CAMPBELL COUNTY WIND SOUND MODELING

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Prepared for Campbell County Wind Farm 2, LLC

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Campbell County Wind Sound Modeling

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1.0 INTRODUCTION

Campbell County Wind Farm 2, LLC ("Campbell County Wind"), an indirect subsidiary of RWE Clean Energy Development, LLC ("RWE"), is developing an up to approximately 100 MW wind power project ("Project") in Campbell County, South Dakota. All wind turbines are proposed for Campbell County. As part of the Campbell County Siting Approval Permit process for the Project, RSG has performed sound propagation modeling of proposed Project components to assess compliance with applicable noise thresholds. This report includes:

- A Project description;
- Identification of applicable noise thresholds;
- Sound propagation modeling procedures and results; and
- Conclusions.

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

2.0 PROJECT DESCRIPTION

Campbell County Wind is an up to approximately 100 MW wind power project proposed for Campbell County in South Dakota. The area around the Project is composed primarily of agricultural land uses with rural and farm residences spread throughout the area. The closest city is Herreid, located approximately 7 kilometers (4.4 miles) northwest of the Project area.

This sound propagation modeling in this report is for the second phase of the Campbell County Wind Farm. The first phase, which is already constructed, is located to the west of the second phase and includes 55 GE 1.7-103 turbines. Modeling results of both phases is found in Appendix E.

This Phase II Project will include approximately 29 wind turbines and a substation (with transformer), all contained within Campbell County. There are also two alternative turbine locations under consideration. Wind turbines currently considered for this project are the GE Sierra 140 3.4 MW with a hub height of 98 meters. This is a 3.4 MW turbine with a rotor diameter of 140 meters. The Project substation would be located west of the Project area on 113 St, 4 kilometers (2.5 miles) east of South Dakota Highway 1804.

A map of the Project area is shown in Figure 1. The Project area is between US Route 83, 5 kilometers (3.1 miles) to the east and South Dakota Highway 1804, 4 kilometers (2.5 miles) to the west. The Project turbines furthest north are just north of 109th Street and the most southern turbine is 500 meters (1,640 feet) south of 115th Street. Bisecting the Project area from north to south is 301st Avenue.

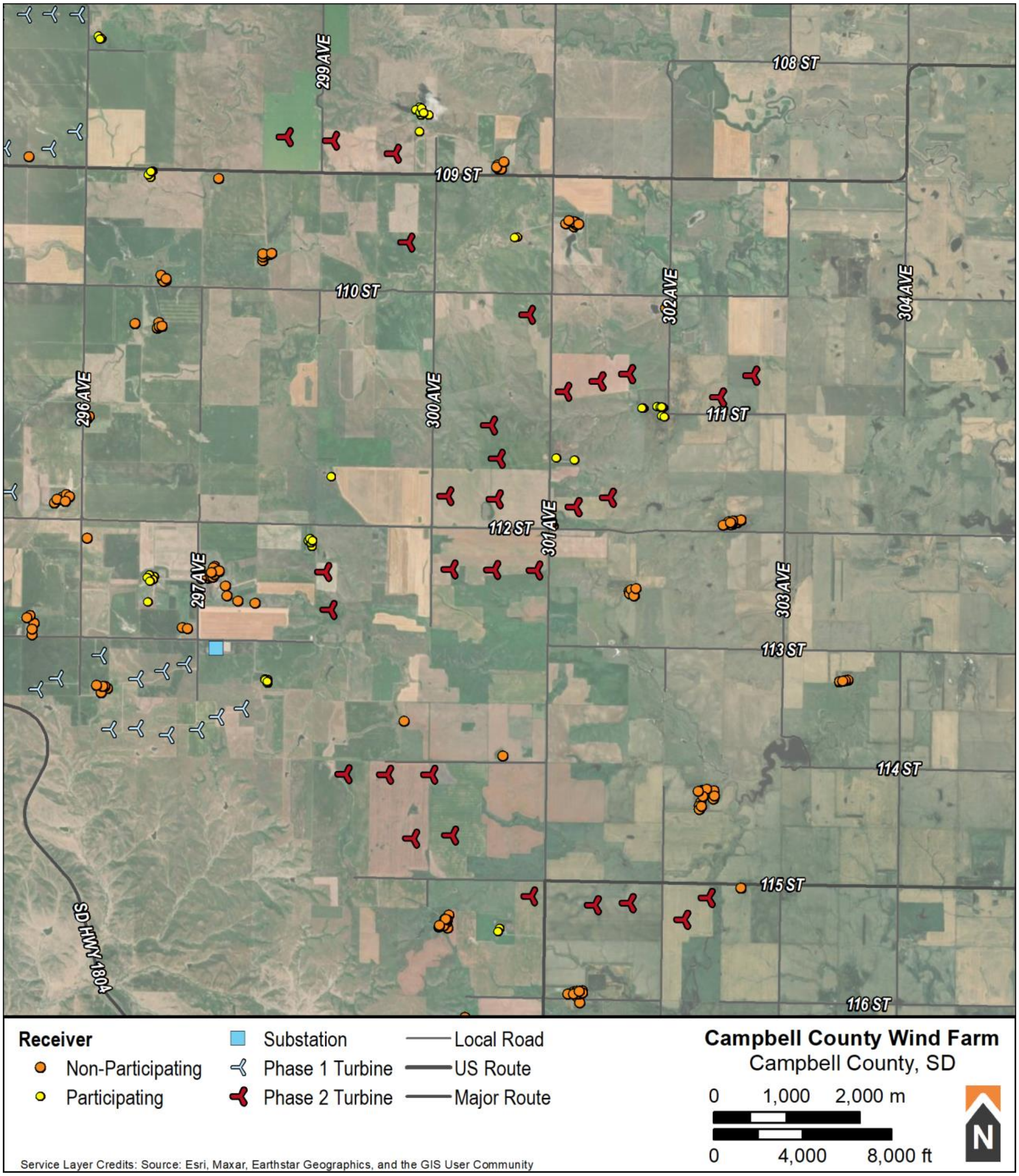

FIGURE 1: PROJECT AREA MAP

3.0 APPLICABLE NOISE CRITERIA

3.1 LOCAL

Applicable local noise limits are found in Chapter 5.24 Section 14, for Wind Energy Systems (WES). This section is reproduced below.

> 14. Noise. Noise level shall not exceed 45 dBA, average A-weighted Sound pressure including constructive interference effects at the perimeter of the principal and accessory structures of existing off-site residences, businesses, and buildings.

This sets a noise limit of 45 dBA at the perimeter of nonparticipating structures and includes the combined contribution of all sound sources within the project. The limit does not specify the metric or averaging time. Recommendations of metrics and averaging times in situations where they are not directly specified are found in ANSI/ACP 111-1 (2022) *Wind Turbine Sound Modeling.* Based on this we will specify the sound metric as a one-hour equivalent average sound level (L_{1h}).

3.2 STATE

There are no quantitative statewide noise standards that apply to this project.

4.0 SOUND PROPAGATION MODELING

4.1 PROCEDURES

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

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

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

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

The sound modeling procedure follows the ANSI/ACP American National Standard for wind turbine sound modeling.[1] These include the use of a ground absorption factor of G=0.5 (half hard/half porous ground) and a +2 dB factor added to the model results to account for uncertainty.

As mentioned in Section 2.0, 31 GE Sierra 140 3.4 MW wind turbines and one high voltage transformer were included in the sound propagation model. This includes the 29 primary turbine locations and the two alternative turbine locations. Turbines from Phase 1 of the Campbell County wind farm are not included in modeling shown in the body of this report, but can be found in Appendix E. The transformer overall sound power was based on equipment specifications provided by RWE and NEMA TR-1 specified sound levels. A transformer with sound levels 9 dB less than the NEMA TR-1 standard is assumed. This overall sound power was then adjusted to full octave bands using the spectra measured from a similar power

[1] ANSI/ACP Standard 111-1, “Wind Turbine Sound Modeling,” American National Standards Institute, 2022.

transformer. The new substation is south of the existing substation and west of an existing switchyard.

A search distance up to 6,000 meters (3.7 miles) allows for the contributions of distant turbines to be considered at receivers. Other modeling parameters can be found in Appendix C.

A total of 251 receptors (structures of any kind) were modeled at a height of 4 meters (13 feet) above ground level throughout the Project area. The receptors are the same as those identified in Appendix D. In addition to the discrete receptors, a 20-meter by 20-meter (65 feet by 65 feet) grid of receptors was set up in the model covering 339 square kilometers (131 square miles) in and around the Project. The grid is used to calculate the sound pressure level contours in the result maps.

4.2 RESULTS

A map showing modeled sound levels in and around the Project area is shown in Figure 2 and discrete receiver results at each receptor are shown in Table 4. The highest sound level at a nonparticipating structure is 44 dBA L_{1h}, meeting the Campbell County limit. Two nonparticipating structures are above 40 dBA. The highest sound level at a participating structure is 48 dBA.

Modeling including the Phase 1 project are included in Appendix E.

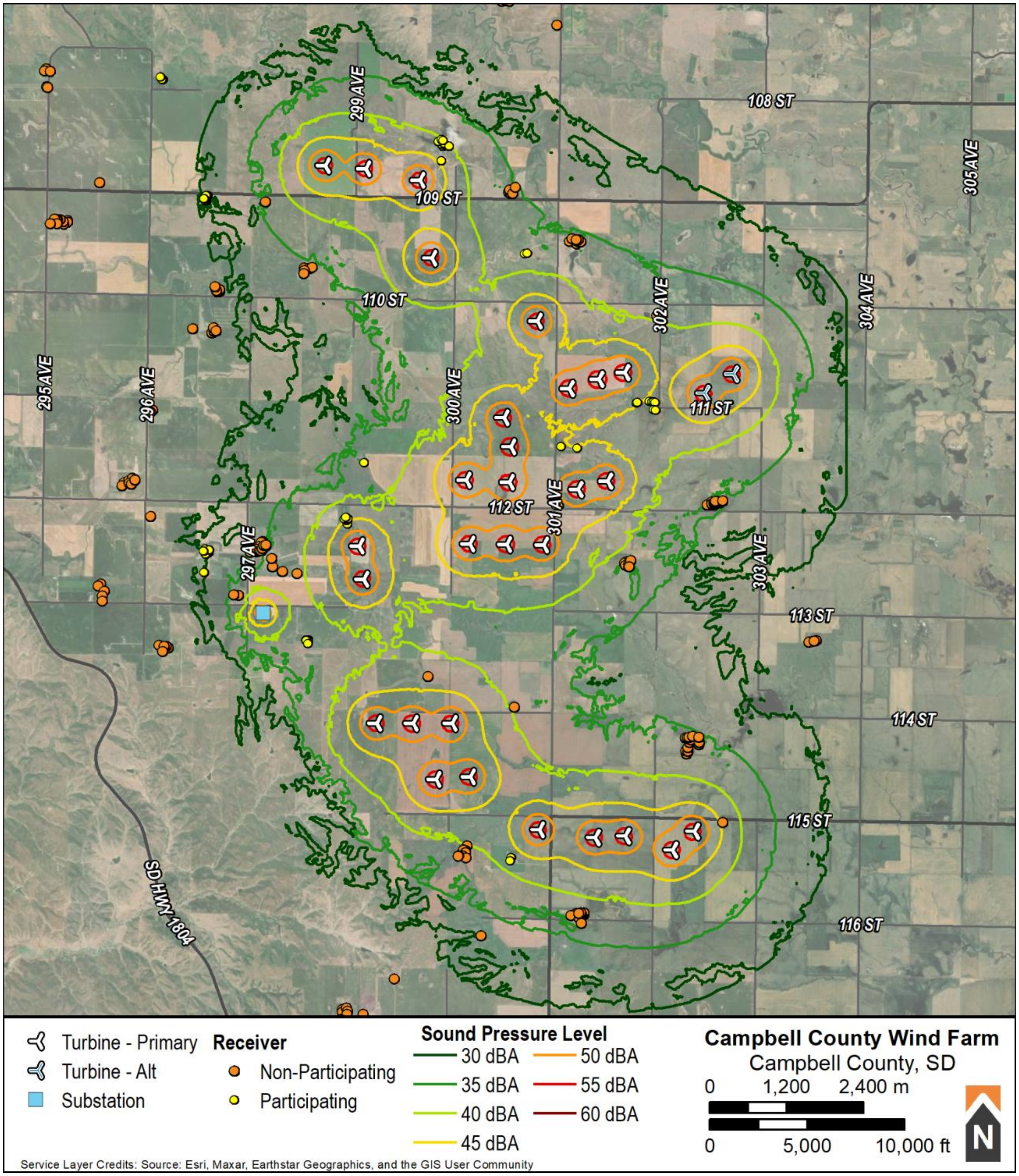

FIGURE 2: SOUND PROPAGATION MODELING RESULTS

5.0 CONCLUSIONS

RSG conducted sound propagation modeling of the proposed Campbell County Wind Farm project in Campbell County, South Dakota in preparation for the Project's Special Use Permit application. This is the second phase of an existing project. The existing project has 55 GE 1.7-103 turbines. The current Project will include up to 29 wind turbines with a total capacity of up to 100 MW. For this assessment, 31 turbine locations (two spare locations and 29 primary locations) were modeled as GE Sierra 140 3.4 MW wind turbines. The model also included one high voltage transformer at the Project substation.

Campbell County has a 45 dBA noise limit at nonparticipating structures that is applicable to wind power projects. We are assessing this as a one-hour equivalent continuous average (L_{1h}) sound level, consistent with the recommendations of ACP/ANSI standard 111-1, since the County's limit does not state a metric or averaging time.

Sound levels from the Project were modeled at 251 receptors throughout the Project area. Receptors are any structure. Some of these are residences and others include barns, sheds, and other unoccupied structures. Model results are presented in Section 4.2 and Appendix D. The highest sound level at a nonparticipating structure was 44 dBA L_{1h}. All receptors have modeled sound levels below the Campbell County noise limit from the Phase 2 project.

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").2 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 3.

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.

[2] 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.

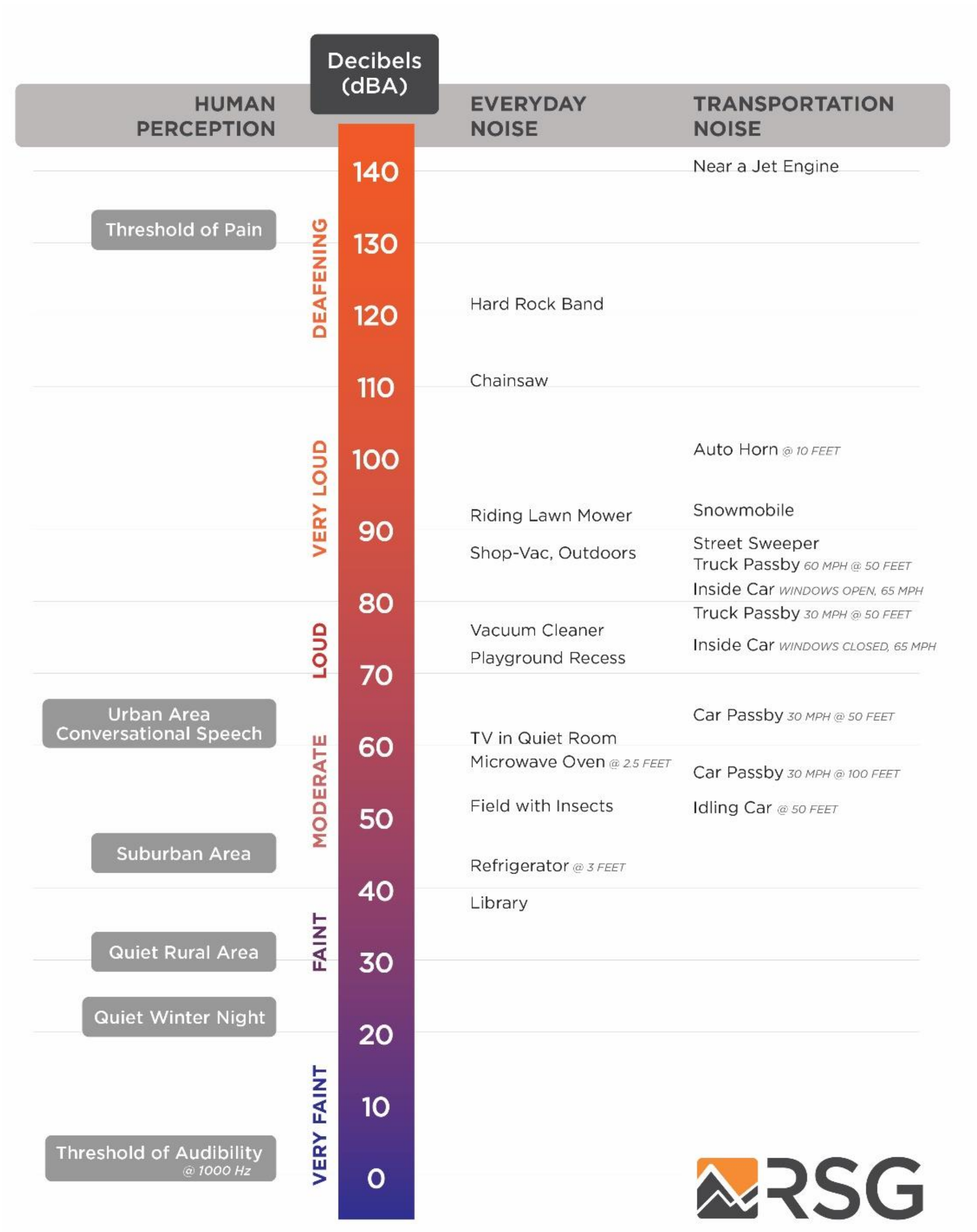

FIGURE 3: A SCALE OF SOUND PRESSURE LEVELS FOR TYPICAL SOUND SOURCES

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.

THE SPECTROGRAM

One method of viewing the spectral sound level is to look at a spectrogram of the sound. As shown in Figure 4, the spectrogram shows the level, frequency spectra, and time in one graph. That is, the horizontal axis represents time, the vertical axis is frequency, and the intensity of the color is proportional to the intensity of the sound.

