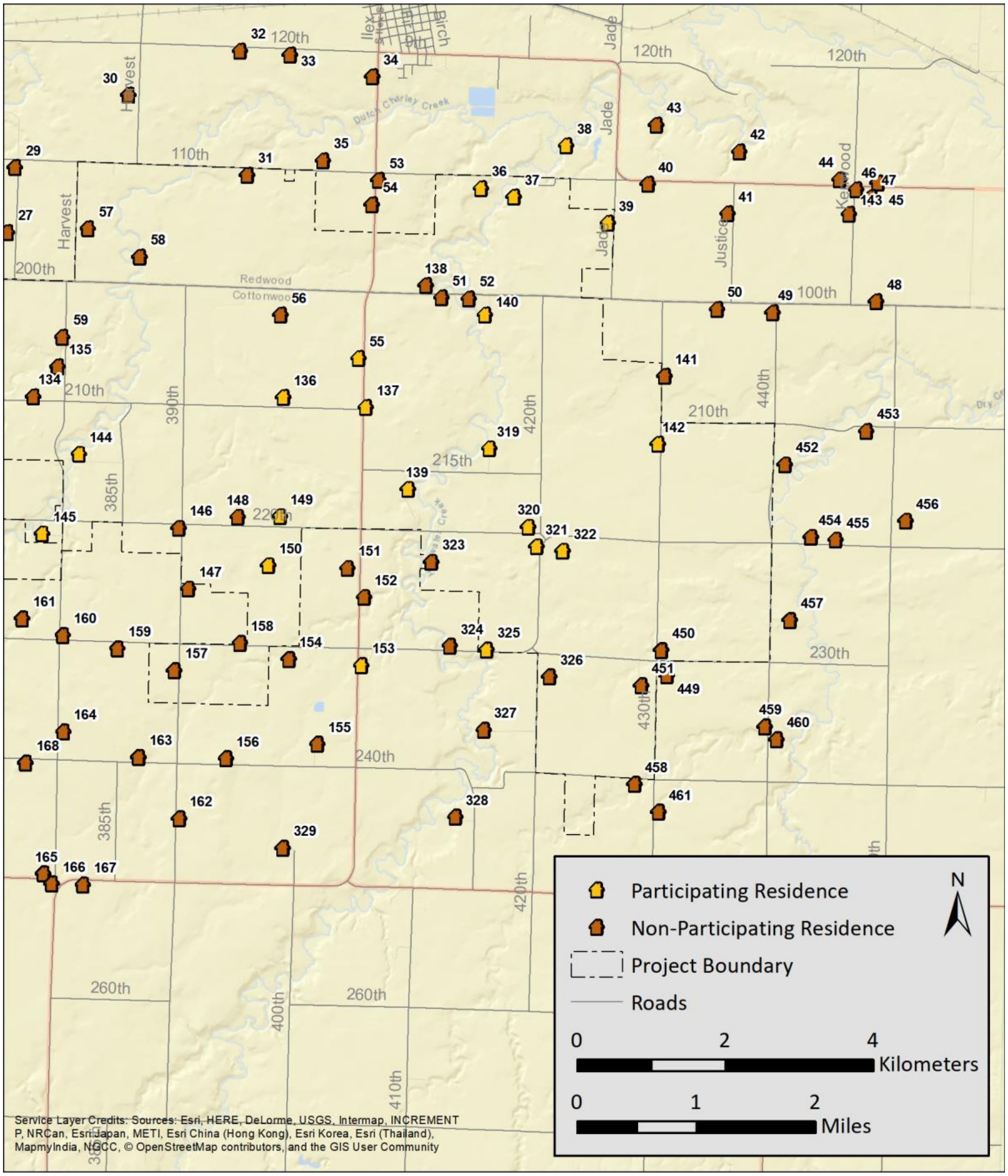

FIGURE 39: MAP OF MODELED RECEIVERS - NORTHEAST AREA

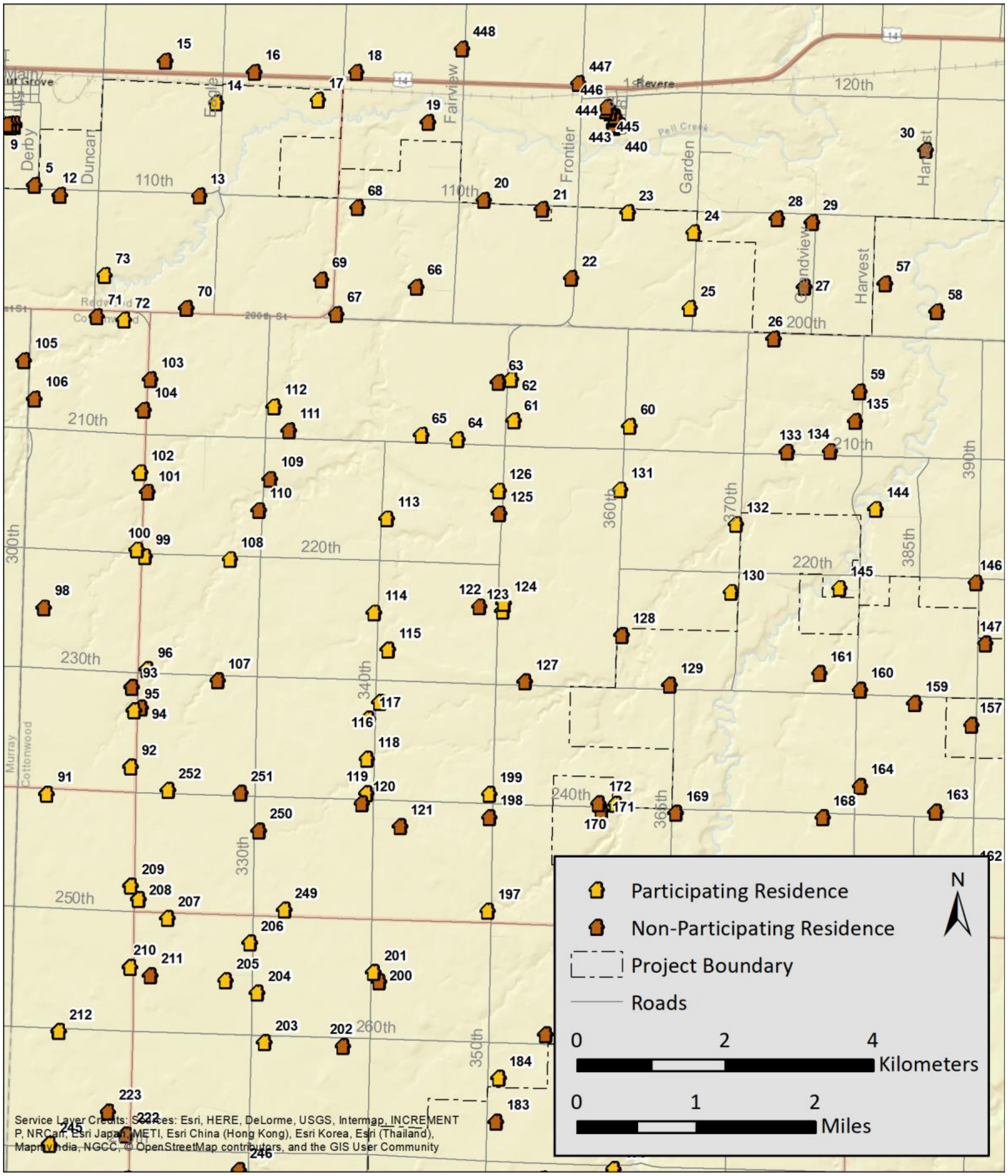

FIGURE 40: MAP OF MODELED RECEIVERS - NORTH-CENTRAL AREA

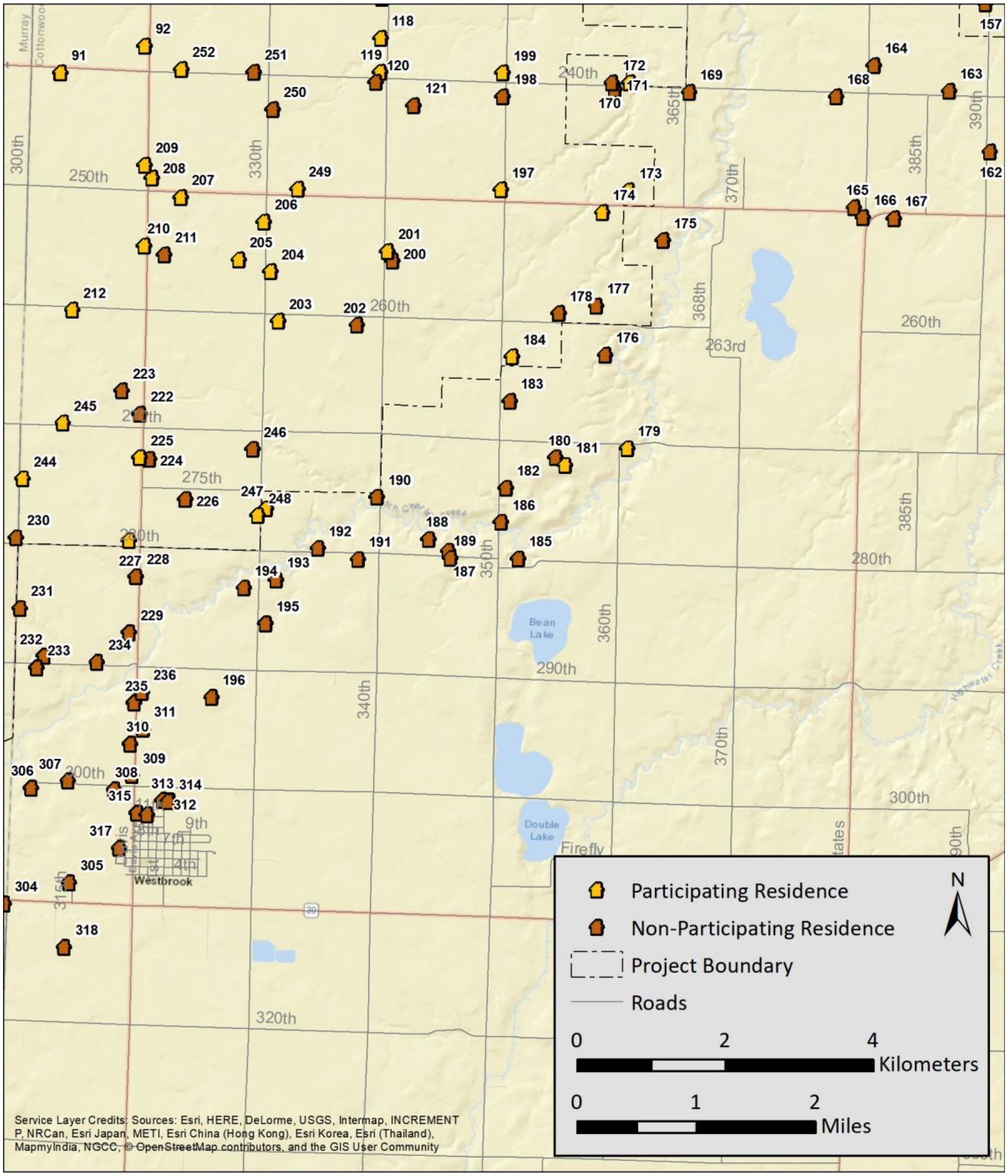

FIGURE 41: MAP OF MODELED RECEIVERS - SOUTH-CENTRAL AREA

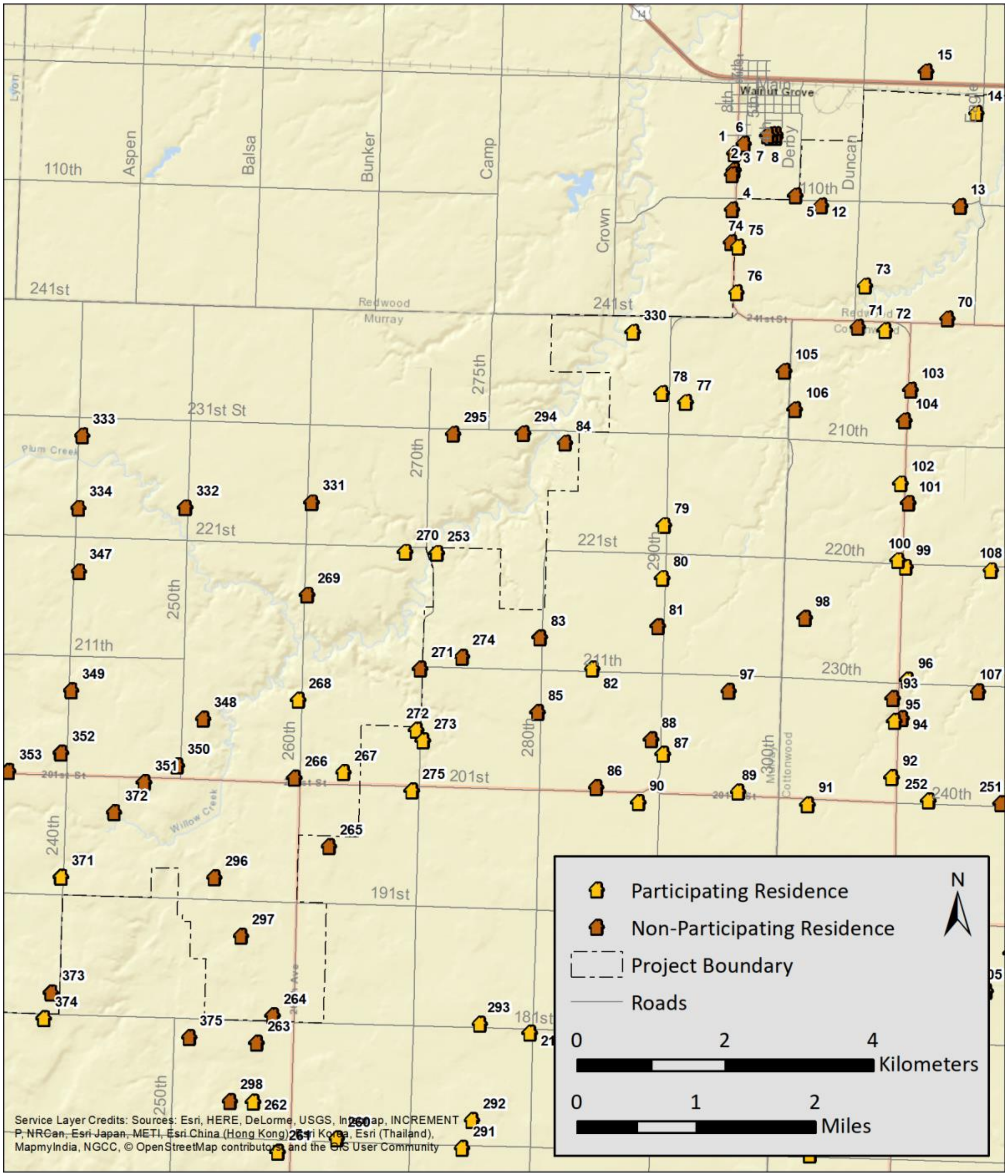

FIGURE 42: MAP OF MODELED RECEIVERS - NORTHWEST AREA

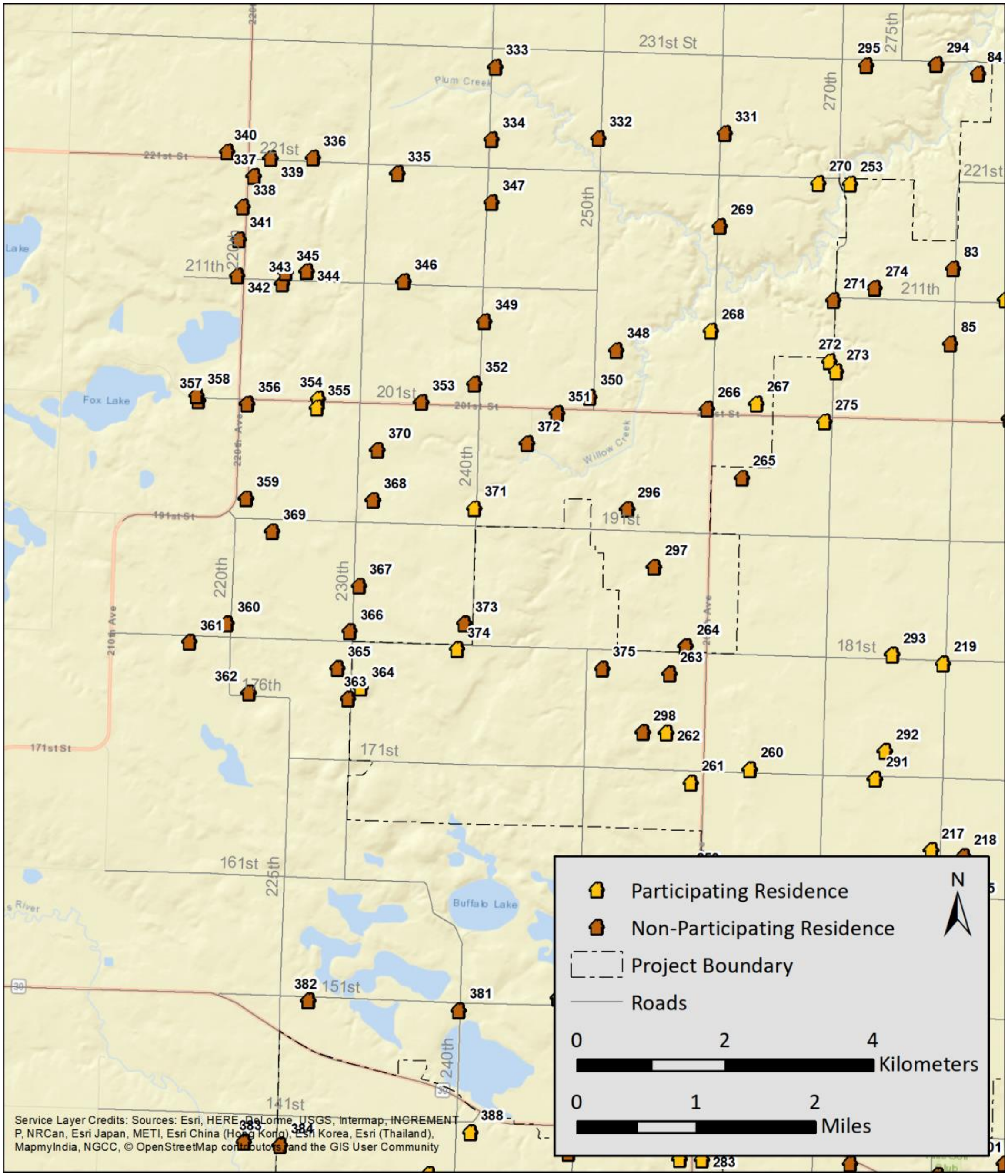

FIGURE 43: MAP OF MODELED RECEIVERS - WESTERN AREA

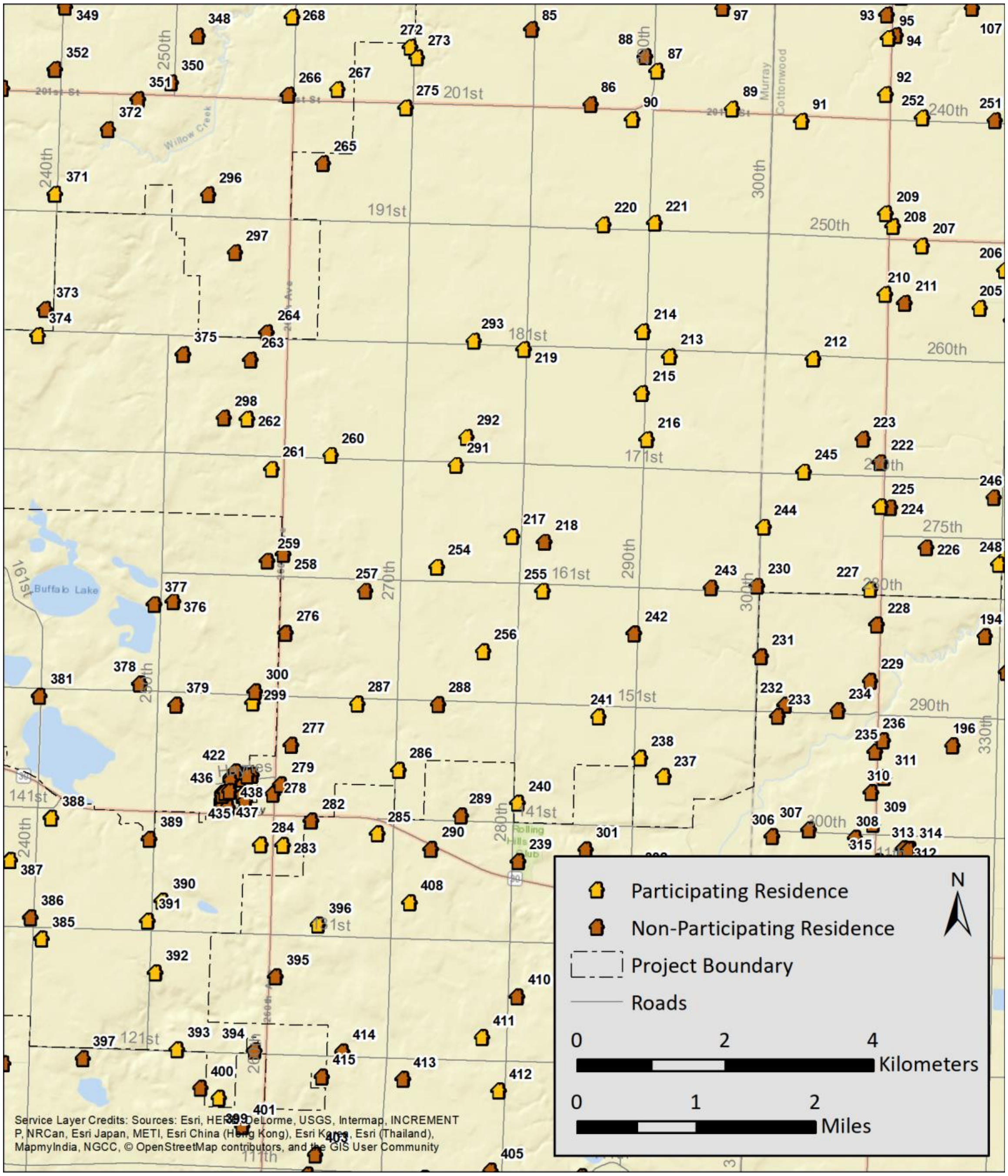

FIGURE 44: MAP OF MODELED RECEIVERS - SOUTHWEST-CENTRAL AREA

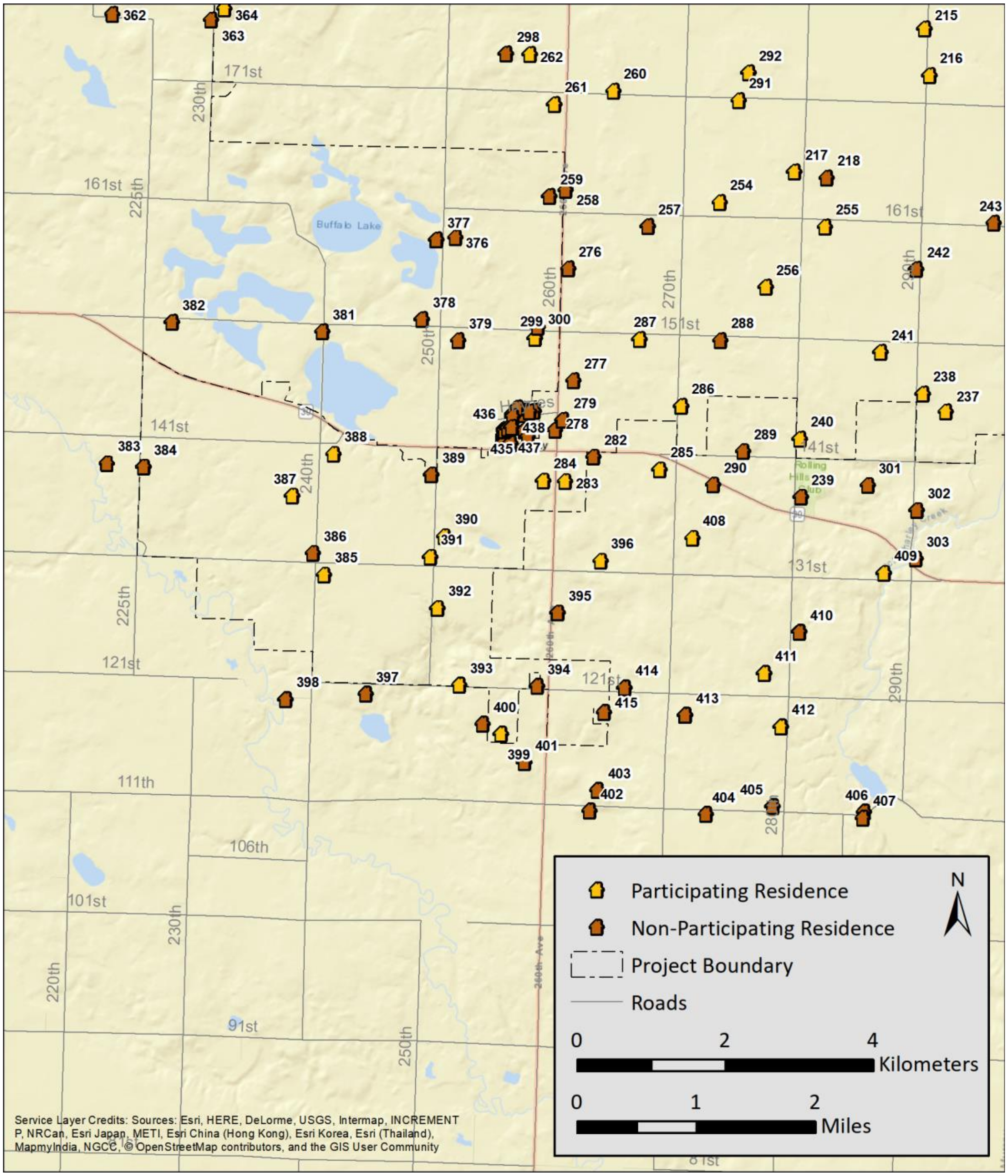

FIGURE 45: MAP OF MODELED RECEIVERS - SOUTHWEST AREA

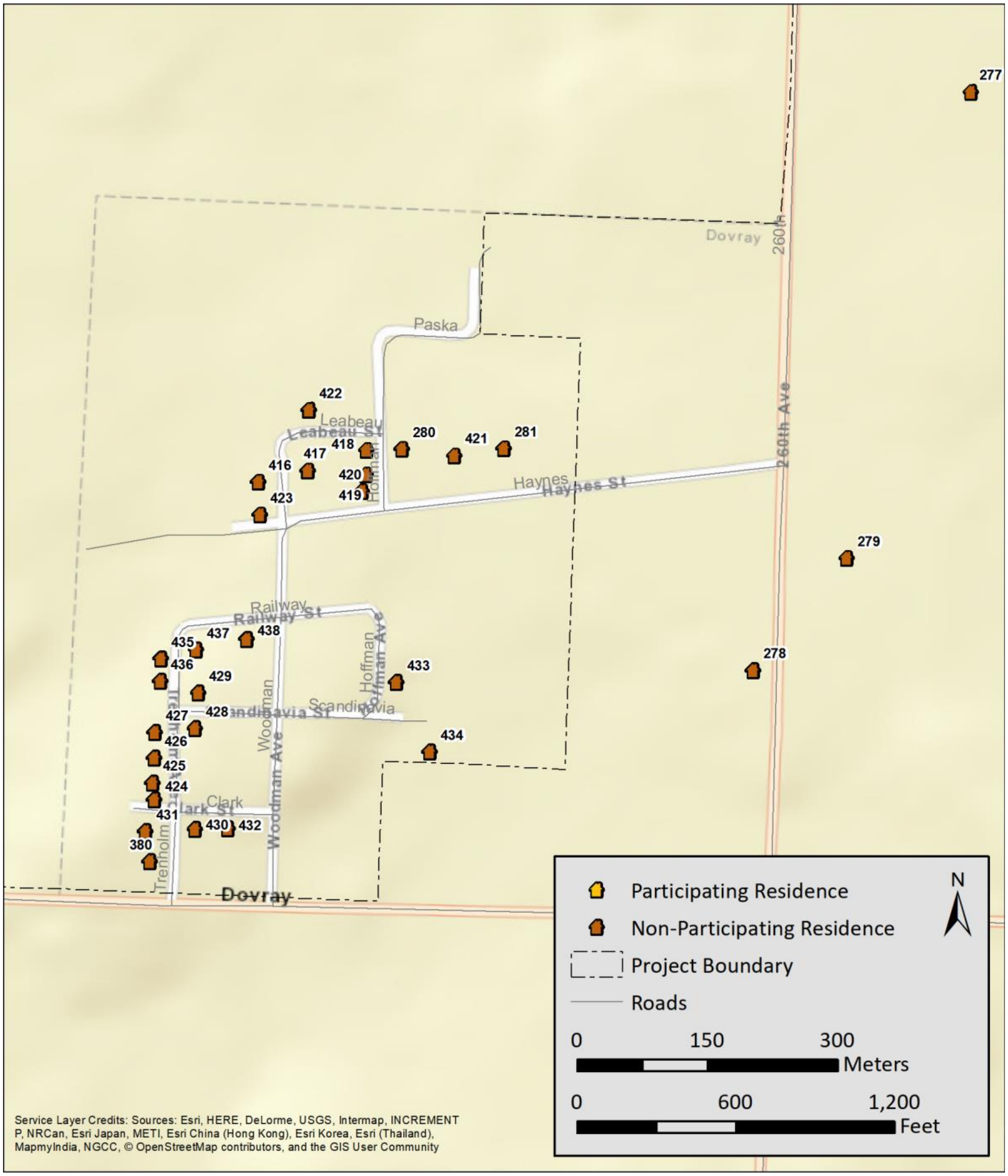

FIGURE 46: MAP OF MODELED RECEIVERS – DOVRAY

TABLE 14: MODELED RECEIVER COORDINATES

RECEIVER ID	COORDINATES (UTM NAD 83 Z15N) X(m)	COORDINATES (UTM NAD 83 Z15N) Y (m)	ELEVATION + RECEIVER HEIGHT (m)
1	302440	4898831	381
2	302434	4898600	382
3	302410	4898539	383
4	302410	4898068	387