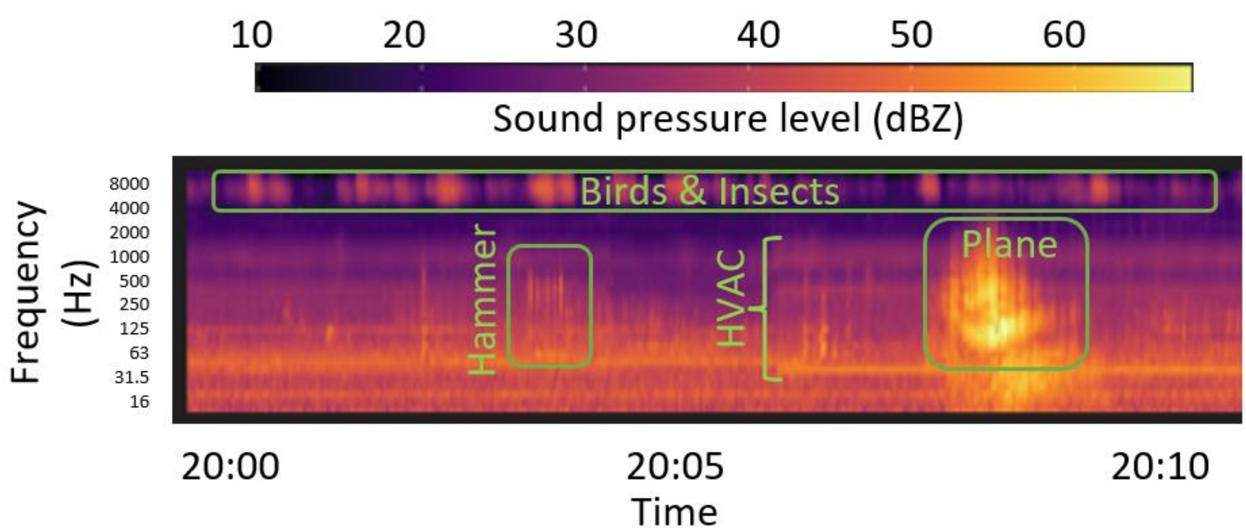

FIGURE 4: AN EXAMPLE OF A SOUND SPECTROGRAM WITH ANNOTATIONS

The spectrogram is useful for identifying the sources of sound. For example, birds show short bursts of high frequency sound, while airplanes are mostly low frequency sound and show slow rise and fall times. In the example above, we can see several of these events.

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. 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.

A relatively new standard weighting is the ANS weight. ANS stands for A-weighted, natural sounds. The ANS weight is the same as the A-weighting, but it filters out all sound above the 1,000 Hz octave band. Thus, it removes the impact of many high frequency biogenic sounds such as insects, birds, and amphibians. The ANS weighting is often used to eliminate the effects of seasonality of sound, as there are fewer insects and birds during the winter than the summer.

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.[3] 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 $L_{eq.max}$.

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 5. 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 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 - L_{eq}

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

[3] 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.

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 5, 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.

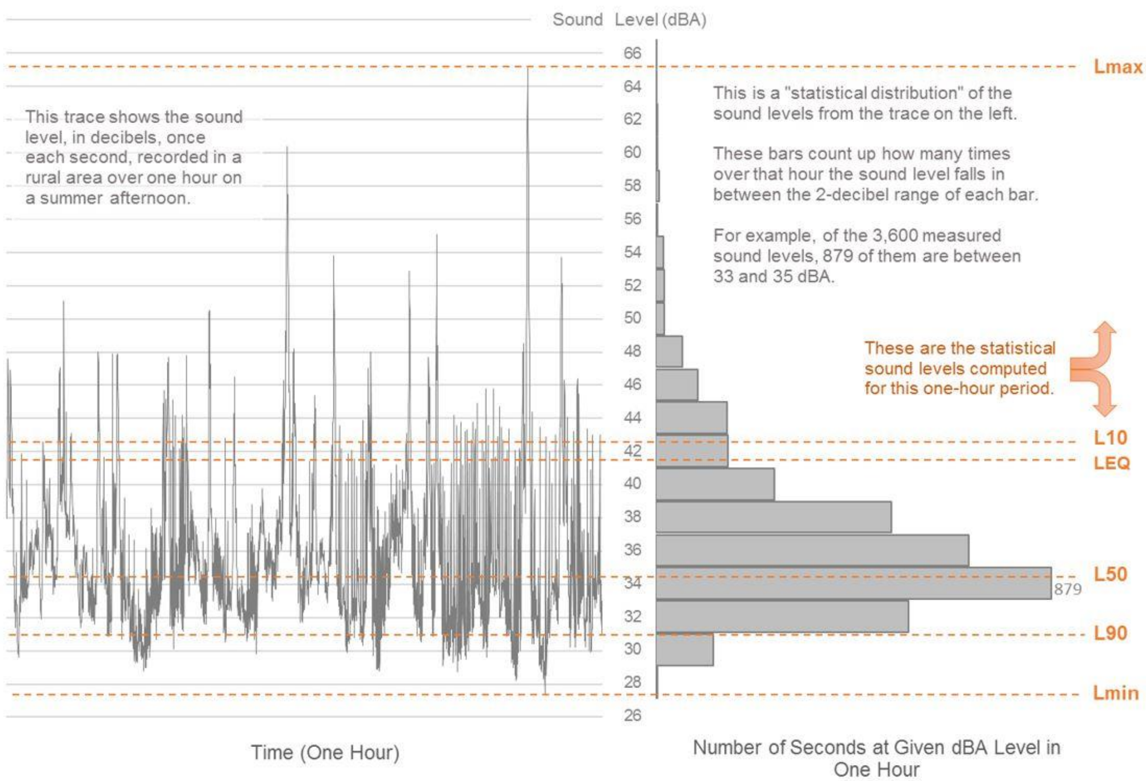

FIGURE 5: EXAMPLE OF DESCRIPTIVE TERMS OF SOUND MEASUREMENT OVER TIME

Percentile Sound Levels – L_n

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. L_{50} (the “median level”) is exceeded 50% of the time: half of the time the sound is louder than L_{50}, and half the time it is quieter than L_{50}. Note that L_{50} (median) and L_{eq} (mean) are not always the same, for reasons described in the previous section.

L_{90} 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.

Sound Levels from Multiple Sources: Adding Decibels

Because of the way that sound levels in decibels are calculated, the sounds from more than one source do not add arithmetically. Instead, two sound sources that are the same decibel level increase the total sound level by 3 dB. For example, suppose the sound from an industrial blower registers 80 dB at a distance of 2 meters (6.6 feet). If a second industrial blower is operated next to the first one, the sound level from both machines will be 83 dB, not 160 dB. Adding two more blowers (a total of four) raises the sound level another 3 dB to 86 dB. Finally, adding four more blowers (a total of eight) raises the sound level to 89 dB. It would take eight total blowers, running together, for a person to judge the sound as having "doubled in loudness".

Recall from the explanation of sound levels that a difference of 10 decibels is a factor of 20 in sound pressure and a factor of 10 in sound power. (The difference between sound pressure and sound power is described in the next Section.) If two sources of sound differ individually by 10 decibels, the louder of the two is generating *ten times* more sound. This means that the loudest source(s) in any situation always dominates the total sound level. Looking again at the industrial blower running at 80 decibels, if a small ventilator fan whose level alone is 70 decibels were operated next to the industrial blower, the total sound level increases by only 0.4 decibels, to 80.4 decibels. The small fan is only 10% as loud as the industrial blower, so the larger blower completely dominates the total sound level.

The Difference between Sound Pressure and Sound Power

The human ear and microphones respond to variations in sound *pressure*. However, in characterizing the sound emitted by a specific source, it is proper to refer to sound *power*. While sound pressure induced by a source can vary with distance and conditions, the power is the same for the source under all conditions, regardless of the surroundings or the distance to the nearest listener. In this way, sound power levels are used to characterize noise sources because they act like a "fingerprint" of the source. An analogy can be made to light bulbs. The bulb emits a constant amount of light under all conditions, but its perceived brightness diminishes as one moves away from it.

Both sound power and sound pressure levels are described in terms of decibels, but they are not the same thing. Decibels of sound pressure are related to 20 micropascals, as explained at the beginning of this primer. Sound power is a measure of the acoustic power emitted or radiated by a source; its decibels are relative to one picowatt.

Sound Propagation Outdoors

As a listener moves away from a source of sound, the sound level decreases due to “geometrical divergence”: the sound waves spread outward like ripples in a pond and lose energy. For a sound source that is compact in size, the received sound level diminishes or attenuates by 6 dB for every doubling of distance: a sound whose level is measured as 70 dBA at 100 feet from a source will have a measured level of 64 dBA at 200 feet from the source and 58 dBA at 400 feet. Other factors, such as walls, berms, buildings, terrain, atmospheric absorption, and intervening vegetation will also further reduce the sound level reaching the listener.

The type of ground over which sound is propagating can have a strong influence on sound levels. Harder ground, pavement, and open water are very reflective, while soft ground, snow cover, or grass is more absorptive. In general, sounds of higher frequency will attenuate more over a given distance than sounds of lower frequency: the “boom” of thunder can be heard much further away than the initial “crack”.

Atmospheric and meteorological conditions can enhance or attenuate sound from a source in the direction of the listener. Wind blowing from the source toward the listener tends to enhance sound levels; wind blowing away from the listener toward the source tends to attenuate sound levels. Normal temperature profiles (typical of a sunny day, where the air is warmer near the ground and gets colder with increasing altitude) tend to attenuate sound levels; inverted profiles (typical of nighttime and some overcast conditions) tend to enhance sound levels.

APPENDIX B. WIND TURBINE ACOUSTICS PRIMER

Sources of Sound Generation by Wind Turbines

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

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

Wind turbines emit aerodynamic broadband sound as the rotating blades interact with atmospheric turbulence and as air flows along their surfaces. This produces a characteristic “whooshing” sound through several mechanisms (Figure 6):

- 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.

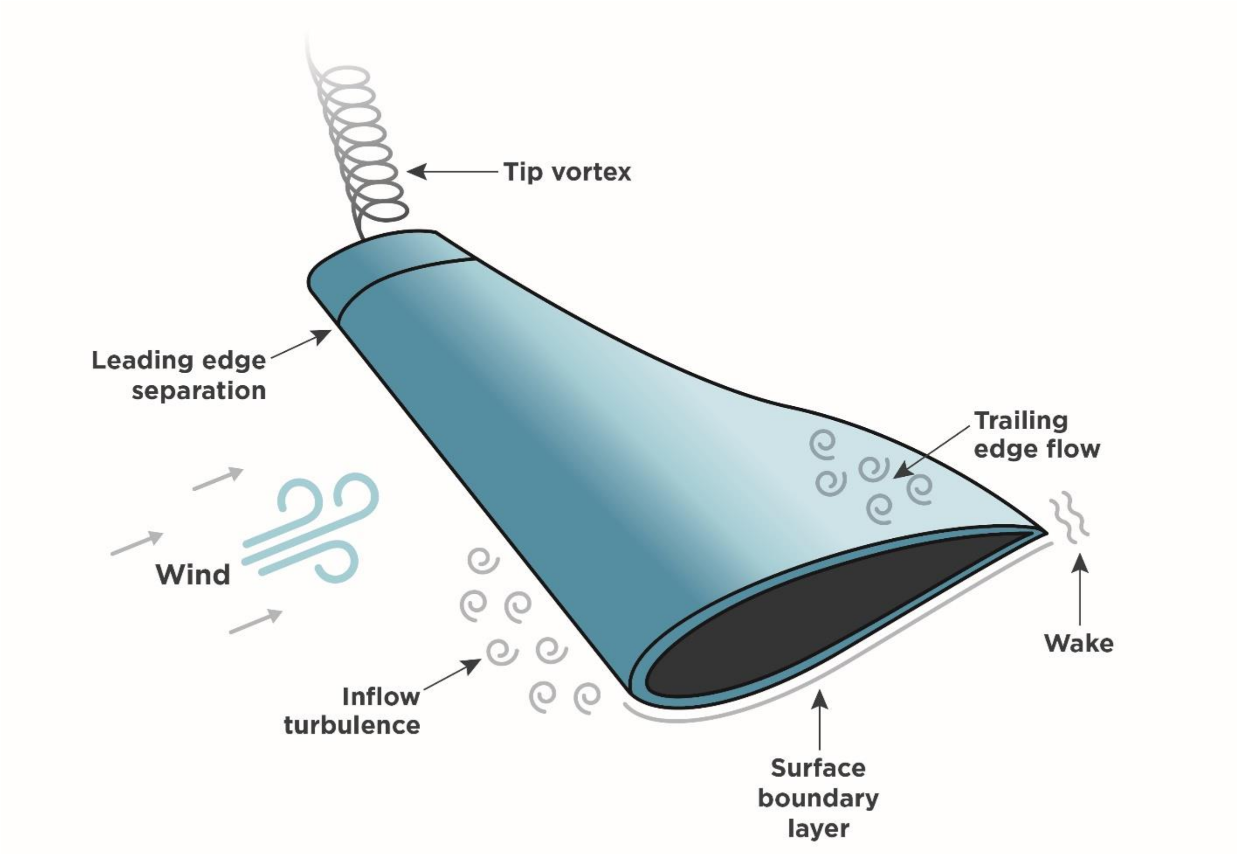

FIGURE 6: AIRFLOW AROUND A ROTOR BLADE

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

Amplitude Modulation

Amplitude modulation (AM) is a fluctuation in sound level that occurs at the blade passage frequency. There is no consistent definition of 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.

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 7).

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[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.

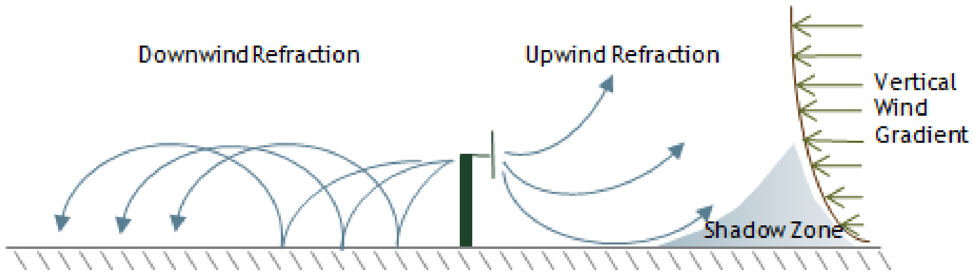

FIGURE 7: SCHEMATIC OF THE REFRACTION OF SOUND DUE TO VERTICAL WIND GRADIENT (WIND SHEAR)

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

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

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

Masking

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

The sound from a wind turbine can often be masked by wind sound at downwind receptors because the frequency spectrum from wind is very similar to the frequency spectrum from a wind turbine. Figure 8 compares the shape of the sound spectrum measured during a 5 m/s wind event to that of the V163 4.5 MW wind turbine. As shown, the shapes of the spectra are very similar. As a result, the masking of turbine sound occurs at higher wind speeds for some meteorological conditions. Masking will occur most, when ground wind speeds are relatively high, creating wind-caused sound such as wind blowing through the trees and interaction of wind with structures.

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

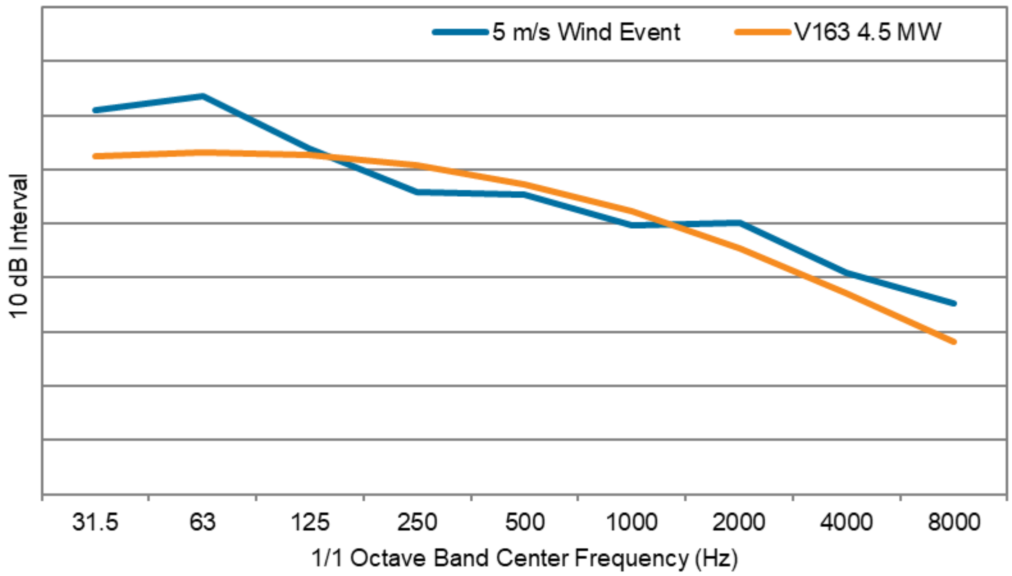

FIGURE 8: COMPARISON OF NORMALIZED FREQUENCY SPECTRA FROM WIND AND THE V162 6.0 MW TURBINE[7]

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.

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[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 9 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.