5	303263	4898256	382
6	302569	4898952	379
7	302991	4899049	376
8	302935	4899048	376
9	302993	4899080	376
10	302938	4899080	376
11	302889	4899071	376
12	303607	4898119	383
13	305486	4898110	370
14	305709	4899371	362
15	305029	4899934	363
16	306229	4899784	360
17	307085	4899404	359
18	307602	4899778	359
19	308573	4899106	355
20	309321	4898056	362
21	310114	4897936	365
22	310503	4896999	367
23	311268	4897890	364
24	312160	4897614	362
25	312103	4896593	365
26	313241	4896184	365
27	313653	4896880	360
28	313286	4897805	359
29	313755	4897756	355
30	315290	4898733	355
31	316889	4897657	352
32	316794	4899329	352
33	317467	4899274	356
34	318580	4898982	350
35	317909	4897852	352
36	320044	4897476	348
37	320488	4897361	350
38	321192	4898051	347
39	321755	4897005	352
40	322294	4897529	350
41	323375	4897131	351
42	323532	4897971	347
43	322408	4898331	342
44	324880	4897592	348
45	325401	4897546	347
46	325107	4897456	346
47	325309	4897354	348
48	325381	4895945	351
49	323979	4895800	353
50	323227	4895846	354
51	319512	4895997	350