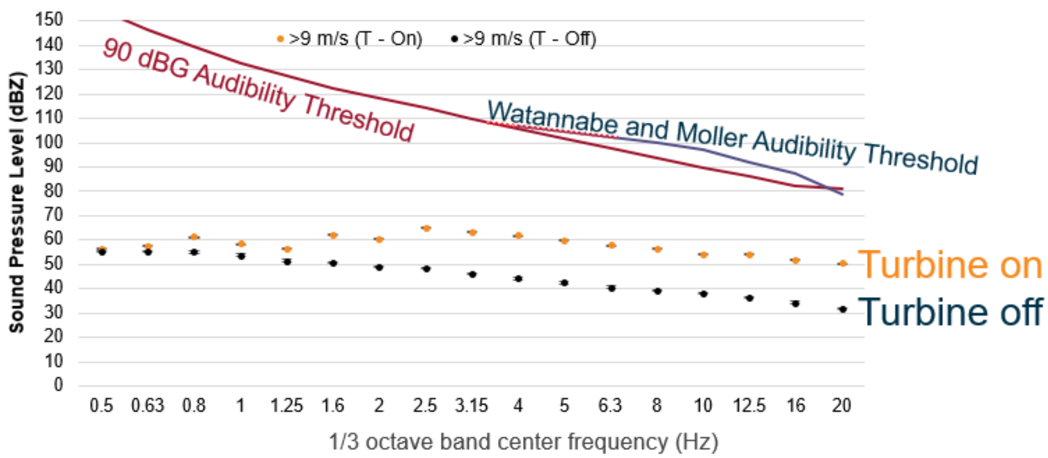

FIGURE 9: INFRASOUND FROM A WIND TURBINE AT 350 METERS (1,148 FEET) COMPARED WITH PERCEPTION THRESHOLDS

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

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

Use of Sound Level Weighting Networks for Wind Turbine Sound

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

[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

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

APPENDIX C. SOURCE INFORMATION

TABLE 1: SOUND PROPAGATION MODELING PARAMETERS

Parameter	Setting
Ground Absorption	Spectral for all sources, mixed ground (G=0.5)
Atmospheric Attenuation	Based on 10 Celsius, 70% relative humidity
Receiver Height	4 meters for residences and isoline contours
Search Distance	6,000 meters

TABLE 2: SOURCE 1/1 OCTAVE BAND SOUND POWER LEVEL SPECTRA (dBZ)

Source	1/1 Octave Band Center Frequency (Hz)								
	31.5	63	125	250	500	1000	2000	4000	8000
Transformer (ONAF)	112	104	117	109	111	106	102	95	86

TABLE 3: MODELED SOURCES LOCATIONS

ID	Source Type	Coordinates (UTM NAD83 Z14N)			Source Height
		X (m)	Y (m)	Z (m)	
Transformer ONAF	Substation	404261	5067295	606	4
T1	GE 3.4 -140	410979	5063880	663	98
T2	GE 3.4 -140	410643	5063586	672	98
T3	GE 3.4 -140	409902	5063809	678	98
T4	GE 3.4 -140	409424	5063786	680	98
T5	GE 3.4 -140	408554	5063907	690	98
T6	GE 3.4 -140	407475	5064735	708	98
T7a	GE 3.4 -140	406941	5064694	715	98
T8	GE 3.4 -140	407189	5065569	698	98
T9	GE 3.4 -140	406582	5065569	714	98
T10	GE 3.4 -140	406013	5065575	715	98
T11	GE 3.4 -140	408624	5068363	691	98
T12	GE 3.4 -140	408049	5068369	695	98
T13	GE 3.4 -140	407466	5068375	689	98
T14	GE 3.4 -140	405810	5067826	687	98
T15	GE 3.4 -140	405736	5068341	699	98
T17	GE 3.4 -140	407411	5069378	703	98
T18	GE 3.4 -140	408087	5069341	696	98
T19	GE 3.4 -140	409157	5069230	686	98
T20	GE 3.4 -140	409625	5069361	681	98

ID	Source Type	Coordinates (UTM NAD83 Z14N)			Source Height
		X (m)	Y (m)	Z (m)	
T21	GE 3.4 -140	408113	5069894	699	98
T22	GE 3.4 -140	408004	5070351	700	98
T23	GE 3.4 -140	409025	5070810	676	98
T24	GE 3.4 -140	409484	5070949	669	98
T25	GE 3.4 -140	409890	5071055	666	98
T26	GE 3.4 -140	408526	5071864	660	98
T27	GE 3.4 -140	406689	5074066	661	98
T28	GE 3.4 -140	405845	5074246	671	98
T29	GE 3.4 -140	405212	5074294	676	98
T31	GE 3.4 -140	406878	5072848	638	98
Alt3	GE 3.4 -140	411139	5070730	636	98
Alt4	GE 3.4 -140	411590	5071033	625	98