52	319882	4895985	352
53	318665	4897583	354
54	318571	4897256	354
55	318392	4895181	358
56	317339	4895765	355
57	314740	4896929	357
58	315441	4896547	355
59	314397	4895470	364
60	311292	4895001	375
61	309727	4895074	375
62	309691	4895631	375
63	309516	4895594	374
64	308968	4894821	380
65	308479	4894880	379
66	308415	4896879	371
67	307332	4896515	375

RECEIVER ID	COORDINATES (UTM NAD 83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
	X(m)	Y (m)	
68	307616	4897952	366
69	307129	4896978	371
70	305314	4896593	380
71	304105	4896480	385
72	304473	4896440	383
73	304206	4897040	382
74	302391	4897623	390
75	302489	4897566	390
76	302467	4896951	391
77	301787	4895466	406
78	301465	4895588	408
79	301488	4893806	418
80	301469	4893094	423
81	301409	4892442	424
82	300524	4891872	430
83	299816	4892289	429
84	300155	4894922	407
85	299782	4891280	439
86	300578	4890267	437
87	301479	4890717	435
88	301316	4890916	433
89	302494	4890211	431
90	301148	4890065	438
91	303429	4890039	428
92	304563	4890401	424
93	304577	4891475	419
94	304698	4891201	419
95	304602	4891163	419
96	304777	4891721	417
97	302364	4891566	426
98	303389	4892554	417
99	304750	4893244	407
100	304645	4893333	407
101	304787	4894112	400
102	304688	4894375	398
103	304824	4895632	390
104	304736	4895223	393
105	303116	4895888	391
106	303259	4895373	394
107	305729	4891565	413
108	305898	4893203	398
109	306437	4894291	393
110	306286	4893869	394
111	306691	4894942	386
112	306493	4895268	382
113	308018	4893754	388
114	307842	4892489	395
115	308030	4891978	400
116	307920	4891279	405
117	307763	4891048	408
118	307749	4890507	411
119	307740	4890046	415
120	307680	4889909	417
121	308195	4889597	417
122	309261	4892567	392
123	309578	4892507	388
124	309591	4892613	388
125	309534	4893820	382
126	309523	4894130	380
127	309883	4891551	397
128	311188	4892176	381
129	311835	4891505	387
130	312659	4892764	376
131	311165	4894146	376
132	312724	4893680	374
133	313418	4894654	370
134	314000	4894665	371
135	314335	4895070	366
136	317374	4894651	357
137	318490	4894518	358

RECEIVER ID	COORDINATES (UTM NAD 83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
	X(m)	Y (m)	
138	319300	4896162	353
139	319057	4893415	360
140	320098	4895767	352
141	322522	4894937	355
142	322432	4894021	355
143	325012	4897124	348
144	314615	4893885	368
145	314125	4892813	374
146	315963	4892890	368
147	316091	4892068	374
148	316760	4893037	368
149	317329	4893046	367
150	317173	4892383	372
151	318240	4892349	369
152	318463	4891955	370
153	318428	4891036	372
154	317450	4891118	374
155	317839	4889972	379
156	316601	4889775	388
157	315906	4890969	378
158	316792	4891336	376
159	315139	4891258	380
160	314401	4891442	380
161	313855	4891664	382
162	315970	4888971	391
163	315422	4889795	383
164	314406	4890141	390
165	314138	4888222	397
166	314253	4888085	396
167	314675	4888072	396
168	313897	4889718	390
169	311913	4889779	392
170	311105	4889903	397
171	310907	4889813	401
172	310867	4889907	401

RECEIVER ID	COORDINATES (UTM NAD 83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
	X(m)	Y (m)	
173	311094	4888449	405
174	310737	4888155	409
175	311557	4887777	400
176	310774	4886232	417
177	310659	4886894	413
178	310154	4886791	415
179	311074	4884972	408
180	310109	4884845	425
181	310239	4884745	424
182	309440	4884436	425
183	309489	4885610	427
184	309523	4886206	423
185	309603	4883480	425
186	309375	4883975	412
187	308656	4883585	428
188	308396	4883744	428
189	308687	4883487	428
190	307699	4884311	427
191	307441	4883475	429
192	306902	4883620	428
193	306336	4883196	435
194	305898	4883087	433
195	306192	4882604	431
196	305466	4881612	441
197	309373	4888459	414
198	309397	4889720	408
199	309397	4890037	406
200	307908	4887500	427
201	307839	4887630	427
202	307426	4886633	432
203	306366	4886685	432
204	306265	4887354	432
205	305837	4887518	433
206	306171	4888030	432
207	305053	4888360	434

RECEIVER ID	COORDINATES (UTM NAD 83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
	X(m)	Y (m)	
208	304662	4888619	433
209	304563	4888793	432
210	304555	4887703	433
211	304822	4887585	432
212	303588	4886835	435
213	301649	4886866	439
214	301288	4887203	438
215	301276	4886371	440
216	301342	4885743	444
217	299523	4884438	447
218	299957	4884360	447
219	299682	4886958	444
220	300754	4888643	438
221	301445	4888665	435
222	304492	4885437	429
223	304253	4885748	433
224	304623	4884826	433
225	304499	4884845	434
226	305112	4884283	434
227	304353	4883725	441
228	304444	4883240	433
229	304356	4882484	437
230	302829	4883767	442
231	302882	4882812	438
232	303201	4882162	438
233	303103	4882008	441
234	303920	4882082	435
235	304422	4881532	437
236	304528	4881679	435
237	301564	4881199	441
238	301254	4881443	446
239	299607	4880051	444
240	299598	4880835	438
241	300686	4882004	447
242	301168	4883123	449

RECEIVER ID	COORDINATES (UTM NAD 83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
	X(m)	Y (m)	
243	302208	4883746	443
244	302916	4884561	439
245	303460	4885312	438
246	306021	4884959	429
247	306197	4884156	429
248	306090	4884064	430
249	306631	4888472	428
250	306288	4889543	423
251	306037	4890049	423
252	305062	4890086	424
253	298424	4893434	407
254	298512	4884026	449
255	299933	4883698	449
256	299134	4882883	445
257	297541	4883702	448
258	296436	4884193	448
259	296213	4884106	452
260	297075	4885531	452
261	296279	4885349	451
262	295949	4886025	453
263	295991	4886821	449
264	296212	4887189	444
265	296971	4889470	451
266	296499	4890396	448
267	297162	4890469	442
268	296552	4891448	438
269	296672	4892865	443
270	298000	4893446	423
271	298199	4891867	438
272	298148	4891041	438
273	298237	4890899	437
274	298761	4892031	439
275	298085	4890223	439
276	296466	4883131	459
277	296541	4881622	462

RECEIVER ID	COORDINATES (UTM NAD 83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
	X(m)	Y (m)	
278	296290	4880956	465
279	296398	4881086	466
280	295886	4881211	466
281	296003	4881212	465
282	296810	4880595	468
283	296427	4880265	475
284	296130	4880273	471
285	297701	4880422	456
286	297993	4881280	453
287	297432	4882178	453
288	298520	4882167	443
289	298829	4880667	451
290	298426	4880214	452
291	298767	4885402	447
292	298902	4885776	451
293	299001	4887076	448
294	299590	4895047	413
295	298643	4895038	424
296	295420	4889048	448
297	295783	4888265	447
298	295629	4886034	461
299	296019	4882191	459
300	296054	4882340	459
301	300511	4880208	442
302	301172	4879873	448
303	301158	4879218	439
304	302662	4878821	444
305	303544	4879111	437
306	303028	4880384	440
307	303524	4880479	441
308	304152	4880363	441
309	304392	4880555	442
310	304365	4880978	440
311	304540	4881184	442
312	304801	4880223	442
313	304893	4880211	442
314	304875	4880203	442
315	304458	4880046	442
316	304595	4880027	442
317	304215	4879572	440
318	303476	4878235	442
319	320154	4893962	356
320	320681	4892907	360
321	320794	4892643	360
322	321147	4892580	358
323	319375	4892433	364
324	319627	4891295	366
325	320122	4891247	374
326	320971	4890880	374
327	320080	4890163	373
328	319697	4888987	383
329	317368	4888570	386
330	301074	4896416	395
331	296734	4894119	431
332	295033	4894051	441
333	293638	4895016	440
334	293591	4894038	446
335	292315	4893575	445
336	291174	4893786	450
337	290378	4893537	456
338	290231	4893127	456
339	290602	4893783	457
340	290017	4893869	461
341	290179	4892686	456
342	290153	4892196	461
343	290761	4892086	458
344	291091	4892258	450
345	290810	4892239	455
346	292400	4892119	457
347	293591	4893187	442

RECEIVER ID	COORDINATES (UTM NAD 83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
	X(m)	Y (m)	
348	295273	4891191	444
349	293490	4891579	455
350	294914	4890560	448
351	294475	4890336	454
352	293355	4890737	460
353	292641	4890487	460
354	291246	4890532	455
355	291230	4890414	456
356	290290	4890466	469
357	289627	4890515	466
358	289608	4890582	467
359	290271	4889187	468
360	290011	4887500	474
361	289512	4887252	471
362	290315	4886569	469
363	291648	4886488	479
364	291825	4886638	478
365	291503	4886894	473
366	291675	4887391	467
367	291799	4888012	469
368	291990	4889164	467
369	290632	4888748	466
370	292052	4889840	465
371	293353	4889057	460
372	294068	4889931	450
373	293219	4887500	478
374	293120	4887152	477
375	295080	4886893	454
376	294943	4883554	468
377	294689	4883523	470
378	294494	4882448	467
379	294981	4882162	468
380	295596	4880736	473
381	293146	4882280	464
382	291118	4882412	482

RECEIVER ID	COORDINATES (UTM NAD 83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
	X(m)	Y (m)	
383	290244	4880506	462
384	290735	4880458	465
385	293170	4879002	482
386	293020	4879293	482
387	292743	4880064	482
388	293301	4880632	474
389	294624	4880352	462
390	294798	4879518	468
391	294604	4879244	473
392	294704	4878550	474
393	294996	4877510	471
394	296046	4877497	476
395	296328	4878491	468
396	296903	4879190	468
397	293731	4877392	459
398	292652	4877320	455
399	295559	4876854	472
400	295312	4876988	468
401	295879	4876470	472
402	296755	4875816	462
403	296860	4876092	475
404	298324	4875771	479
405	299227	4875871	468
406	300456	4875798	452
407	300441	4875720	453
408	298142	4879496	456
409	300728	4879025	442
410	299591	4878225	450
411	299116	4877671	459
412	299340	4876952	461
413	298047	4877108	470
414	297228	4877478	471
415	296951	4877144	477
416	295720	4881173	465
417	295777	4881187	466

RECEIVER ID	COORDINATES (UTM NAD 83 Z15N)		ELEVATION + RECEIVER HEIGHT (m)
	X(m)	Y (m)	
418	295845	4881210	467
419	295844	4881182	467
420	295840	4881163	467
421	295946	4881204	465
422	295778	4881256	465
423	295722	4881136	465
424	295600	4880808	473
425	295598	4880827	473
426	295600	4880855	471
427	295601	4880885	470
428	295647	4880889	470
429	295651	4880930	470
430	295647	4880773	471
431	295590	4880771	474
432	295685	4880774	470
433	295880	4880943	465
434	295918	4880862	463
435	295608	4880969	467
436	295607	4880944	467
437	295649	4880980	469
438	295707	4880992	469
439	311154	4899063	353
440	311084	4899038	353
441	311085	4899067	353
442	311094	4899148	353
443	311086	4899178	353
444	311028	4899235	353
445	310969	4899266	353
446	310982	4899306	353
447	310603	4899627	354
448	309031	4900100	354
449	322551	4890896	372
450	322478	4891236	367
451	322205	4890762	374
452	324146	4893748	354
453	325243	4894199	352
454	324499	4892766	354
455	324832	4892729	355
456	325775	4892983	354
457	324215	4891646	360
458	322116	4889430	375
459	323874	4890208	371
460	324031	4890035	367
461	322437	4889055	377