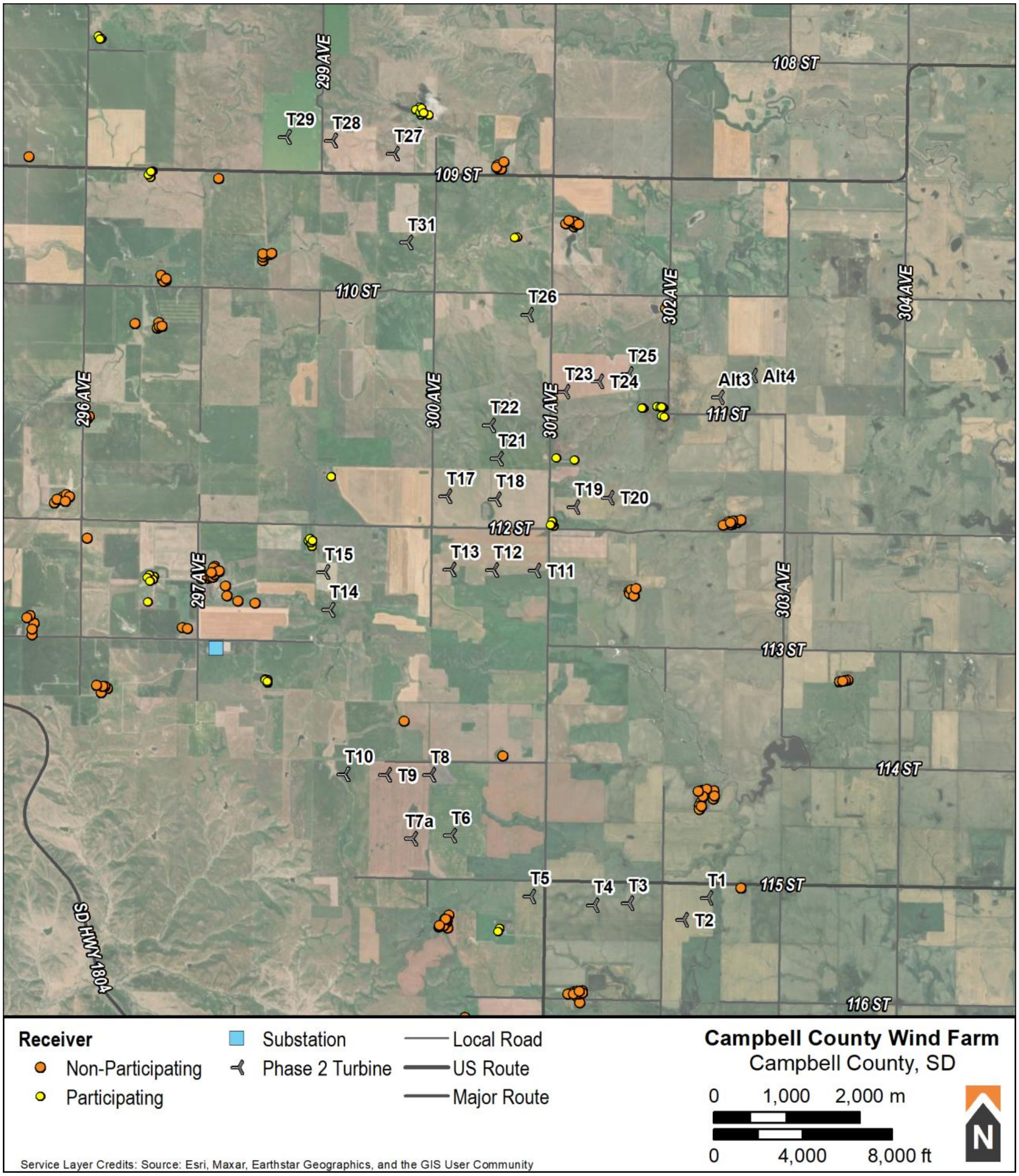

FIGURE 10: TURBINE MAP

APPENDIX D. RECEIVER INFORMATION

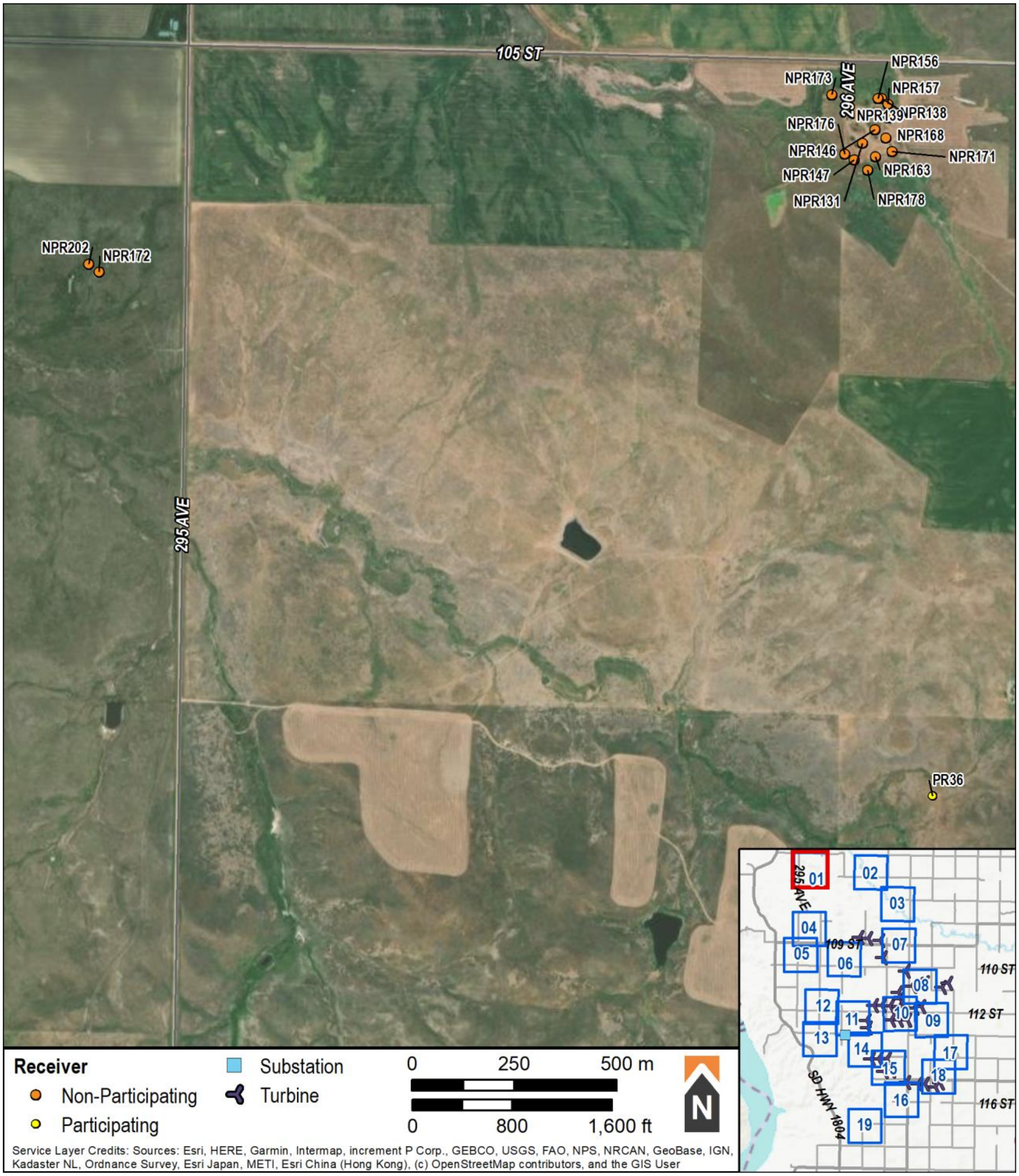

FIGURE 11: RECEIVER MAP 1

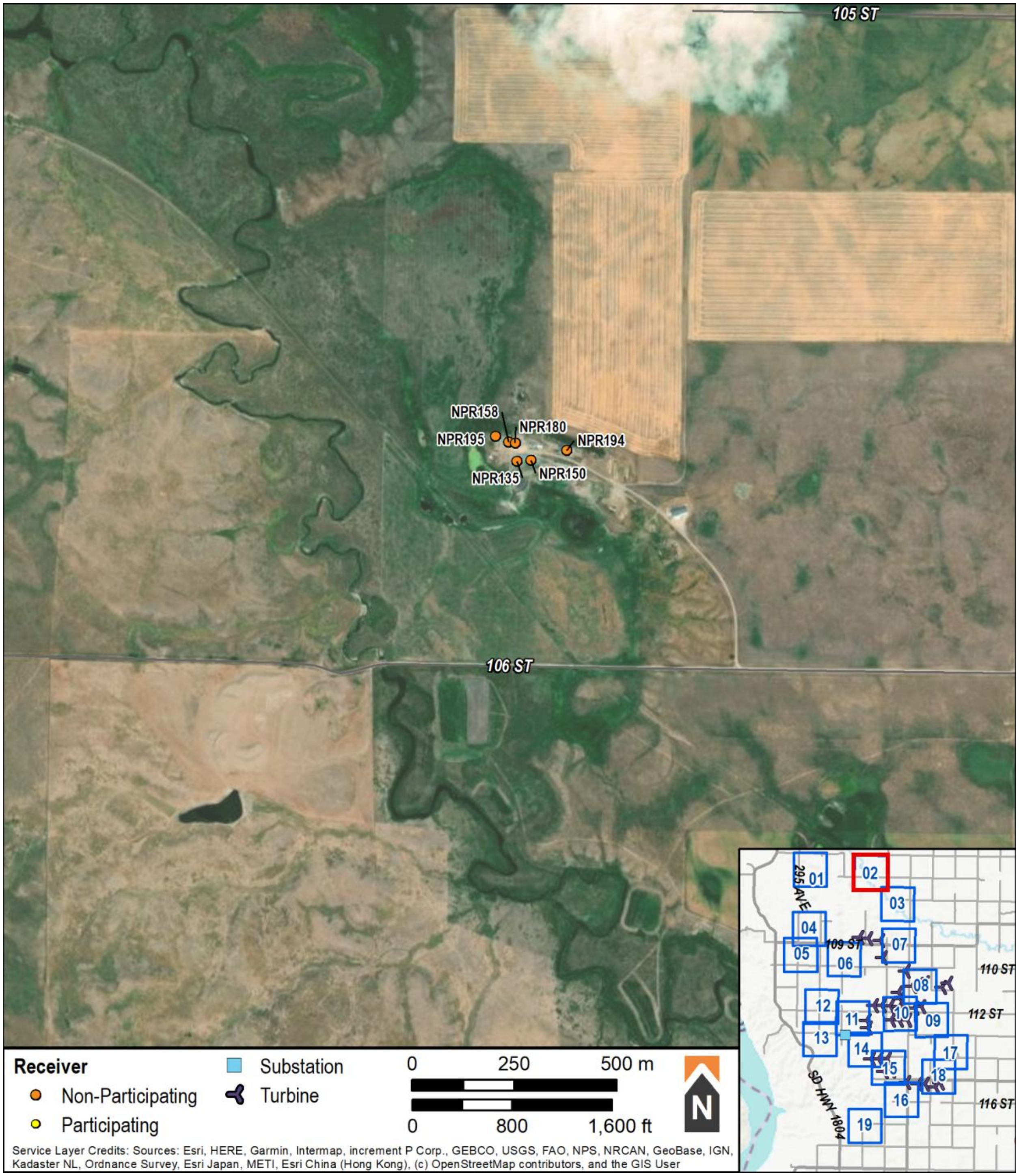

FIGURE 12: RECEIVER MAP 2

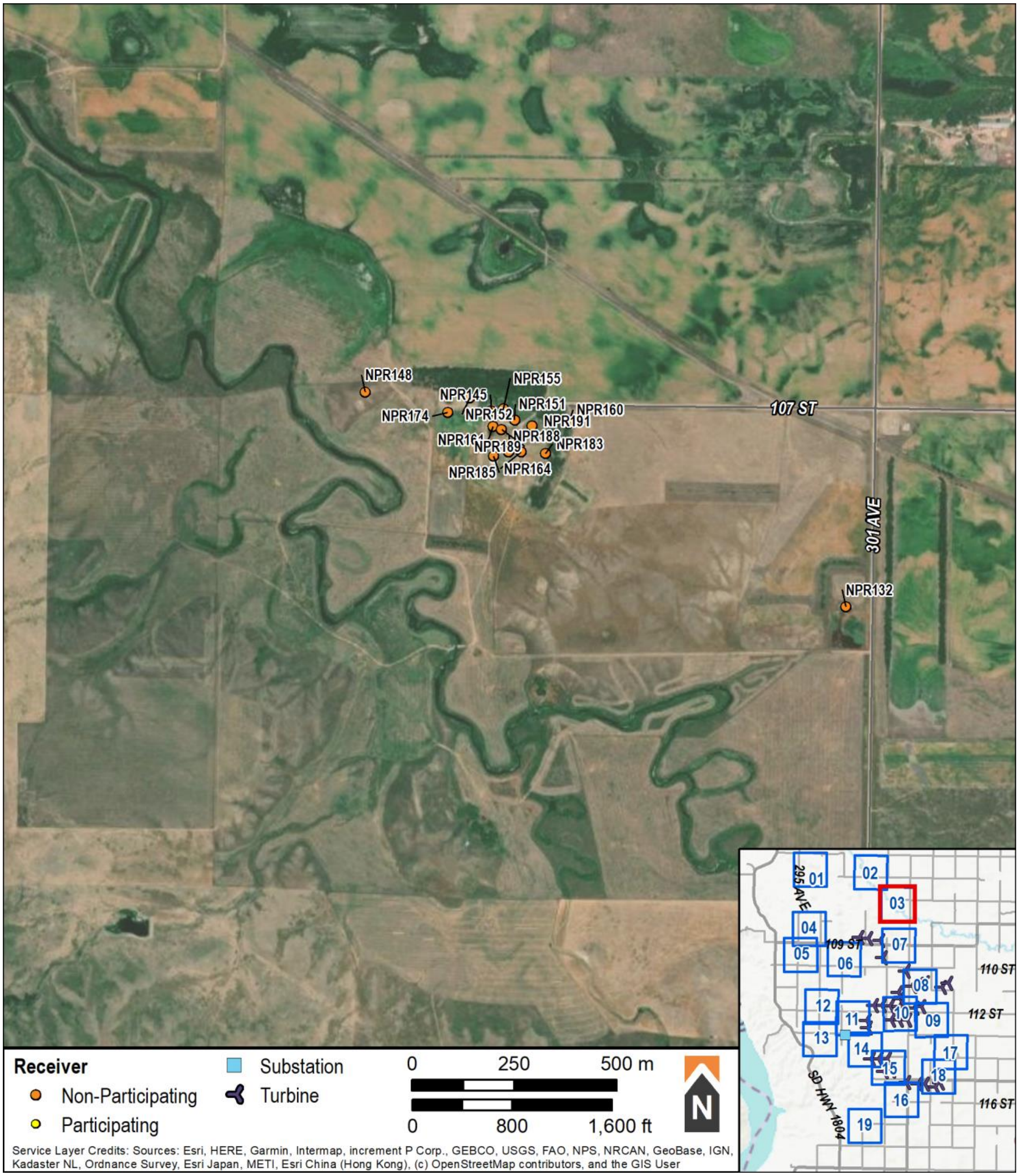

FIGURE 13: RECEIVER MAP 3

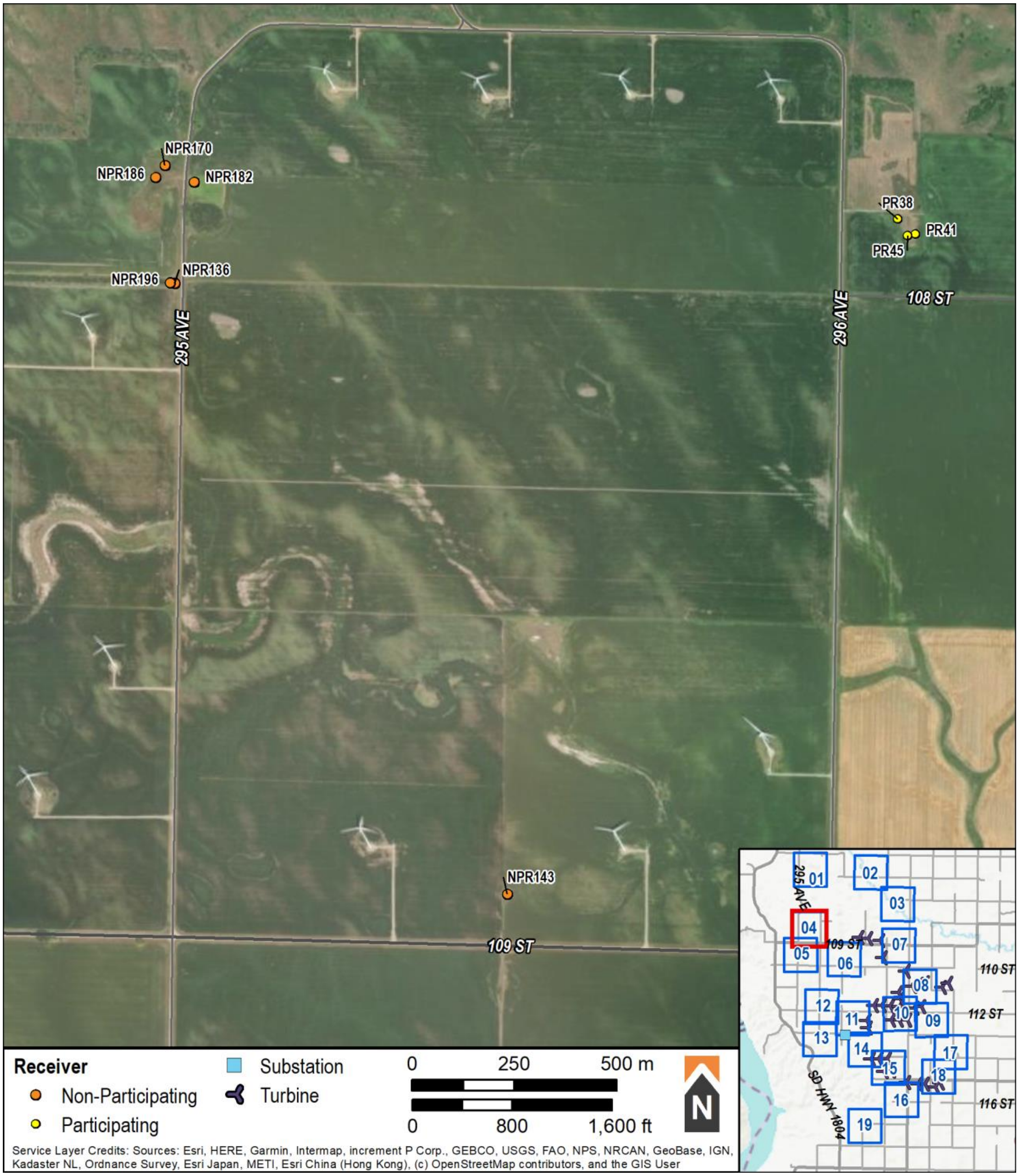

FIGURE 14: RECEIVER MAP 4

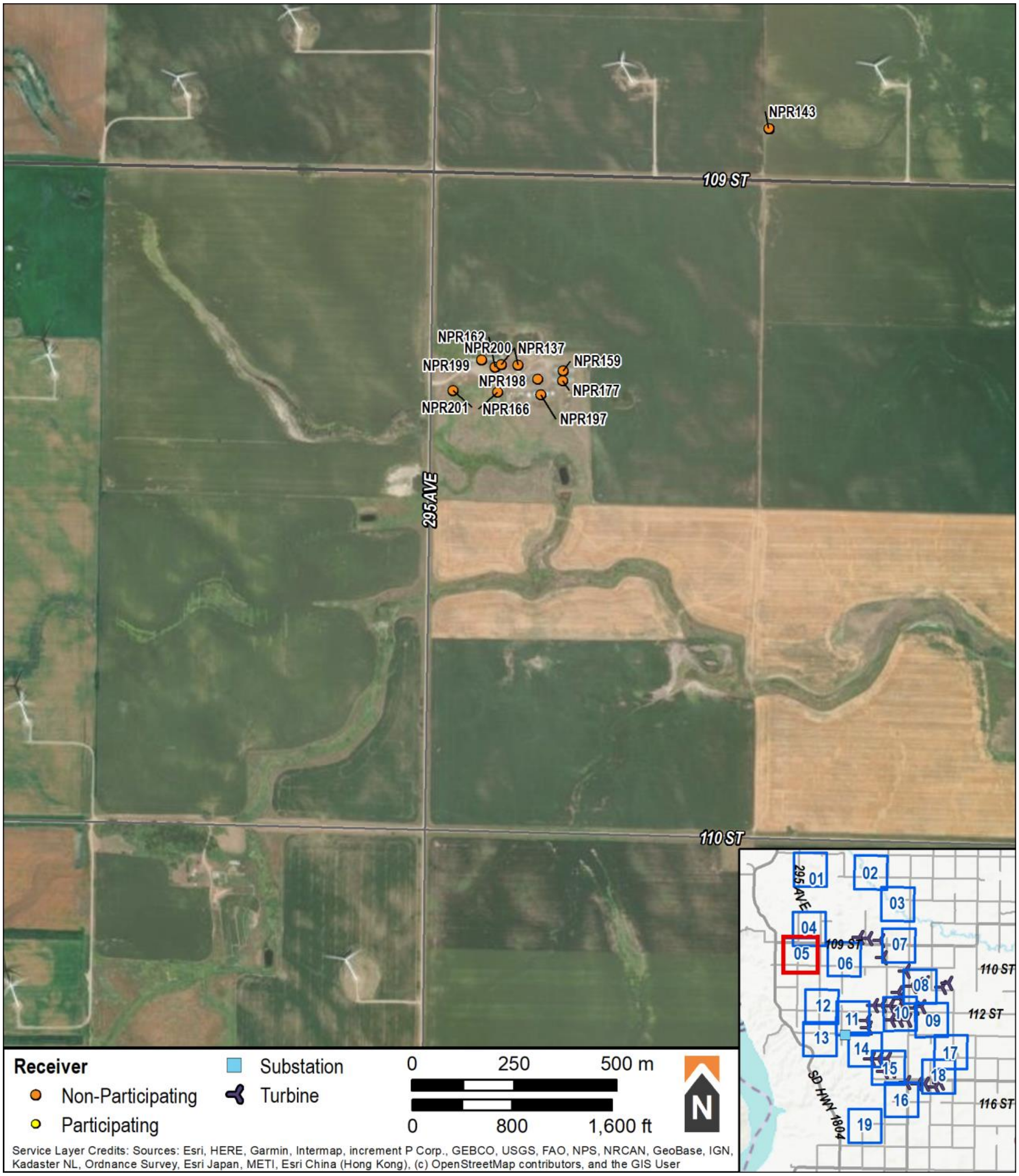

FIGURE 15: RECEIVER MAP 5

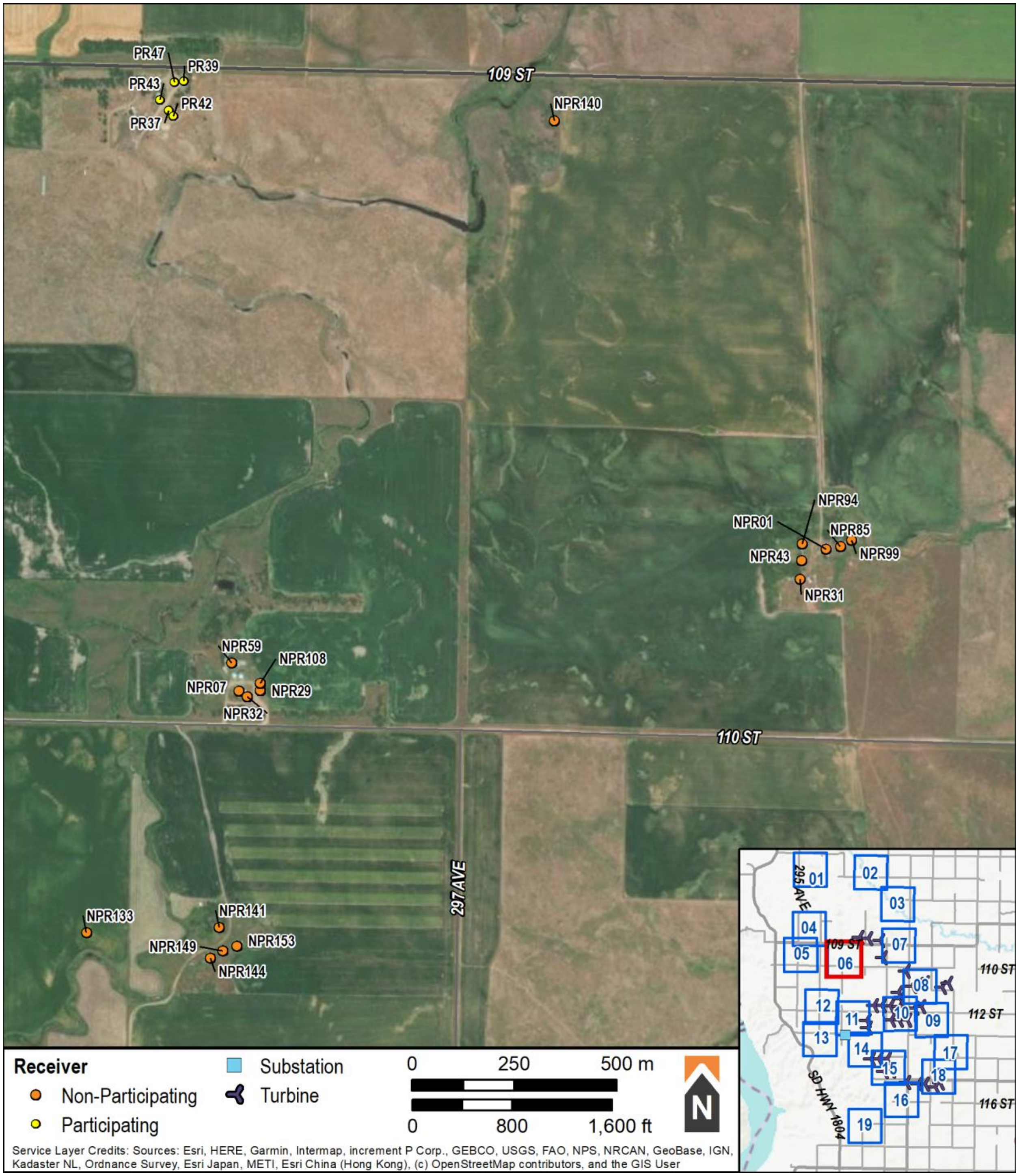

FIGURE 16: RECEIVER MAP 6

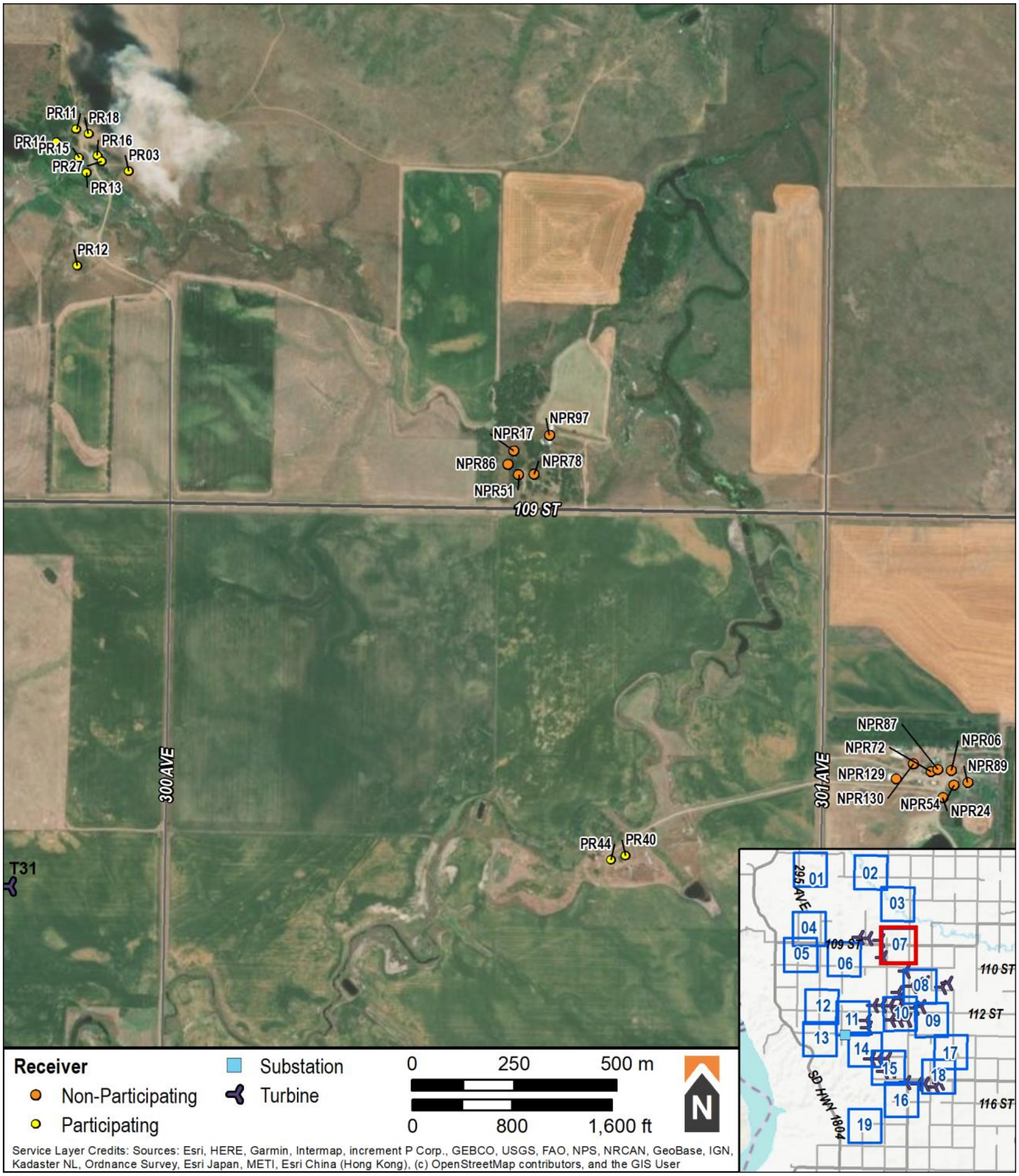

FIGURE 17: RECEIVER MAP 7

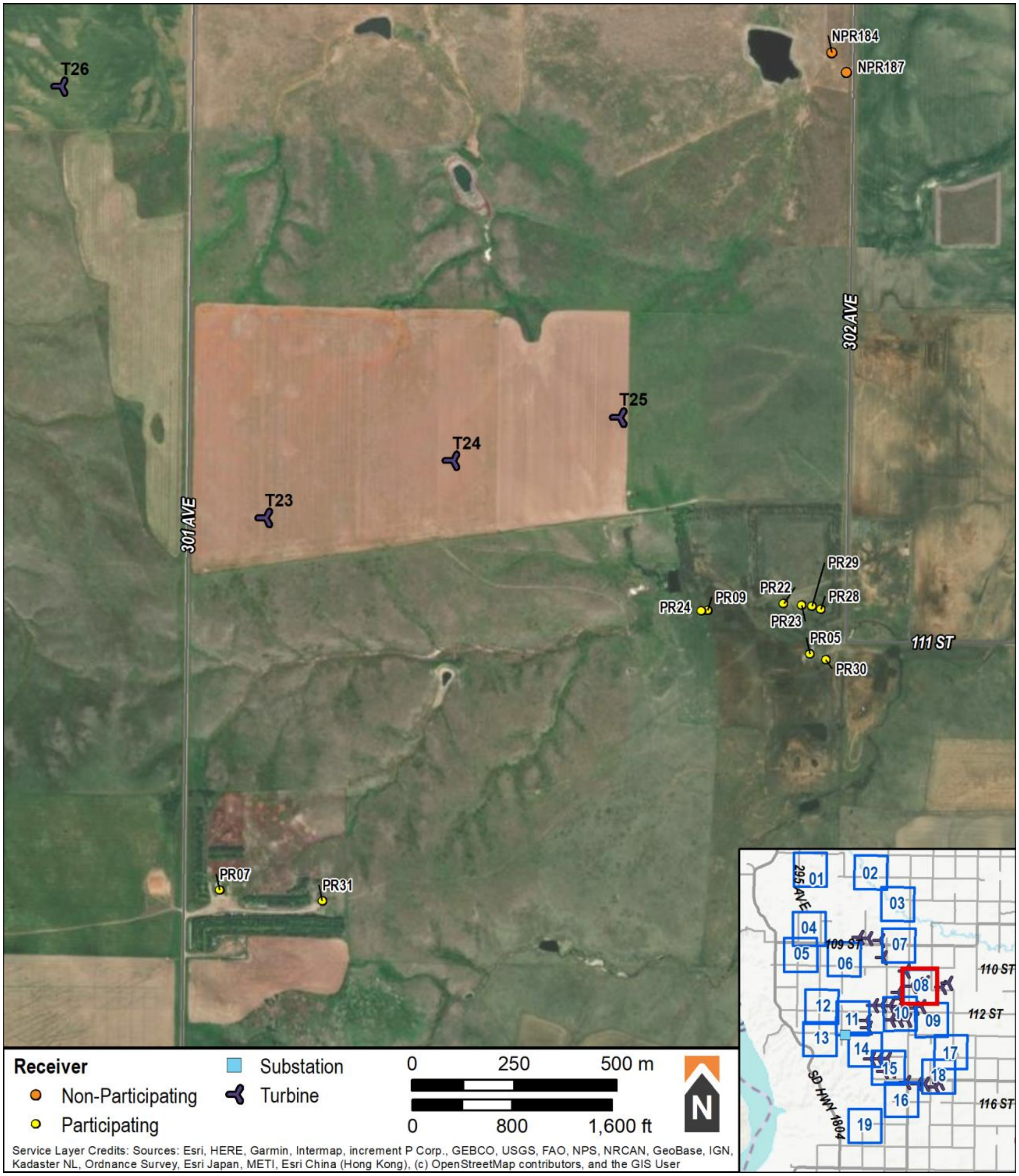

FIGURE 18: RECEIVER MAP 8

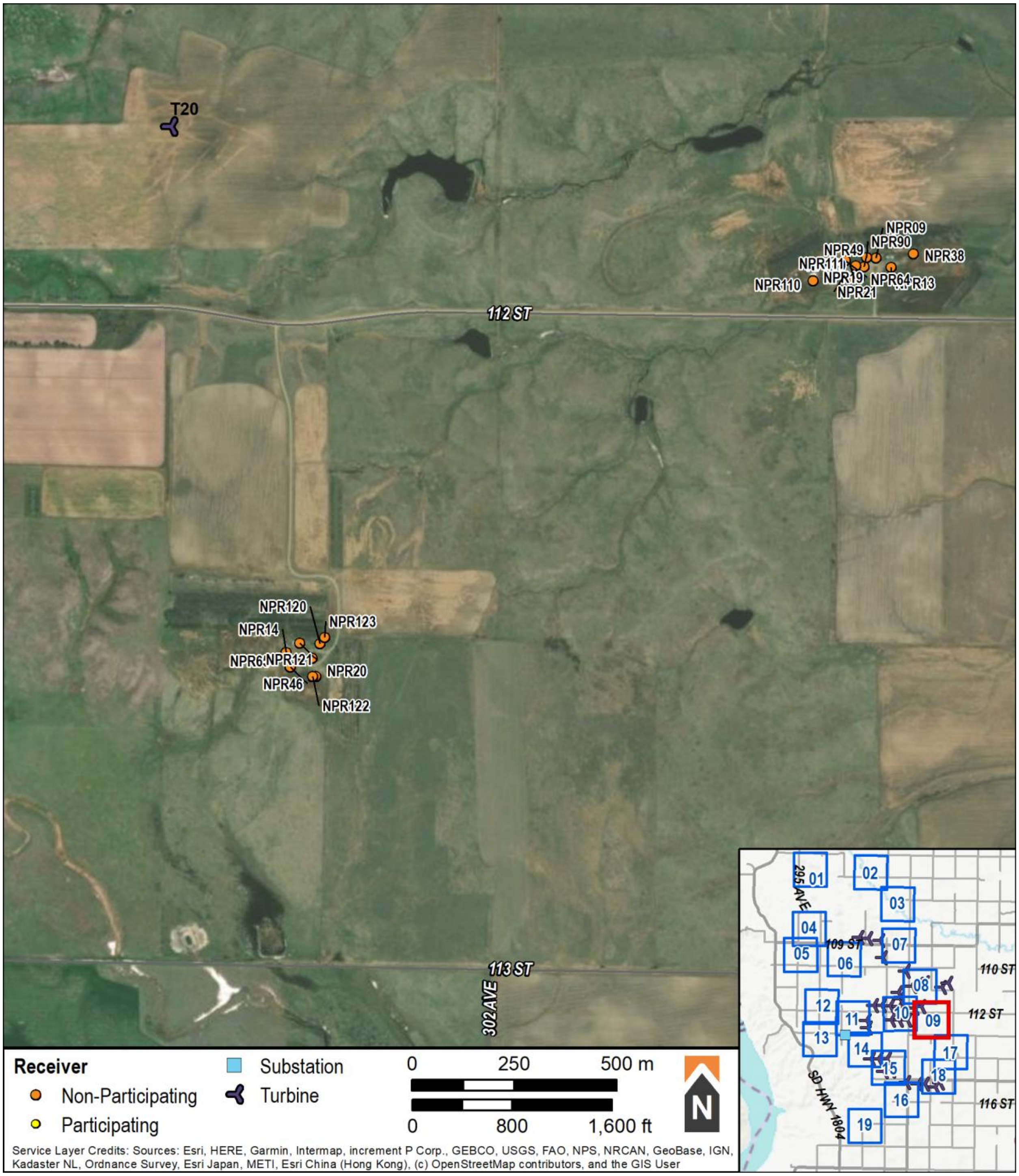

FIGURE 19: RECEIVER MAP 9

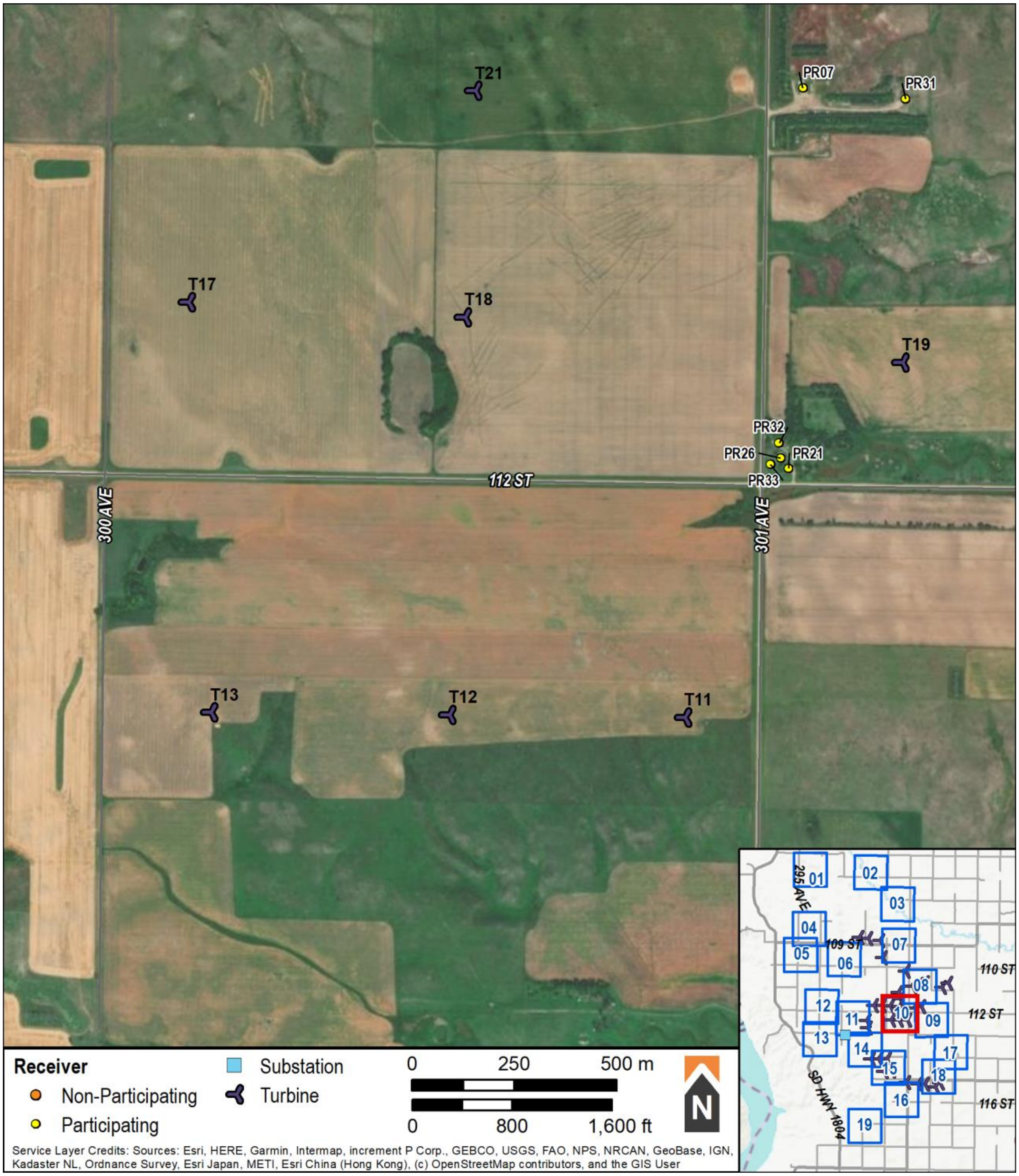

FIGURE 20: RECEIVER MAP 10

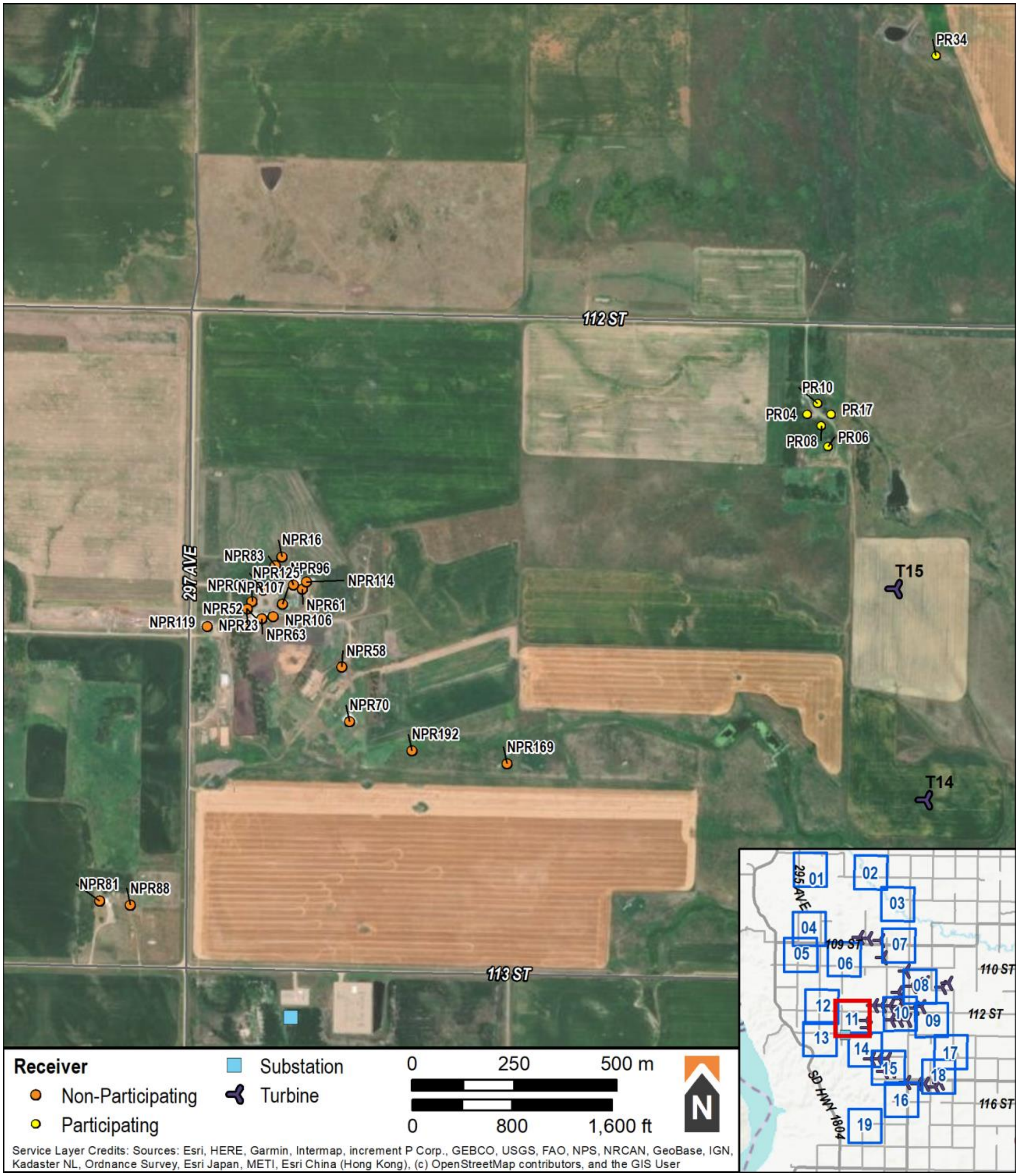

FIGURE 21: RECEIVER MAP 11

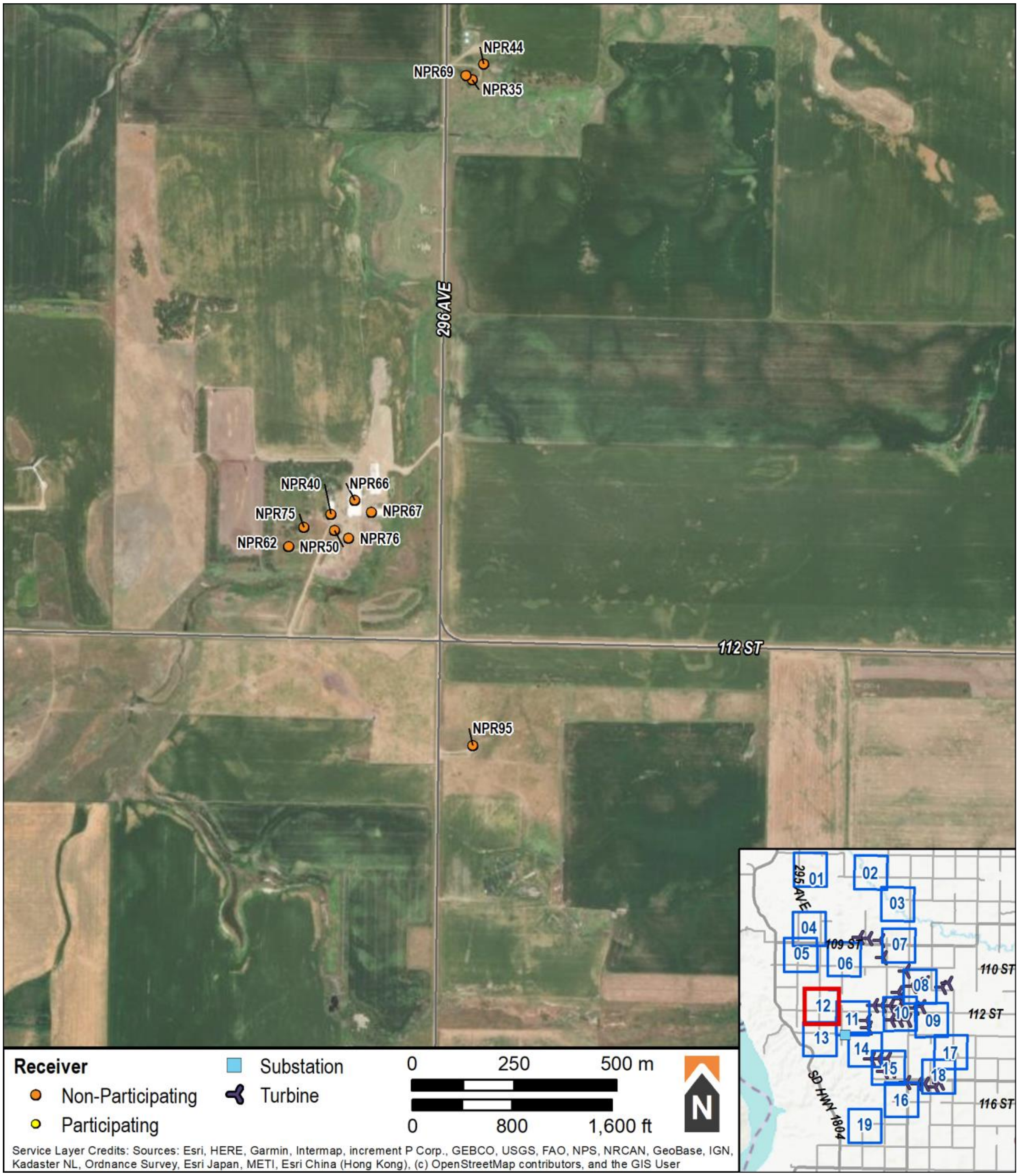

FIGURE 22: RECEIVER MAP 12

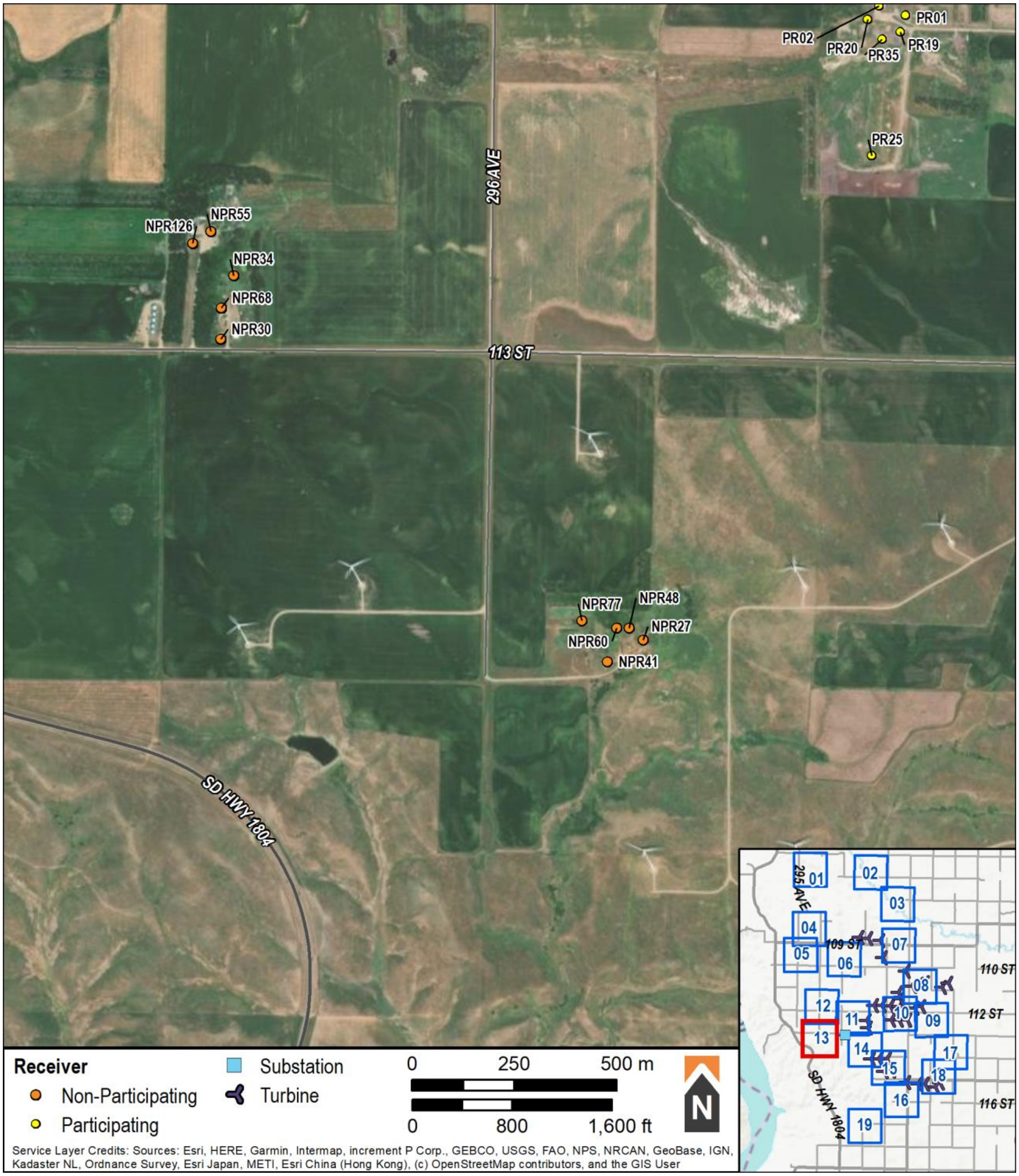

FIGURE 23: RECEIVER MAP 13

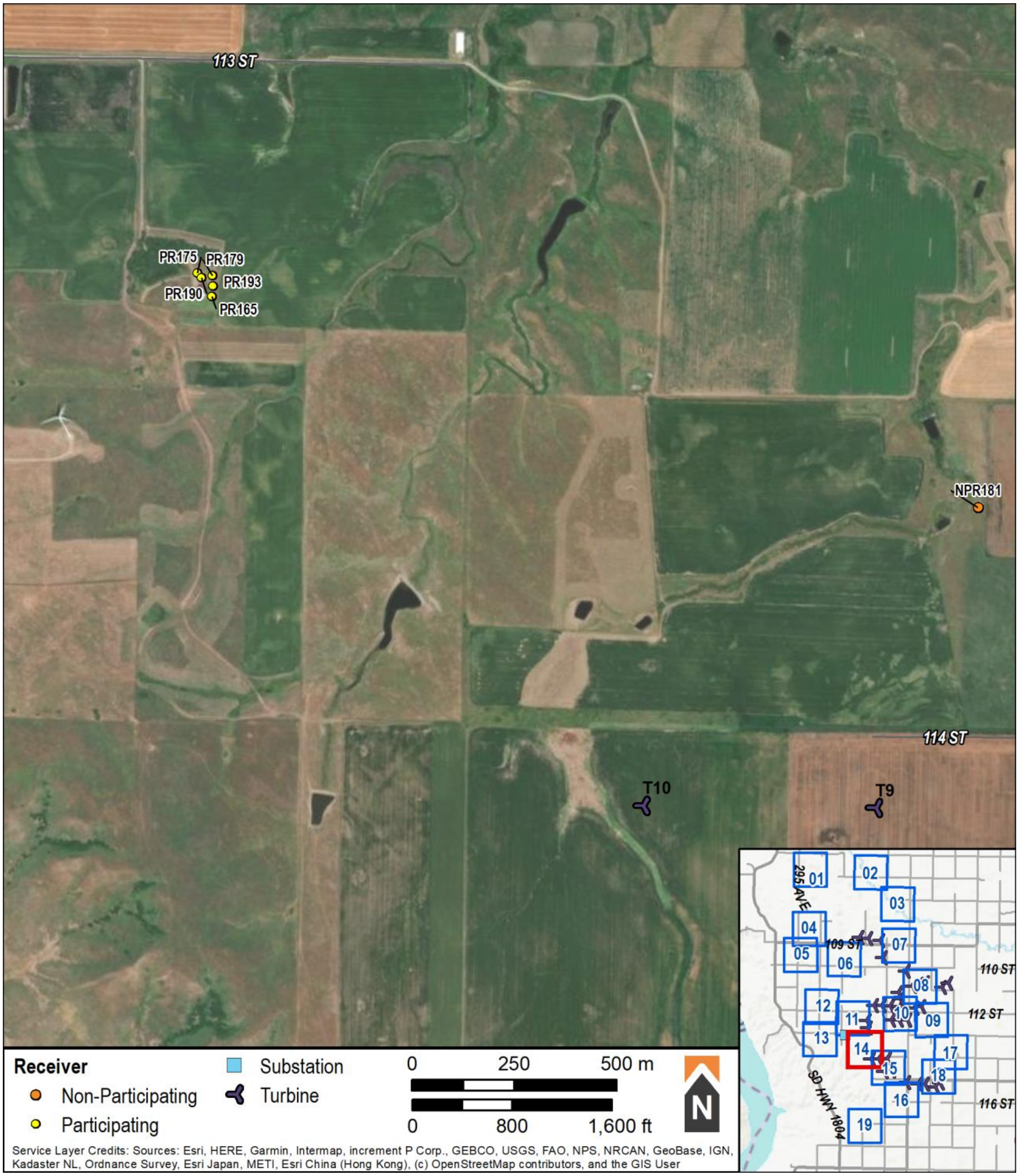

FIGURE 24: RECEIVER MAP 14

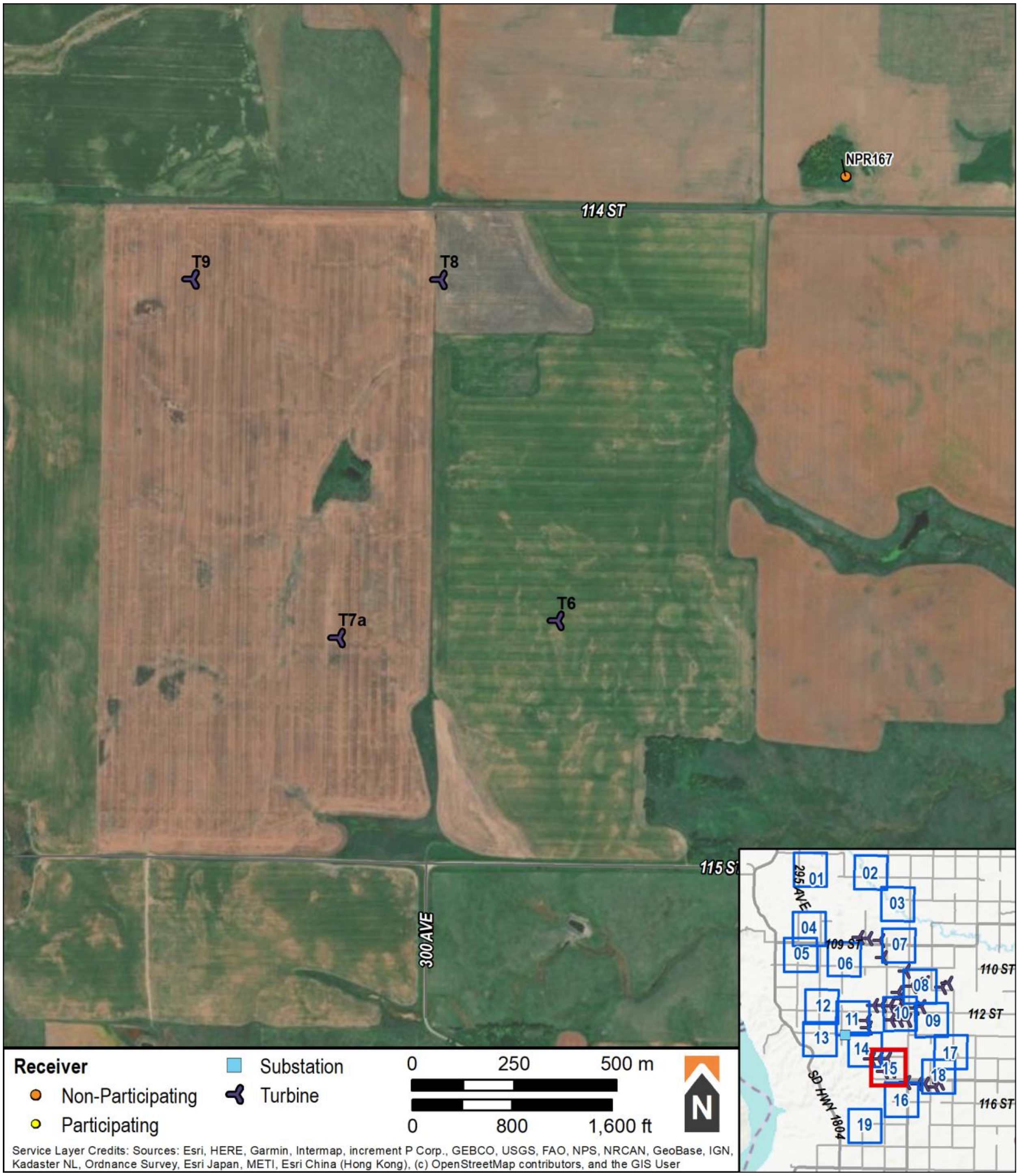

FIGURE 25: RECEIVER MAP 15

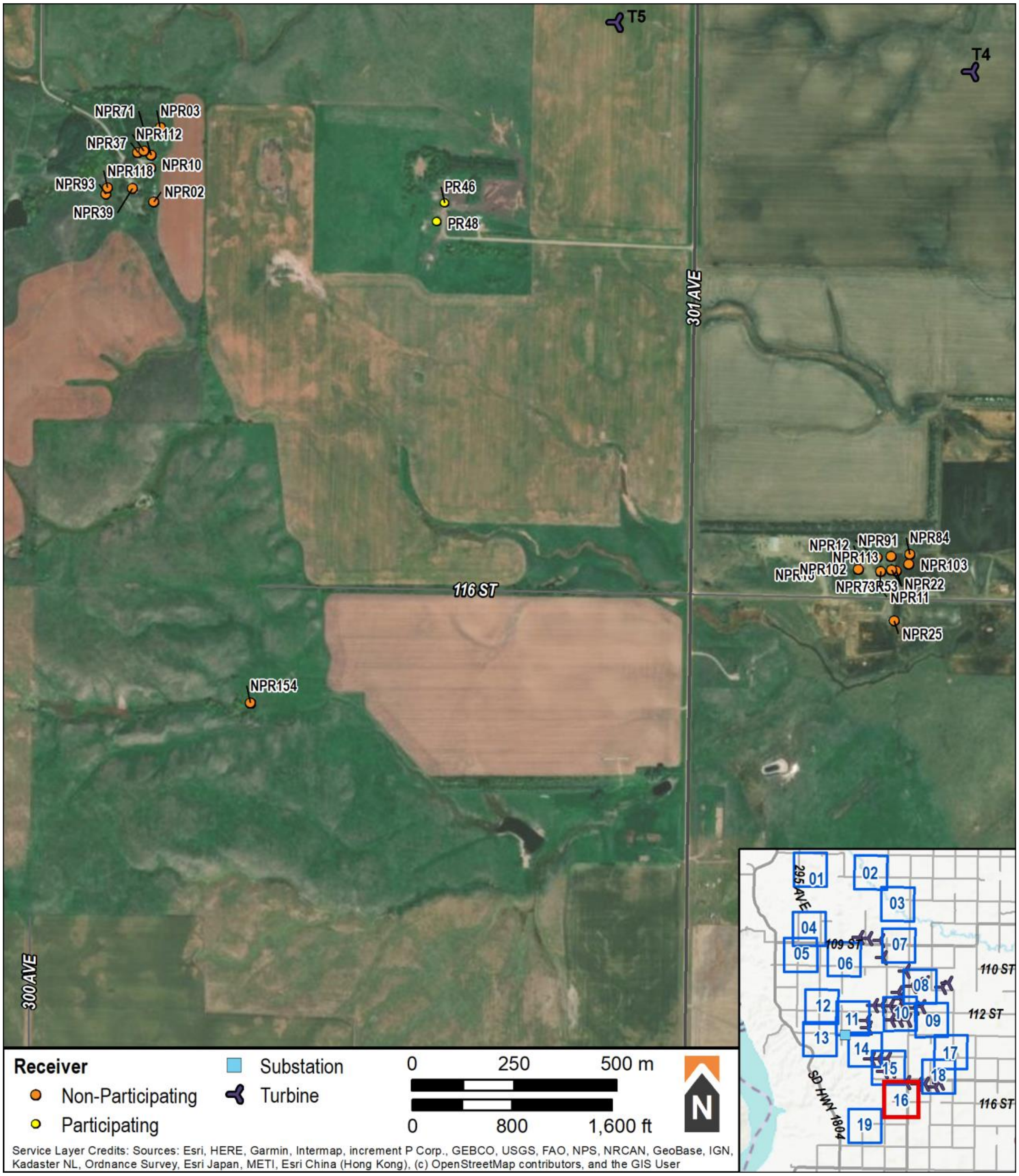

FIGURE 26: RECEIVER MAP 16

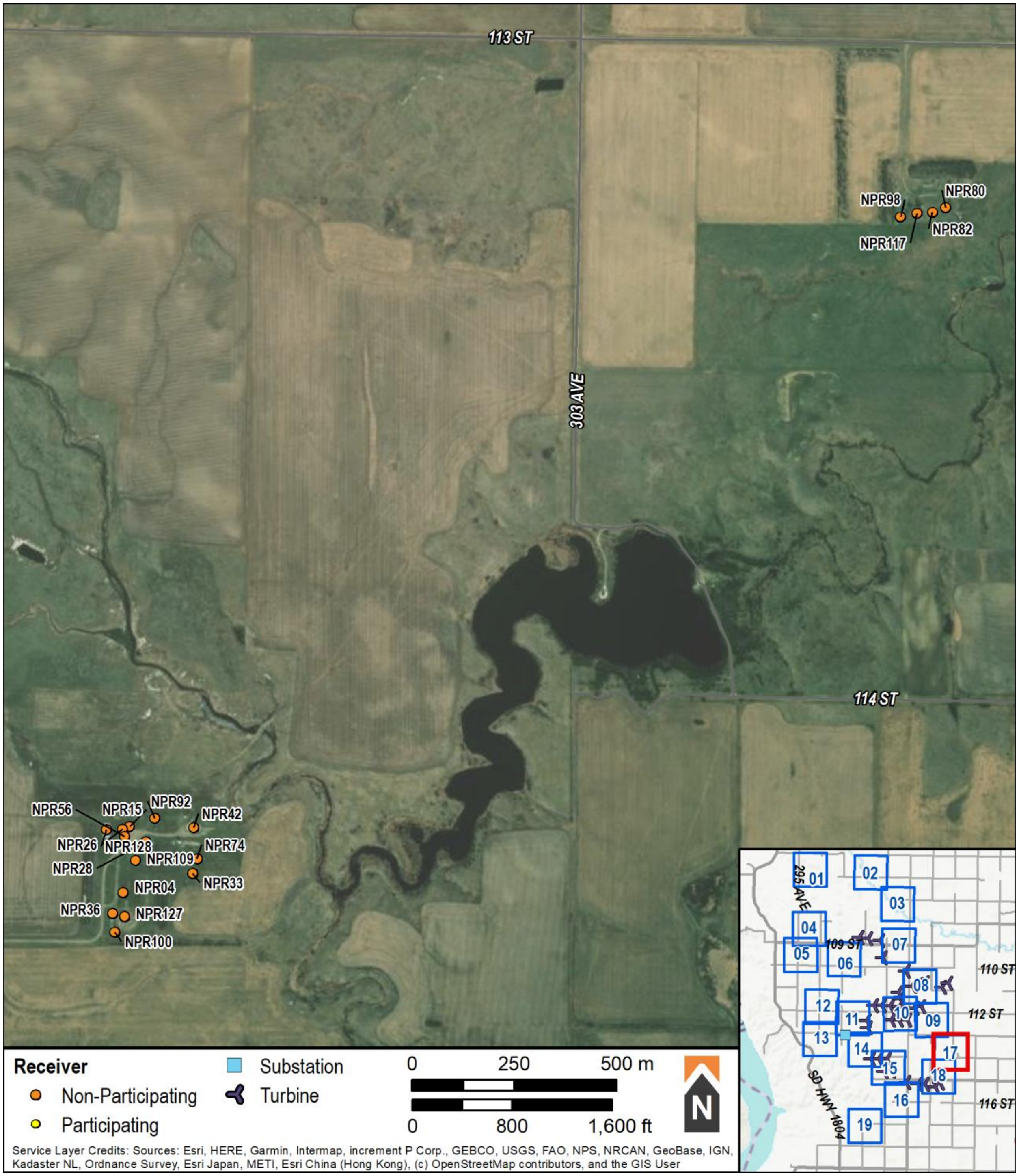

FIGURE 27: RECEIVER MAP 17

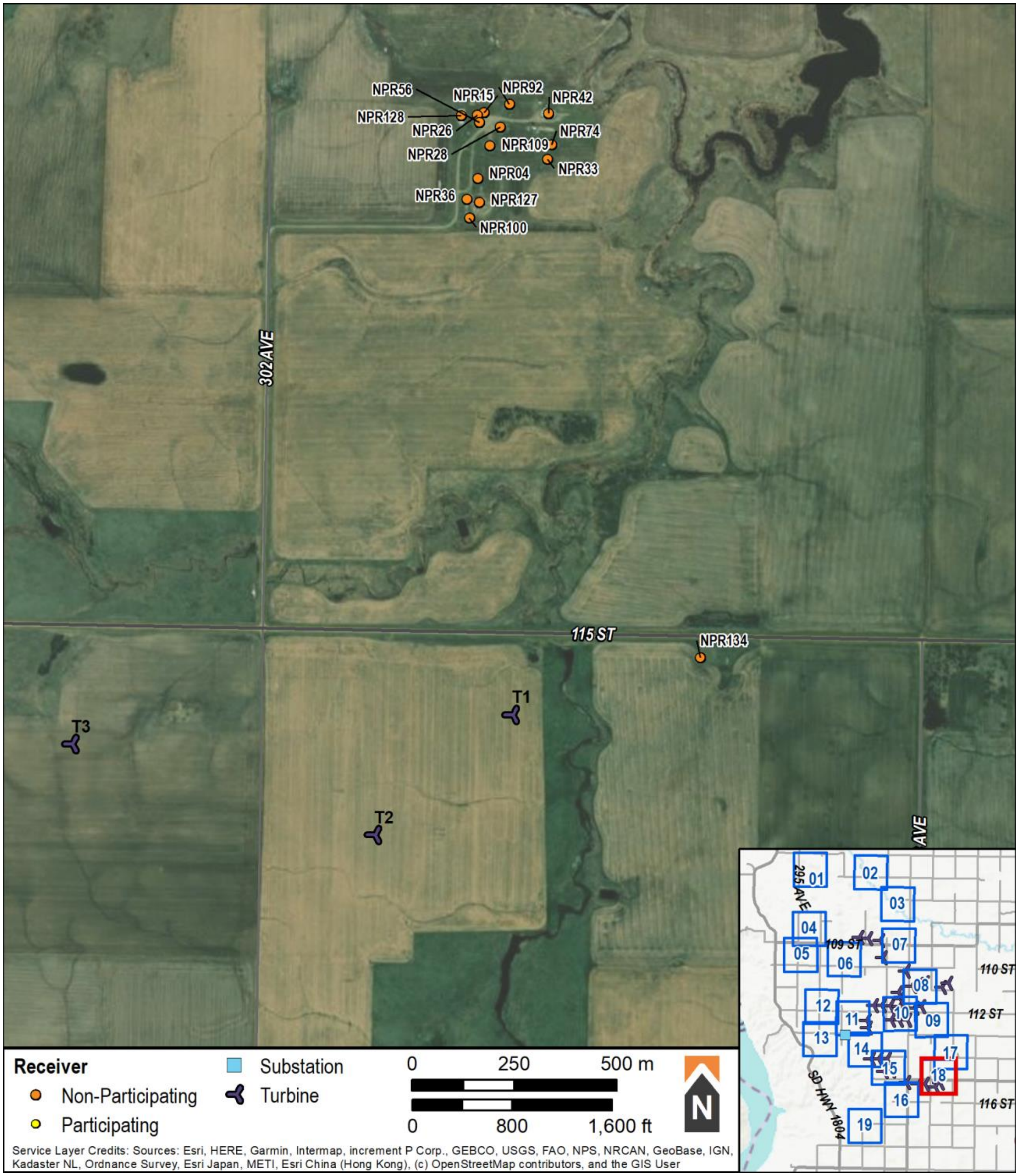

FIGURE 28: RECEIVER MAP 18

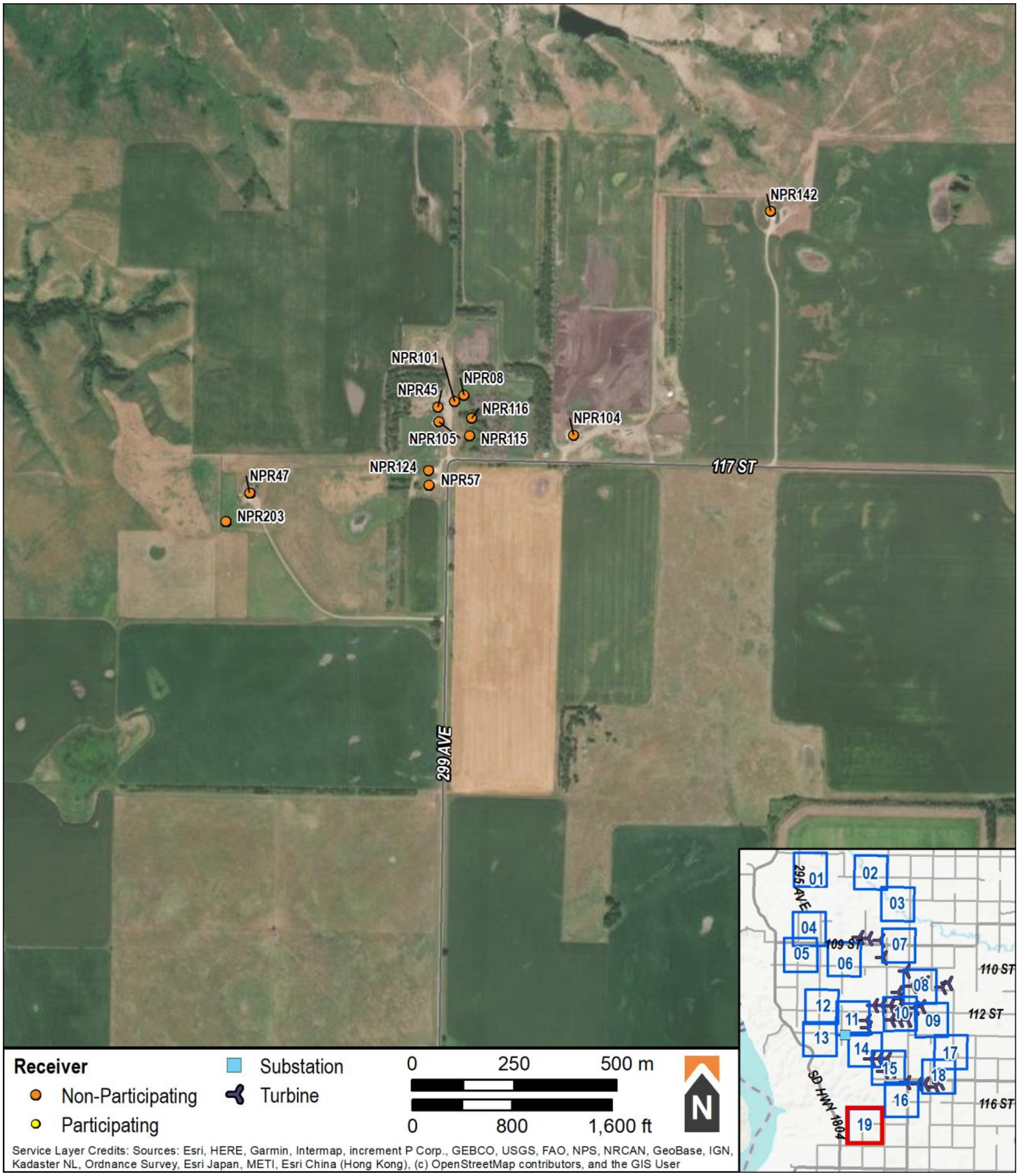

FIGURE 29: RECEIVER MAP 19

TABLE 4: DISCRETE RECEIVER RESULTS – PHASE 2 ONLY

Receiver ID	Receiver Type	Sound Pressure Level (dBA)	Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
				X (m)	Y (m)	
NPR01	Nonparticipating	34	4	404959	5072680	557
NPR02	Nonparticipating	39	4	407428	5063469	613
NPR03	Nonparticipating	40	4	407443	5063650	607
NPR04	Nonparticipating	36	4	410896	5065191	557
NPR05	Nonparticipating	34	4	404166	5068311	610
NPR06	Nonparticipating	36	4	409182	5073131	530
NPR07	Nonparticipating	30	4	403523	5072333	578
NPR08	Nonparticipating	26	4	405556	5061122	616
NPR09	Nonparticipating	35	4	411351	5069041	539
NPR10	Nonparticipating	39	4	407419	5063551	609
NPR11	Nonparticipating	37	4	409201	5062526	576
NPR12	Nonparticipating	37	4	409148	5062596	577
NPR13	Nonparticipating	35	4	411388	5069018	538
NPR14	Nonparticipating	39	4	409910	5068076	584
NPR15	Nonparticipating	36	4	410912	5065352	553
NPR16	Nonparticipating	35	4	404240	5068420	615
NPR17	Nonparticipating	36	4	408113	5073912	524
NPR18	Nonparticipating	37	4	409072	5062567	582
NPR19	Nonparticipating	35	4	411276	5069034	541
NPR20	Nonparticipating	38	4	409982	5068018	584
NPR21	Nonparticipating	35	4	411274	5068998	541
NPR22	Nonparticipating	37	4	409242	5062566	574
NPR23	Nonparticipating	34	4	404154	5068293	609
NPR24	Nonparticipating	36	4	409161	5073065	532
NPR25	Nonparticipating	37	4	409236	5062445	574
NPR26	Nonparticipating	36	4	410894	5065345	553
NPR27	Nonparticipating	26	4	402771	5066748	616
NPR28	Nonparticipating	36	4	410951	5065316	553
NPR29	Nonparticipating	30	4	403575	5072335	577
NPR30	Nonparticipating	20	4	401739	5067484	603
NPR31	Nonparticipating	34	4	404896	5072606	562
NPR32	Nonparticipating	30	4	403543	5072319	578
NPR33	Nonparticipating	36	4	411066	5065238	554

Receiver ID	Receiver Type	Sound Pressure Level (dBA)	Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
				X (m)	Y (m)	
NPR34	Nonparticipating	20	4	401771	5067638	601
NPR35	Nonparticipating	27	4	402496	5070430	581
NPR36	Nonparticipating	37	4	410870	5065140	559
NPR37	Nonparticipating	39	4	407388	5063589	609
NPR38	Nonparticipating	34	4	411442	5069051	537
NPR39	Nonparticipating	39	4	407375	5063501	613