TABLE 15: MODEL RESULTS FOR EACH RECEIVER, WITH AND WITHOUT BACKGROUND SOUND LEVELS (L_{50}, dBA)

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
1	26	36	40	45	50	25	35	40	45	50
2	27	36	40	45	50	25	35	40	45	50
3	27	36	40	45	50	26	35	40	45	50
4	28	36	40	45	50	27	36	40	45	50
5	27	36	40	45	50	27	36	40	45	50
6	26	35	40	45	50	25	35	40	45	50
7	26	35	40	45	50	25	35	40	45	50
8	26	35	40	45	50	25	35	40	45	50
9	26	35	40	45	50	25	35	40	45	50
10	26	35	40	45	50	25	35	40	45	50
11	26	35	40	45	50	25	35	40	45	50
12	28	36	40	45	50	28	36	40	45	50
13	31	36	40	45	50	36	39	42	46	50
14	26	36	40	45	50	29	36	40	45	50
15	24	35	40	45	50	26	35	40	45	50
16	24	35	40	45	50	27	36	40	45	50
17	26	35	40	45	50	29	36	40	45	50
18	24	35	40	45	50	26	36	40	45	50
19	25	35	40	45	50	27	36	40	45	50
20	28	36	40	45	50	30	36	40	45	50
21	29	36	40	45	50	30	36	40	45	50
22	33	37	41	45	50	36	39	42	46	50
23	29	36	40	45	50	30	36	40	45	50
24	29	36	40	45	50	30	36	40	45	50
25	34	37	41	45	50	35	38	41	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
26	30	36	40	45	50	31	36	40	45	50
27	27	36	40	45	50	28	36	40	45	50
28	26	35	40	45	50	27	36	40	45	50
29	25	35	40	45	50	26	36	40	45	50
30	23	35	40	45	50	24	35	40	45	50
31	25	35	40	45	50	26	36	40	45	50
32	23	35	40	45	50	23	35	40	45	50
33	23	35	40	45	50	24	35	40	45	50
34	25	35	40	45	50	25	35	40	45	50
35	26	36	40	45	50	28	36	40	45	50
36	30	36	40	45	50	31	37	41	45	50
37	31	37	41	45	50	32	37	41	45	50
38	28	36	40	45	50	29	36	40	45	50
39	32	37	41	45	50	33	37	41	45	50
40	29	36	40	45	50	30	36	40	45	50
41	28	36	40	45	50	29	36	40	45	50
42	24	35	40	45	50	25	35	40	45	50
43	26	36	40	45	50	27	36	40	45	50
44	24	35	40	45	50	24	35	40	45	50
45	23	35	40	45	50	23	35	40	45	50
46	23	35	40	45	50	24	35	40	45	50
47	23	35	40	45	50	24	35	40	45	50
48	25	35	40	45	50	26	35	40	45	50
49	29	36	40	45	50	30	36	40	45	50
50	32	37	41	45	50	32	37	41	45	50
51	37	39	42	46	50	38	40	42	46	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
52	38	40	42	46	50	39	40	42	46	50
53	28	36	40	45	50	30	36	40	45	50
54	29	36	40	45	50	31	36	40	45	50
55	38	40	42	46	50	41	42	44	47	51
56	31	37	41	45	50	33	37	41	45	50
57	25	35	40	45	50	26	35	40	45	50
58	26	36	40	45	50	27	36	40	45	50
59	27	36	40	45	50	28	36	40	45	50
60	45	45	46	48	51	44	44	45	47	51
61	40	41	43	46	50	39	41	43	46	50
62	39	40	42	46	50	39	40	42	46	50
63	39	40	42	46	50	38	40	42	46	50
64	44	44	45	47	51	43	44	45	47	51
65	44	45	46	48	51	45	45	46	48	51
66	33	37	41	45	50	33	37	41	45	50
67	35	38	41	45	50	35	38	41	45	50
68	30	36	40	45	50	32	37	41	45	50
69	36	38	41	45	50	36	39	42	46	50
70	36	38	41	45	50	36	39	42	46	50
71	31	37	41	45	50	31	36	41	45	50
72	32	37	41	45	50	32	37	41	45	50
73	31	36	40	45	50	31	36	40	45	50
74	30	36	40	45	50	28	36	40	45	50
75	30	36	40	45	50	28	36	40	45	50
76	34	37	41	45	50	30	36	40	45	50
77	44	45	46	48	51	39	40	43	46	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
78	41	42	44	47	51	37	39	42	46	50
79	44	44	45	47	51	44	44	45	47	51
80	38	40	42	46	50	38	40	42	46	50
81	36	38	41	45	50	36	38	41	45	50
82	34	38	41	45	50	35	38	41	45	50
83	34	38	41	45	50	34	38	41	45	50
84	38	40	42	46	50	37	39	42	46	50
85	35	38	41	45	50	36	39	41	46	50
86	38	40	42	46	50	39	40	42	46	50
87	37	39	42	46	50	38	40	42	46	50
88	36	38	41	45	50	37	39	42	46	50
89	41	42	43	46	50	42	43	44	47	51
90	40	42	43	46	50	41	42	43	46	50
91	45	46	46	48	51	47	47	48	49	52
92	41	42	43	46	50	41	42	44	47	51
93	40	41	43	46	50	39	40	42	46	50
94	39	40	43	46	50	38	40	42	46	50
95	39	41	43	46	50	39	40	42	46	50
96	42	43	44	47	51	40	41	43	46	50
97	36	39	42	46	50	36	39	42	46	50
98	38	40	42	46	50	38	40	42	46	50
99	42	43	44	47	51	42	42	44	47	51
100	42	43	44	47	51	41	42	44	47	51
101	38	40	42	46	50	37	39	42	46	50
102	37	39	42	46	50	36	39	41	46	50
103	33	37	41	45	50	33	37	41	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
104	34	37	41	45	50	33	37	41	45	50
105	36	39	42	46	50	34	37	41	45	50
106	36	39	42	46	50	35	38	41	45	50
107	39	40	42	46	50	37	39	42	46	50
108	43	43	44	47	51	41	42	44	46	51
109	35	38	41	45	50	35	38	41	45	50
110	36	39	42	46	50	36	38	41	45	50
111	34	38	41	45	50	34	38	41	45	50
112	34	37	41	45	50	34	38	41	45	50
113	45	46	46	48	51	46	46	47	49	51
114	42	43	44	47	51	40	41	43	46	50
115	43	44	45	47	51	41	42	44	47	51
116	39	40	42	46	50	37	39	42	46	50
117	37	39	42	46	50	36	38	41	45	50
118	33	37	41	45	50	33	37	41	45	50
119	32	37	41	45	50	33	37	41	45	50
120	33	37	41	45	50	33	37	41	45	50
121	32	37	41	45	50	33	37	41	45	50
122	38	40	42	46	50	35	38	41	45	50
123	35	38	41	45	50	35	38	41	45	50
124	36	38	41	45	50	35	38	41	45	50
125	38	40	42	46	50	38	39	42	46	50
126	39	40	42	46	50	38	40	42	46	50
127	31	37	41	45	50	32	37	41	45	50
128	29	36	40	45	50	35	38	41	45	50
129	27	36	40	45	50	29	36	40	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
130	27	36	40	45	50	30	36	40	45	50
131	36	39	42	46	50	37	39	42	46	50
132	30	36	40	45	50	31	36	40	45	50
133	29	36	40	45	50	30	36	40	45	50
134	28	36	40	45	50	28	36	40	45	50
135	27	36	40	45	50	28	36	40	45	50
136	36	38	41	45	50	36	38	41	45	50
137	44	45	46	48	51	43	44	45	47	51
138	35	38	41	45	50	37	39	42	46	50
139	43	43	45	47	51	43	43	45	47	51
140	41	42	44	46	51	41	42	44	46	51
141	39	40	42	46	50	39	40	42	46	50
142	44	44	45	47	51	43	44	45	47	51
143	24	35	40	45	50	25	35	40	45	50
144	27	36	40	45	50	27	36	40	45	50
145	26	36	40	45	50	27	36	40	45	50
146	28	36	40	45	50	29	36	40	45	50
147	27	36	40	45	50	28	36	40	45	50
148	32	37	41	45	50	32	37	41	45	50
149	35	38	41	45	50	35	38	41	45	50
150	31	37	41	45	50	32	37	41	45	50
151	34	38	41	45	50	35	38	41	45	50
152	33	37	41	45	50	35	38	41	45	50
153	29	36	40	45	50	32	37	41	45	50
154	28	36	40	45	50	30	36	40	45	50
155	25	35	40	45	50	27	36	40	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
156	24	35	40	45	50	25	35	40	45	50
157	25	35	40	45	50	26	36	40	45	50
158	27	36	40	45	50	28	36	40	45	50
159	25	35	40	45	50	26	35	40	45	50
160	25	35	40	45	50	26	35	40	45	50
161	25	35	40	45	50	26	36	40	45	50
162	22	35	40	45	50	23	35	40	45	50
163	22	35	40	45	50	23	35	40	45	50
164	22	35	40	45	50	24	35	40	45	50
165	21	35	40	45	50	22	35	40	45	50
166	21	35	40	45	50	22	35	40	45	50
167	22	35	40	45	50	22	35	40	45	50
168	22	35	40	45	50	23	35	40	45	50
169	25	35	40	45	50	26	35	40	45	50
170	26	35	40	45	50	27	36	40	45	50
171	26	36	40	45	50	27	36	40	45	50
172	26	36	40	45	50	27	36	40	45	50
173	25	35	40	45	50	26	36	40	45	50
174	25	35	40	45	50	27	36	40	45	50
175	23	35	40	45	50	24	35	40	45	50
176	24	35	40	45	50	25	35	40	45	50
177	24	35	40	45	50	26	36	40	45	50
178	26	35	40	45	50	28	36	40	45	50
179	17	35	40	45	50	18	35	40	45	50
180	24	35	40	45	50	24	35	40	45	50
181	22	35	40	45	50	23	35	40	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
182	24	35	40	45	50	25	35	40	45	50
183	26	36	40	45	50	27	36	40	45	50
184	27	36	40	45	50	29	36	40	45	50
185	23	35	40	45	50	23	35	40	45	50
186	19	35	40	45	50	20	35	40	45	50
187	24	35	40	45	50	24	35	40	45	50
188	25	35	40	45	50	25	35	40	45	50
189	24	35	40	45	50	24	35	40	45	50
190	27	36	40	45	50	28	36	40	45	50
191	25	35	40	45	50	25	35	40	45	50
192	27	36	40	45	50	27	36	40	45	50
193	26	36	40	45	50	27	36	40	45	50
194	27	36	40	45	50	28	36	40	45	50
195	25	35	40	45	50	26	36	40	45	50
196	24	35	40	45	50	25	35	40	45	50
197	29	36	40	45	50	35	38	41	45	50
198	29	36	40	45	50	31	36	40	45	50
199	30	36	40	45	50	30	36	40	45	50
200	36	39	41	46	50	38	40	42	46	50
201	37	39	42	46	50	39	40	43	46	50
202	37	39	42	46	50	37	39	42	46	50
203	44	45	46	48	51	44	44	45	47	51
204	46	46	47	48	51	45	45	46	48	51
205	45	45	46	48	51	44	44	45	47	51
206	43	44	45	47	51	42	43	44	47	51
207	40	41	43	46	50	40	41	43	46	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
208	38	40	42	46	50	38	40	42	46	50
209	38	40	42	46	50	38	40	42	46	50
210	38	40	42	46	50	38	40	42	46	50
211	39	40	43	46	50	39	40	42	46	50
212	40	41	43	46	50	39	41	43	46	50
213	42	43	44	47	51	41	42	44	47	51
214	44	44	45	47	51	43	44	45	47	51
215	40	41	43	46	50	41	42	43	46	50
216	41	42	43	46	51	43	44	45	47	51
217	35	38	41	45	50	35	38	41	45	50
218	36	38	41	45	50	36	38	41	45	50
219	39	40	43	46	50	40	41	43	46	50
220	41	42	43	46	50	45	46	46	48	51
221	45	46	46	48	51	45	46	46	48	51
222	35	38	41	45	50	37	39	42	46	50
223	37	39	42	46	50	38	40	42	46	50
224	32	37	41	45	50	37	39	42	46	50
225	33	37	41	45	50	38	40	42	46	50
226	30	36	40	45	50	34	37	41	45	50
227	30	36	40	45	50	36	39	41	46	50
228	28	36	40	45	50	32	37	41	45	50
229	26	35	40	45	50	28	36	40	45	50
230	34	38	41	45	50	35	38	41	45	50
231	30	36	40	45	50	31	36	40	45	50
232	28	36	40	45	50	28	36	40	45	50
233	28	36	40	45	50	28	36	40	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
234	25	35	40	45	50	27	36	40	45	50
235	24	35	40	45	50	25	35	40	45	50
236	25	35	40	45	50	26	36	40	45	50
237	27	36	40	45	50	26	36	40	45	50
238	29	36	40	45	50	28	36	40	45	50
239	28	36	40	45	50	24	35	40	45	50
240	29	36	40	45	50	25	35	40	45	50
241	31	37	41	45	50	31	36	40	45	50
242	34	37	41	45	50	34	37	41	45	50
243	36	38	41	45	50	35	38	41	45	50
244	39	41	43	46	50	37	39	42	46	50
245	37	39	42	46	50	37	39	42	46	50
246	31	37	41	45	50	32	37	41	45	50
247	29	36	40	45	50	30	36	40	45	50
248	29	36	40	45	50	30	36	40	45	50
249	40	41	43	46	50	40	41	43	46	50
250	35	38	41	45	50	35	38	41	45	50
251	35	38	41	45	50	34	38	41	45	50
252	37	39	42	46	50	37	39	42	46	50
253	26	35	40	45	50	26	36	40	45	50
254	33	37	41	45	50	33	37	41	45	50
255	43	44	45	47	51	42	43	44	47	51
256	37	39	42	46	50	36	38	41	45	50
257	31	37	41	45	50	29	36	40	45	50
258	30	36	40	45	50	28	36	40	45	50
259	29	36	40	45	50	27	36	40	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
260	33	37	41	45	50	33	37	41	45	50
261	30	36	40	45	50	30	36	40	45	50
262	30	36	40	45	50	30	36	40	45	50
263	31	36	40	45	50	31	36	41	45	50
264	32	37	41	45	50	32	37	41	45	50
265	37	39	42	46	50	37	39	42	46	50
266	31	37	41	45	50	32	37	41	45	50
267	34	38	41	45	50	35	38	41	45	50
268	30	36	40	45	50	30	36	40	45	50
269	28	36	40	45	50	28	36	40	45	50
270	30	36	40	45	50	30	36	40	45	50
271	33	37	41	45	50	34	37	41	45	50
272	38	40	42	46	50	38	40	42	46	50
273	40	41	43	46	50	40	41	43	46	50
274	33	37	41	45	50	34	37	41	45	50
275	41	42	43	46	50	41	42	43	46	50
276	31	37	41	45	50	26	36	40	45	50
277	40	41	43	46	50	24	35	40	45	50
278	35	38	41	45	50	21	35	40	45	50
279	37	39	42	46	50	22	35	40	45	50
280	34	37	41	45	50	22	35	40	45	50
281	34	38	41	45	50	22	35	40	45	50
282	36	39	41	46	50	21	35	40	45	50
283	33	37	41	45	50	20	35	40	45	50
284	32	37	41	45	50	20	35	40	45	50
285	35	38	41	45	50	23	35	40	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
286	41	42	44	47	51	25	35	40	45	50
287	42	43	44	47	51	26	36	40	45	50
288	36	38	41	45	50	29	36	40	45	50
289	32	37	41	45	50	25	35	40	45	50
290	31	37	41	45	50	23	35	40	45	50
291	40	41	43	46	50	40	41	43	46	50
292	45	45	46	48	51	44	45	46	48	51
293	44	44	45	47	51	45	45	46	48	51
294	34	38	41	45	50	34	37	41	45	50
295	30	36	40	45	50	30	36	40	45	50
296	29	36	40	45	50	30	36	40	45	50
297	31	36	40	45	50	32	37	41	45	50
298	29	36	40	45	50	29	36	40	45	50
299	33	37	41	45	50	24	35	40	45	50
300	33	37	41	45	50	24	35	40	45	50
301	26	36	40	45	50	24	35	40	45	50
302	25	35	40	45	50	23	35	40	45	50
303	22	35	40	45	50	19	35	40	45	50
304	22	35	40	45	50	20	35	40	45	50
305	21	35	40	45	50	20	35	40	45	50
306	24	35	40	45	50	23	35	40	45	50
307	24	35	40	45	50	24	35	40	45	50
308	23	35	40	45	50	23	35	40	45	50
309	23	35	40	45	50	23	35	40	45	50
310	24	35	40	45	50	24	35	40	45	50
311	24	35	40	45	50	24	35	40	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
312	22	35	40	45	50	22	35	40	45	50
313	22	35	40	45	50	22	35	40	45	50
314	22	35	40	45	50	22	35	40	45	50
315	22	35	40	45	50	22	35	40	45	50
316	22	35	40	45	50	22	35	40	45	50
317	22	35	40	45	50	21	35	40	45	50
318	18	35	40	45	50	17	35	40	45	50
319	43	44	45	47	51	46	46	47	48	51
320	40	41	43	46	50	46	47	47	49	52
321	38	40	42	46	50	45	46	46	48	51
322	38	39	42	46	50	44	44	45	47	51
323	36	39	42	46	50	40	41	43	46	50
324	30	36	40	45	50	36	39	42	46	50
325	31	36	40	45	50	38	40	42	46	50
326	29	36	40	45	50	36	39	42	46	50
327	27	36	40	45	50	32	37	41	45	50
328	24	35	40	45	50	27	36	40	45	50
329	22	35	40	45	50	24	35	40	45	50
330	35	38	41	45	50	32	37	41	45	50
331	26	36	40	45	50	26	36	40	45	50
332	23	35	40	45	50	23	35	40	45	50
333	20	35	40	45	50	19	35	40	45	50
334	20	35	40	45	50	21	35	40	45	50
335	18	35	40	45	50	18	35	40	45	50
336	16	35	40	45	50	16	35	40	45	50
337	13	35	40	45	50	14	35	40	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
338	13	35	40	45	50	14	35	40	45	50
339	11	35	40	45	50	13	35	40	45	50
340	13	35	40	45	50	12	35	40	45	50
341	14	35	40	45	50	15	35	40	45	50
342	14	35	40	45	50	16	35	40	45	50
343	16	35	40	45	50	17	35	40	45	50
344	17	35	40	45	50	18	35	40	45	50
345	16	35	40	45	50	17	35	40	45	50
346	19	35	40	45	50	20	35	40	45	50
347	22	35	40	45	50	22	35	40	45	50
348	27	36	40	45	50	27	36	40	45	50
349	23	35	40	45	50	23	35	40	45	50
350	27	36	40	45	50	27	36	40	45	50
351	25	35	40	45	50	26	35	40	45	50
352	23	35	40	45	50	24	35	40	45	50
353	21	35	40	45	50	22	35	40	45	50
354	18	35	40	45	50	20	35	40	45	50
355	17	35	40	45	50	19	35	40	45	50
356	13	35	40	45	50	17	35	40	45	50
357	14	35	40	45	50	16	35	40	45	50
358	14	35	40	45	50	16	35	40	45	50
359	18	35	40	45	50	20	35	40	45	50
360	18	35	40	45	50	22	35	40	45	50
361	18	35	40	45	50	20	35	40	45	50
362	17	35	40	45	50	23	35	40	45	50
363	22	35	40	45	50	33	37	41	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
364	22	35	40	45	50	34	38	41	45	50
365	20	35	40	45	50	31	36	40	45	50
366	20	35	40	45	50	30	36	40	45	50
367	21	35	40	45	50	27	36	40	45	50
368	20	35	40	45	50	23	35	40	45	50
369	17	35	40	45	50	21	35	40	45	50
370	20	35	40	45	50	22	35	40	45	50
371	21	35	40	45	50	24	35	40	45	50
372	25	35	40	45	50	26	36	40	45	50
373	24	35	40	45	50	32	37	41	45	50
374	24	35	40	45	50	35	38	41	45	50
375	28	36	40	45	50	29	36	40	45	50
376	28	36	40	45	50	25	35	40	45	50
377	27	36	40	45	50	23	35	40	45	50
378	30	36	40	45	50	22	35	40	45	50
379	29	36	40	45	50	22	35	40	45	50
380	33	37	41	45	50	20	35	40	45	50
381	31	36	40	45	50	18	35	40	45	50
382	28	36	40	45	50	18	35	40	45	50
383	30	36	40	45	50	9	35	40	45	50
384	33	37	41	45	50	11	35	40	45	50
385	39	41	43	46	50	12	35	40	45	50
386	41	42	44	46	51	13	35	40	45	50
387	46	46	47	48	51	14	35	40	45	50
388	42	43	44	47	51	17	35	40	45	50
389	38	40	42	46	50	18	35	40	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
390	38	40	42	46	50	16	35	40	45	50
391	40	41	43	46	50	16	35	40	45	50
392	43	43	44	47	51	14	35	40	45	50
393	32	37	41	45	50	9	35	40	45	50
394	27	36	40	45	50	12	35	40	45	50
395	29	36	40	45	50	16	35	40	45	50
396	29	36	40	45	50	18	35	40	45	50
397	32	37	41	45	50	4	35	40	45	50
398	30	36	40	45	50	5	35	40	45	50
399	27	36	40	45	50	8	35	40	45	50
400	28	36	40	45	50	10	35	40	45	50
401	25	35	40	45	50	9	35	40	45	50
402	19	35	40	45	50	1	35	40	45	50
403	23	35	40	45	50	7	35	40	45	50
404	20	35	40	45	50	9	35	40	45	50
405	20	35	40	45	50	11	35	40	45	50
406	17	35	40	45	50	10	35	40	45	50
407	18	35	40	45	50	11	35	40	45	50
408	29	36	40	45	50	21	35	40	45	50
409	21	35	40	45	50	19	35	40	45	50
410	24	35	40	45	50	18	35	40	45	50
411	22	35	40	45	50	15	35	40	45	50
412	22	35	40	45	50	15	35	40	45	50
413	23	35	40	45	50	13	35	40	45	50
414	25	35	40	45	50	14	35	40	45	50
415	25	35	40	45	50	13	35	40	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
416	33	37	41	45	50	22	35	40	45	50
417	33	37	41	45	50	22	35	40	45	50
418	33	37	41	45	50	21	35	40	45	50
419	33	37	41	45	50	21	35	40	45	50
420	33	37	41	45	50	21	35	40	45	50
421	34	37	41	45	50	22	35	40	45	50
422	33	37	41	45	50	21	35	40	45	50
423	33	37	41	45	50	22	35	40	45	50
424	32	37	41	45	50	21	35	40	45	50
425	33	37	41	45	50	21	35	40	45	50
426	33	37	41	45	50	21	35	40	45	50
427	33	37	41	45	50	21	35	40	45	50
428	33	37	41	45	50	20	35	40	45	50
429	33	37	41	45	50	20	35	40	45	50
430	32	37	41	45	50	21	35	40	45	50
431	33	37	41	45	50	21	35	40	45	50
432	32	37	41	45	50	18	35	40	45	50
433	33	37	41	45	50	21	35	40	45	50
434	33	37	41	45	50	21	35	40	45	50
435	32	37	41	45	50	20	35	40	45	50
436	32	37	41	45	50	20	35	40	45	50
437	33	37	41	45	50	21	35	40	45	50
438	33	37	41	45	50	21	35	40	45	50
439	25	35	40	45	50	26	36	40	45	50
440	25	35	40	45	50	26	36	40	45	50
441	25	35	40	45	50	26	36	40	45	50