NPR40	Nonparticipating	25	4	402151	5069369	593
NPR41	Nonparticipating	25	4	402683	5066695	615
NPR42	Nonparticipating	35	4	411069	5065350	552
NPR43	Nonparticipating	34	4	404900	5072652	559
NPR44	Nonparticipating	27	4	402525	5070469	580
NPR45	Nonparticipating	26	4	405492	5061093	617
NPR46	Nonparticipating	38	4	409920	5068041	585
NPR47	Nonparticipating	25	4	405032	5060883	618
NPR48	Nonparticipating	26	4	402737	5066778	616
NPR49	Nonparticipating	35	4	411321	5069018	540
NPR50	Nonparticipating	23	4	402160	5069330	592
NPR51	Nonparticipating	36	4	408124	5073854	524
NPR52	Nonparticipating	34	4	404154	5068254	608
NPR53	Nonparticipating	37	4	409230	5062570	574
NPR54	Nonparticipating	36	4	409188	5073095	530
NPR55	Nonparticipating	21	4	401715	5067747	600
NPR56	Nonparticipating	36	4	410900	5065328	554
NPR57	Nonparticipating	25	4	405471	5060902	615
NPR58	Nonparticipating	37	4	404386	5068151	609
NPR59	Nonparticipating	29	4	403506	5072402	575
NPR60	Nonparticipating	26	4	402706	5066778	615
NPR61	Nonparticipating	32	4	404289	5068341	613
NPR62	Nonparticipating	25	4	402048	5069289	595
NPR63	Nonparticipating	32	4	404190	5068269	609
NPR64	Nonparticipating	36	4	411310	5068990	540
NPR65	Nonparticipating	38	4	409972	5068062	585
NPR66	Nonparticipating	25	4	402209	5069403	592
NPR67	Nonparticipating	22	4	402250	5069373	590

Receiver ID	Receiver Type	Sound Pressure Level (dBA)	Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
				X (m)	Y (m)	
NPR68	Nonparticipating	20	4	401740	5067560	602
NPR69	Nonparticipating	27	4	402481	5070440	581
NPR70	Nonparticipating	37	4	404405	5068017	606
NPR71	Nonparticipating	39	4	407421	5063583	608
NPR72	Nonparticipating	36	4	409132	5073128	531
NPR73	Nonparticipating	37	4	409203	5062566	575
NPR74	Nonparticipating	36	4	411077	5065274	553
NPR75	Nonparticipating	26	4	402084	5069337	595
NPR76	Nonparticipating	22	4	402193	5069310	591
NPR77	Nonparticipating	26	4	402621	5066795	615
NPR78	Nonparticipating	36	4	408162	5073854	524
NPR79	Nonparticipating	36	4	411298	5068990	540
NPR80	Nonparticipating	26	4	412906	5066864	535
NPR81	Nonparticipating	36	4	403793	5067579	611
NPR82	Nonparticipating	26	4	412874	5066853	536
NPR83	Nonparticipating	34	4	404222	5068398	613
NPR84	Nonparticipating	37	4	409275	5062607	574
NPR85	Nonparticipating	34	4	404994	5072686	556
NPR86	Nonparticipating	36	4	408098	5073879	524
NPR87	Nonparticipating	36	4	409149	5073133	531
NPR88	Nonparticipating	37	4	403868	5067568	608
NPR89	Nonparticipating	36	4	409222	5073101	529
NPR90	Nonparticipating	35	4	411328	5069042	540
NPR91	Nonparticipating	36	4	409195	5062600	575
NPR92	Nonparticipating	36	4	410973	5065372	552
NPR93	Nonparticipating	38	4	407311	5063488	613
NPR94	Nonparticipating	34	4	404900	5072692	558
NPR95	Nonparticipating	27	4	402498	5068804	615
NPR96	Nonparticipating	33	4	404267	5068351	613
NPR97	Nonparticipating	35	4	408200	5073951	523
NPR98	Nonparticipating	26	4	412796	5066842	538
NPR99	Nonparticipating	34	4	405022	5072701	556
NPR100	Nonparticipating	37	4	410875	5065094	559
NPR101	Nonparticipating	26	4	405532	5061106	617

Receiver ID	Receiver Type	Sound Pressure Level (dBA)	Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
				X (m)	Y (m)	
NPR102	Nonparticipating	37	4	409149	5062570	578
NPR103	Nonparticipating	38	4	409273	5062584	573
NPR104	Nonparticipating	25	4	405823	5061024	616
NPR105	Nonparticipating	26	4	405494	5061056	617
NPR106	Nonparticipating	32	4	404218	5068274	610
NPR107	Nonparticipating	32	4	404240	5068304	611
NPR108	Nonparticipating	30	4	403576	5072353	576
NPR109	Nonparticipating	36	4	410926	5065270	554