RECEIVER ID	SIEMENS GAMESA SG170					VESTAS V162 STE				
	MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL				MODELED TURBINE-ONLY SOUND PRESSURE LEVEL	COMBINED BACKGROUND + MODELED SOUND PRESSURE LEVEL			
		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND		35 dBA BACKGROUND	40 dBA BACKGROUND	45 dBA BACKGROUND	50 dBA BACKGROUND
442	25	35	40	45	50	26	35	40	45	50
443	25	35	40	45	50	26	35	40	45	50
444	25	35	40	45	50	26	35	40	45	50
445	25	35	40	45	50	26	35	40	45	50
446	24	35	40	45	50	25	35	40	45	50
447	24	35	40	45	50	25	35	40	45	50
448	23	35	40	45	50	24	35	40	45	50
449	28	36	40	45	50	32	37	41	45	50
450	29	36	40	45	50	34	37	41	45	50
451	28	36	40	45	50	33	37	41	45	50
452	30	36	40	45	50	31	37	41	45	50
453	26	36	40	45	50	27	36	40	45	50
454	28	36	40	45	50	29	36	40	45	50
455	27	36	40	45	50	28	36	40	45	50
456	24	35	40	45	50	26	35	40	45	50
457	27	36	40	45	50	29	36	40	45	50
458	23	35	40	45	50	27	36	40	45	50
459	24	35	40	45	50	27	36	40	45	50
460	21	35	40	45	50	25	35	40	45	50
461	23	35	40	45	50	26	36	40	45	50

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