NPR110	Nonparticipating	36	4	411197	5068985	541
NPR111	Nonparticipating	35	4	411302	5069021	540
NPR112	Nonparticipating	39	4	407403	5063593	608
NPR113	Nonparticipating	36	4	409229	5062603	575
NPR114	Nonparticipating	32	4	404299	5068358	614
NPR115	Nonparticipating	25	4	405569	5061023	616
NPR116	Nonparticipating	26	4	405575	5061065	616
NPR117	Nonparticipating	26	4	412836	5066850	537
NPR118	Nonparticipating	38	4	407314	5063503	612
NPR119	Nonparticipating	35	4	404056	5068250	610
NPR120	Nonparticipating	38	4	409992	5068098	585
NPR121	Nonparticipating	39	4	409942	5068100	585
NPR122	Nonparticipating	38	4	409974	5068019	584
NPR123	Nonparticipating	38	4	410004	5068113	586
NPR124	Nonparticipating	24	4	405469	5060937	615
NPR125	Nonparticipating	34	4	404192	5068339	610
NPR126	Nonparticipating	20	4	401670	5067718	602
NPR127	Nonparticipating	37	4	410900	5065132	558
NPR128	Nonparticipating	36	4	410856	5065344	554
NPR129	Nonparticipating	36	4	409047	5073110	533
NPR130	Nonparticipating	36	4	409089	5073147	531
NPR131	Nonparticipating	9	4	402622	5080107	311
NPR132	Nonparticipating	27	4	408848	5076491	508
NPR133	Nonparticipating	28	4	403151	5071742	575
NPR134	Nonparticipating	44	4	411440	5064020	571
NPR135	Nonparticipating	21	4	406113	5079119	504

Receiver ID	Receiver Type	Sound Pressure Level (dBA)	Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
				X (m)	Y (m)	
NPR136	Nonparticipating	20	4	400882	5075517	598
NPR137	Nonparticipating	23	4	401082	5073446	594
NPR138	Nonparticipating	9	4	402685	5080170	297
NPR139	Nonparticipating	9	4	402669	5080216	286
NPR140	Nonparticipating	36	4	404295	5073727	578
NPR141	Nonparticipating	27	4	403476	5071755	575
NPR142	Nonparticipating	28	4	406305	5061571	630
NPR143	Nonparticipating	24	4	401695	5074024	592
NPR144	Nonparticipating	28	4	403454	5071680	574
NPR145	Nonparticipating	26	4	407981	5076970	507
NPR146	Nonparticipating	9	4	402652	5080140	303
NPR147	Nonparticipating	9	4	402601	5080067	319
NPR148	Nonparticipating	26	4	407674	5077017	511
NPR149	Nonparticipating	27	4	403485	5071698	574
NPR150	Nonparticipating	21	4	406148	5079122	505
NPR151	Nonparticipating	22	4	408039	5076948	507
NPR152	Nonparticipating	27	4	407928	5077003	508
NPR153	Nonparticipating	26	4	403518	5071709	575
NPR154	Nonparticipating	31	4	407663	5062245	604
NPR155	Nonparticipating	25	4	408012	5076976	507
NPR156	Nonparticipating	9	4	402660	5080216	287
NPR157	Nonparticipating	9	4	402684	5080203	289
NPR158	Nonparticipating	21	4	406093	5079167	505
NPR159	Nonparticipating	23	4	401193	5073433	594
NPR160	Nonparticipating	23	4	408170	5076940	507
NPR161	Nonparticipating	26	4	407986	5076932	508
NPR162	Nonparticipating	20	4	401027	5073442	593
NPR163	Nonparticipating	9	4	402653	5080074	318
NPR164	Nonparticipating	27	4	408055	5076870	511
NPR166	Nonparticipating	19	4	401033	5073380	592
NPR167	Nonparticipating	40	4	408182	5065821	606
NPR168	Nonparticipating	9	4	402678	5080120	308
NPR169	Nonparticipating	39	4	404789	5067914	603
NPR170	Nonparticipating	20	4	400858	5075805	598

Receiver ID	Receiver Type	Sound Pressure Level (dBA)	Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
				X (m)	Y (m)	
NPR171	Nonparticipating	9	4	402694	5080087	315
NPR172	Nonparticipating	6	4	400755	5079792	392
NPR173	Nonparticipating	9	4	402546	5080225	285
NPR174	Nonparticipating	27	4	407875	5076967	508
NPR176	Nonparticipating	9	4	402577	5080081	316
NPR177	Nonparticipating	23	4	401191	5073408	594
NPR178	Nonparticipating	9	4	402634	5080042	325
NPR180	Nonparticipating	21	4	406109	5079164	506
NPR181	Nonparticipating	43	4	406834	5066304	602
NPR182	Nonparticipating	20	4	400930	5075764	597
NPR183	Nonparticipating	26	4	408114	5076866	512
NPR184	Nonparticipating	40	4	410412	5071946	542
NPR185	Nonparticipating	27	4	407987	5076860	509
NPR186	Nonparticipating	20	4	400836	5075775	596
NPR187	Nonparticipating	40	4	410447	5071898	543
NPR188	Nonparticipating	27	4	408024	5076870	511
NPR189	Nonparticipating	25	4	408007	5076924	509
NPR191	Nonparticipating	23	4	408081	5076933	507
NPR192	Nonparticipating	37	4	404557	5067945	602
NPR194	Nonparticipating	21	4	406236	5079146	505
NPR195	Nonparticipating	21	4	406062	5079181	504
NPR196	Nonparticipating	20	4	400871	5075517	598
NPR197	Nonparticipating	23	4	401138	5073374	593
NPR198	Nonparticipating	23	4	401130	5073412	594
NPR199	Nonparticipating	20	4	400993	5073459	593
NPR200	Nonparticipating	21	4	401042	5073448	593
NPR201	Nonparticipating	19	4	400923	5073384	589
NPR202	Nonparticipating	6	4	400730	5079811	388
NPR203	Nonparticipating	23	4	404973	5060812	617
PR01	Participating	32	4	403413	5068275	602
PR02	Participating	32	4	403348	5068298	604
PR03	Participating	40	4	407172	5074595	538
PR04	Participating	44	4	405523	5068768	607
PR05	Participating	43	4	410359	5070477	551

Receiver ID	Receiver Type	Sound Pressure Level (dBA)	Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
				X (m)	Y (m)	
PR06	Participating	46	4	405574	5068689	606
PR07	Participating	46	4	408916	5069900	602
PR08	Participating	45	4	405557	5068739	606
PR09	Participating	45	4	410108	5070584	551
PR10	Participating	44	4	405549	5068794	606
PR11	Participating	40	4	407044	5074698	541
PR12	Participating	44	4	407046	5074365	540
PR13	Participating	41	4	407068	5074591	536
PR14	Participating	41	4	406995	5074666	537
PR15	Participating	41	4	407050	5074628	538
PR16	Participating	41	4	407095	5074634	539
PR17	Participating	45	4	405582	5068768	605
PR18	Participating	40	4	407073	5074687	542
PR19	Participating	31	4	403400	5068234	601
PR20	Participating	30	4	403320	5068265	603
PR21	Participating	48	4	408881	5068971	589
PR22	Participating	44	4	410294	5070601	547
PR23	Participating	44	4	410337	5070596	547
PR24	Participating	45	4	410093	5070582	552
PR25	Participating	29	4	403330	5067932	609
PR26	Participating	48	4	408862	5068997	590
PR27	Participating	41	4	407105	5074620	538
PR28	Participating	44	4	410385	5070587	546
PR29	Participating	44	4	410364	5070594	547
PR30	Participating	43	4	410397	5070463	551
PR31	Participating	46	4	409167	5069873	599
PR32	Participating	48	4	408857	5069033	589
PR33	Participating	48	4	408836	5068981	590
PR34	Participating	37	4	405838	5069645	576
PR35	Participating	30	4	403356	5068217	601
PR36	Participating	13	4	402793	5078512	525
PR37	Participating	31	4	403352	5073752	582
PR38	Participating	26	4	402650	5075673	597
PR39	Participating	31	4	403389	5073823	584

Receiver ID	Receiver Type	Sound Pressure Level (dBA)	Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
				X (m)	Y (m)	
PR40	Participating	38	4	408386	5072922	528
PR41	Participating	26	4	402693	5075637	596
PR42	Participating	31	4	403364	5073737	581
PR43	Participating	31	4	403331	5073777	582
PR44	Participating	38	4	408350	5072912	527
PR45	Participating	26	4	402674	5075634	596
PR46	Participating	42	4	408139	5063466	598
PR47	Participating	31	4	403366	5073821	584
PR48	Participating	42	4	408120	5063420	598
PR165[13]	Participating	37	4	404961	5066820	613
PR175[13]	Participating	37	4	404925	5066876	615
PR179[13]	Participating	37	4	404963	5066871	613
PR190[13]	Participating	37	4	404936	5066865	615
PR193[13]	Participating	37	4	404964	5066844	613

[13] Previously incorrectly labeled as nonparticipating.

APPENDIX E. MODELING RESULTS INCLUDING PHASE 1

Figure 30 is a sound level contour map showing modeling results for both phases. Table 5 shows discrete modeling results for both phases combined and Phase 1 alone. Sound levels from Phase 1 alone are above 45 dBA for a number of receptors, with the highest of 53 dBA at a Phase 2 nonparticipant (NPR196). Note that Phase 1 was permitted before the most recent wind turbine ordinance was passed. At this receptor and others with higher sound levels, the Phase 1 project is easily the greater contributor with sound levels at least 10 dB higher than Phase 2. This is the case for 30 receptors.

There is one nonparticipating receptor (NPR 88) that has a modeled increase from 50.4 dBA in Phase 1 to 50.6 dBA in Phase 2. However, this 0.2 dB increase shows in the table as an increase from 50 to 51 dBA due to rounding. The Phase 2 contribution here is negligible, at 37 dBA.

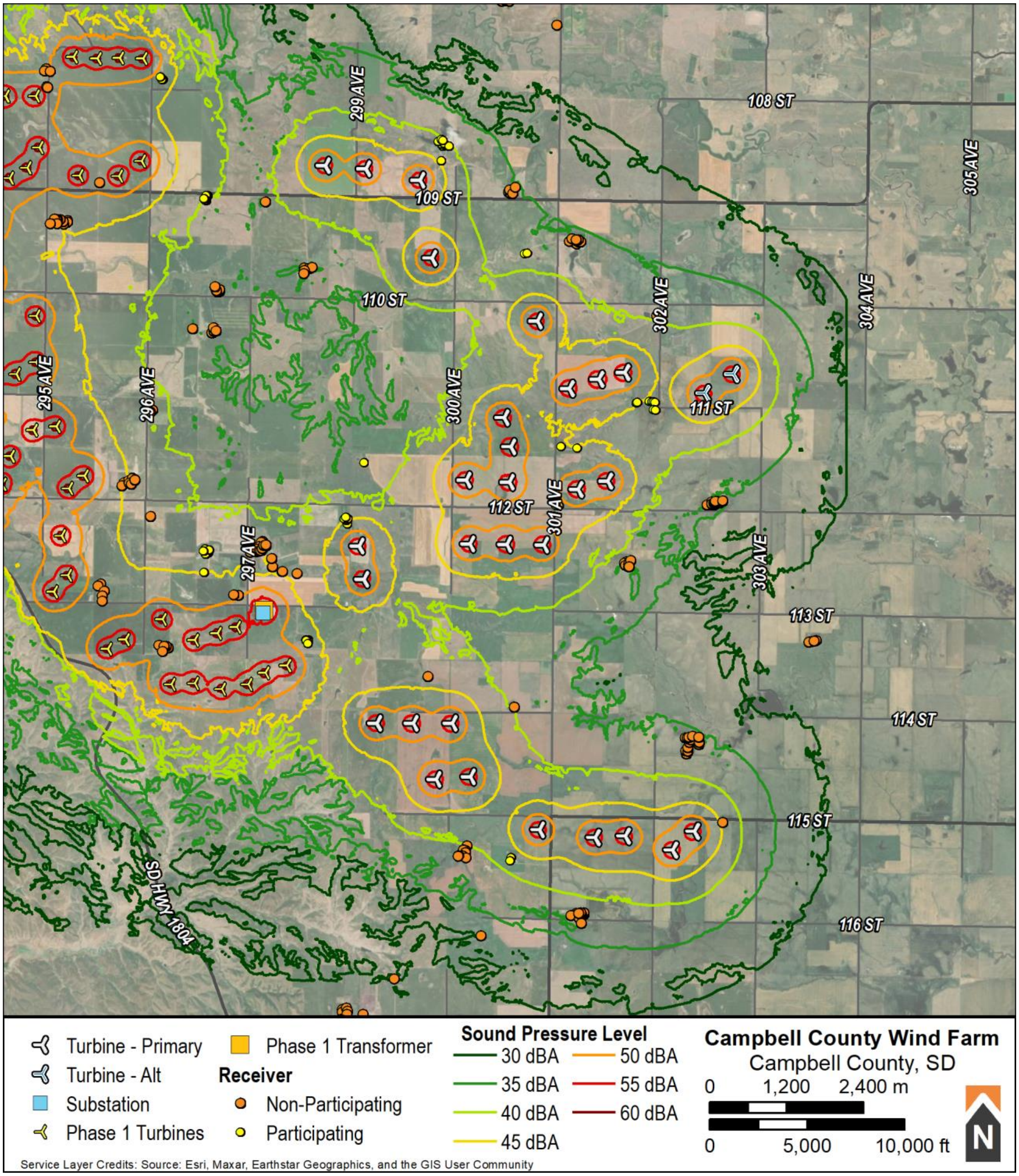

FIGURE 30: SOUND PROPAGATION MODELING RESULTS - BOTH PHASES

TABLE 5: DISCRETE RECEIVER RESULTS - PHASE 1 AND COMBINED

Receiver ID	Receiver Type	Sound Pressure Level (dBA)		Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
		Phase 1	Both Phases		X (m)	Y (m)	
NPR01	Nonparticipating	29	35	4	404959	5072680	557
NPR02	Nonparticipating	24	39	4	407428	5063469	613
NPR03	Nonparticipating	23	40	4	407443	5063650	607
NPR04	Nonparticipating	16	36	4	410896	5065191	557
NPR05	Nonparticipating	41	42	4	404166	5068311	610
NPR06	Nonparticipating	18	36	4	409182	5073131	530
NPR07	Nonparticipating	38	38	4	403523	5072333	578
NPR08	Nonparticipating	26	29	4	405556	5061122	616
NPR09	Nonparticipating	13	35	4	411351	5069041	539
NPR10	Nonparticipating	23	39	4	407419	5063551	609
NPR11	Nonparticipating	17	37	4	409201	5062526	576
NPR12	Nonparticipating	17	37	4	409148	5062596	577
NPR13	Nonparticipating	13	35	4	411388	5069018	538
NPR14	Nonparticipating	25	39	4	409910	5068076	584
NPR15	Nonparticipating	18	36	4	410912	5065352	553
NPR16	Nonparticipating	42	43	4	404240	5068420	615
NPR17	Nonparticipating	19	36	4	408113	5073912	524
NPR18	Nonparticipating	17	37	4	409072	5062567	582
NPR19	Nonparticipating	13	36	4	411276	5069034	541
NPR20	Nonparticipating	25	38	4	409982	5068018	584
NPR21	Nonparticipating	13	35	4	411274	5068998	541
NPR22	Nonparticipating	17	37	4	409242	5062566	574
NPR23	Nonparticipating	41	42	4	404154	5068293	609
NPR24	Nonparticipating	16	36	4	409161	5073065	532
NPR25	Nonparticipating	17	37	4	409236	5062445	574
NPR26	Nonparticipating	16	36	4	410894	5065345	553
NPR27	Nonparticipating	51	51	4	402771	5066748	616
NPR28	Nonparticipating	16	36	4	410951	5065316	553
NPR29	Nonparticipating	37	37	4	403575	5072335	577
NPR30	Nonparticipating	48	48	4	401739	5067484	603
NPR31	Nonparticipating	30	35	4	404896	5072606	562
NPR32	Nonparticipating	38	38	4	403543	5072319	578
NPR33	Nonparticipating	17	36	4	411066	5065238	554

Receiver ID	Receiver Type	Sound Pressure Level (dBA)		Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
		Phase 1	Both Phases		X (m)	Y (m)	
NPR34	Nonparticipating	47	47	4	401771	5067638	601
NPR35	Nonparticipating	41	41	4	402496	5070430	581
NPR36	Nonparticipating	16	37	4	410870	5065140	559
NPR37	Nonparticipating	23	39	4	407388	5063589	609
NPR38	Nonparticipating	12	35	4	411442	5069051	537
NPR39	Nonparticipating	23	39	4	407375	5063501	613
NPR40	Nonparticipating	45	45	4	402151	5069369	593
NPR41	Nonparticipating	51	51	4	402683	5066695	615
NPR42	Nonparticipating	18	36	4	411069	5065350	552
NPR43	Nonparticipating	30	35	4	404900	5072652	559
NPR44	Nonparticipating	41	41	4	402525	5070469	580
NPR45	Nonparticipating	26	29	4	405492	5061093	617
NPR46	Nonparticipating	25	39	4	409920	5068041	585
NPR47	Nonparticipating	24	27	4	405032	5060883	618
NPR48	Nonparticipating	51	51	4	402737	5066778	616
NPR49	Nonparticipating	13	35	4	411321	5069018	540
NPR50	Nonparticipating	44	45	4	402160	5069330	592
NPR51	Nonparticipating	18	36	4	408124	5073854	524
NPR52	Nonparticipating	42	42	4	404154	5068254	608
NPR53	Nonparticipating	17	37	4	409230	5062570	574
NPR54	Nonparticipating	15	36	4	409188	5073095	530
NPR55	Nonparticipating	48	48	4	401715	5067747	600
NPR56	Nonparticipating	16	36	4	410900	5065328	554
NPR57	Nonparticipating	23	27	4	405471	5060902	615
NPR58	Nonparticipating	43	44	4	404386	5068151	609
NPR59	Nonparticipating	37	38	4	403506	5072402	575
NPR60	Nonparticipating	51	51	4	402706	5066778	615
NPR61	Nonparticipating	41	42	4	404289	5068341	613
NPR62	Nonparticipating	45	45	4	402048	5069289	595
NPR63	Nonparticipating	42	42	4	404190	5068269	609
NPR64	Nonparticipating	13	36	4	411310	5068990	540
NPR65	Nonparticipating	25	38	4	409972	5068062	585
NPR66	Nonparticipating	44	44	4	402209	5069403	592
NPR67	Nonparticipating	44	44	4	402250	5069373	590

Receiver ID	Receiver Type	Sound Pressure Level (dBA)		Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
		Phase 1	Both Phases		X (m)	Y (m)	
NPR68	Nonparticipating	48	48	4	401740	5067560	602
NPR69	Nonparticipating	41	41	4	402481	5070440	581
NPR70	Nonparticipating	44	45	4	404405	5068017	606
NPR71	Nonparticipating	23	39	4	407421	5063583	608
NPR72	Nonparticipating	20	36	4	409132	5073128	531
NPR73	Nonparticipating	17	37	4	409203	5062566	575
NPR74	Nonparticipating	17	36	4	411077	5065274	553
NPR75	Nonparticipating	45	45	4	402084	5069337	595
NPR76	Nonparticipating	44	44	4	402193	5069310	591
NPR77	Nonparticipating	51	51	4	402621	5066795	615
NPR78	Nonparticipating	18	36	4	408162	5073854	524
NPR79	Nonparticipating	13	36	4	411298	5068990	540
NPR80	Nonparticipating	0	26	4	412906	5066864	535
NPR81	Nonparticipating	49	49	4	403793	5067579	611
NPR82	Nonparticipating	0	26	4	412874	5066853	536
NPR83	Nonparticipating	43	43	4	404222	5068398	613
NPR84	Nonparticipating	17	37	4	409275	5062607	574
NPR85	Nonparticipating	29	35	4	404994	5072686	556
NPR86	Nonparticipating	18	36	4	408098	5073879	524
NPR87	Nonparticipating	20	36	4	409149	5073133	531
NPR88	Nonparticipating	50	51	4	403868	5067568	608
NPR89	Nonparticipating	15	36	4	409222	5073101	529
NPR90	Nonparticipating	13	35	4	411328	5069042	540
NPR91	Nonparticipating	17	36	4	409195	5062600	575
NPR92	Nonparticipating	18	36	4	410973	5065372	552
NPR93	Nonparticipating	23	38	4	407311	5063488	613
NPR94	Nonparticipating	30	35	4	404900	5072692	558
NPR95	Nonparticipating	43	43	4	402498	5068804	615
NPR96	Nonparticipating	42	42	4	404267	5068351	613
NPR97	Nonparticipating	18	35	4	408200	5073951	523
NPR98	Nonparticipating	0	26	4	412796	5066842	538
NPR99	Nonparticipating	29	35	4	405022	5072701	556
NPR100	Nonparticipating	16	37	4	410875	5065094	559
NPR101	Nonparticipating	26	29	4	405532	5061106	617

Receiver ID	Receiver Type	Sound Pressure Level (dBA)		Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
		Phase 1	Both Phases		X (m)	Y (m)	
NPR102	Nonparticipating	17	37	4	409149	5062570	578
NPR103	Nonparticipating	17	38	4	409273	5062584	573
NPR104	Nonparticipating	26	28	4	405823	5061024	616
NPR105	Nonparticipating	26	29	4	405494	5061056	617
NPR106	Nonparticipating	42	42	4	404218	5068274	610
NPR107	Nonparticipating	41	42	4	404240	5068304	611
NPR108	Nonparticipating	36	37	4	403576	5072353	576
NPR109	Nonparticipating	16	36	4	410926	5065270	554
NPR110	Nonparticipating	13	36	4	411197	5068985	541
NPR111	Nonparticipating	13	35	4	411302	5069021	540
NPR112	Nonparticipating	23	39	4	407403	5063593	608
NPR113	Nonparticipating	17	36	4	409229	5062603	575
NPR114	Nonparticipating	41	42	4	404299	5068358	614
NPR115	Nonparticipating	25	28	4	405569	5061023	616
NPR116	Nonparticipating	26	29	4	405575	5061065	616
NPR117	Nonparticipating	0	26	4	412836	5066850	537
NPR118	Nonparticipating	23	39	4	407314	5063503	612
NPR119	Nonparticipating	42	43	4	404056	5068250	610
NPR120	Nonparticipating	24	38	4	409992	5068098	585
NPR121	Nonparticipating	25	39	4	409942	5068100	585
NPR122	Nonparticipating	25	38	4	409974	5068019	584
NPR123	Nonparticipating	24	38	4	410004	5068113	586
NPR124	Nonparticipating	21	26	4	405469	5060937	615
NPR125	Nonparticipating	41	42	4	404192	5068339	610
NPR126	Nonparticipating	48	48	4	401670	5067718	602
NPR127	Nonparticipating	16	37	4	410900	5065132	558
NPR128	Nonparticipating	16	36	4	410856	5065344	554
NPR129	Nonparticipating	21	36	4	409047	5073110	533
NPR130	Nonparticipating	20	36	4	409089	5073147	531
NPR131	Nonparticipating	23	23	4	402622	5080107	311
NPR132	Nonparticipating	17	27	4	408848	5076491	508
NPR133	Nonparticipating	37	38	4	403151	5071742	575
NPR134	Nonparticipating	17	44	4	411440	5064020	571
NPR135	Nonparticipating	23	25	4	406113	5079119	504

Receiver ID	Receiver Type	Sound Pressure Level (dBA)		Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
		Phase 1	Both Phases		X (m)	Y (m)	
NPR136	Nonparticipating	52	52	4	400882	5075517	598
NPR137	Nonparticipating	47	47	4	401082	5073446	594
NPR138	Nonparticipating	23	23	4	402685	5080170	297
NPR139	Nonparticipating	23	23	4	402669	5080216	286
NPR140	Nonparticipating	36	39	4	404295	5073727	578
NPR141	Nonparticipating	37	38	4	403476	5071755	575
NPR142	Nonparticipating	26	30	4	406305	5061571	630
NPR143	Nonparticipating	52	52	4	401695	5074024	592
NPR144	Nonparticipating	37	38	4	403454	5071680	574
NPR145	Nonparticipating	17	26	4	407981	5076970	507
NPR146	Nonparticipating	23	23	4	402652	5080140	303
NPR147	Nonparticipating	23	23	4	402601	5080067	319
NPR148	Nonparticipating	18	27	4	407674	5077017	511
NPR149	Nonparticipating	37	38	4	403485	5071698	574
NPR150	Nonparticipating	23	25	4	406148	5079122	505
NPR151	Nonparticipating	17	23	4	408039	5076948	507
NPR152	Nonparticipating	17	27	4	407928	5077003	508
NPR153	Nonparticipating	37	37	4	403518	5071709	575
NPR154	Nonparticipating	20	31	4	407663	5062245	604
NPR155	Nonparticipating	17	26	4	408012	5076976	507
NPR156	Nonparticipating	23	23	4	402660	5080216	287
NPR157	Nonparticipating	23	23	4	402684	5080203	289
NPR158	Nonparticipating	22	25	4	406093	5079167	505
NPR159	Nonparticipating	46	46	4	401193	5073433	594
NPR160	Nonparticipating	16	23	4	408170	5076940	507
NPR161	Nonparticipating	17	26	4	407986	5076932	508
NPR162	Nonparticipating	47	47	4	401027	5073442	593
NPR163	Nonparticipating	23	23	4	402653	5080074	318
NPR164	Nonparticipating	17	27	4	408055	5076870	511
NPR166	Nonparticipating	46	46	4	401033	5073380	592
NPR167	Nonparticipating	27	40	4	408182	5065821	606
NPR168	Nonparticipating	23	23	4	402678	5080120	308
NPR169	Nonparticipating	42	44	4	404789	5067914	603
NPR170	Nonparticipating	50	50	4	400858	5075805	598

Receiver ID	Receiver Type	Sound Pressure Level (dBA)		Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
		Phase 1	Both Phases		X (m)	Y (m)	
NPR171	Nonparticipating	23	23	4	402694	5080087	315
NPR172	Nonparticipating	19	19	4	400755	5079792	392
NPR173	Nonparticipating	23	23	4	402546	5080225	285
NPR174	Nonparticipating	17	27	4	407875	5076967	508
NPR176	Nonparticipating	23	23	4	402577	5080081	316
NPR177	Nonparticipating	46	46	4	401191	5073408	594
NPR178	Nonparticipating	23	23	4	402634	5080042	325
NPR180	Nonparticipating	23	25	4	406109	5079164	506
NPR181	Nonparticipating	34	43	4	406834	5066304	602
NPR182	Nonparticipating	50	50	4	400930	5075764	597
NPR183	Nonparticipating	17	27	4	408114	5076866	512
NPR184	Nonparticipating	9	40	4	410412	5071946	542
NPR185	Nonparticipating	17	27	4	407987	5076860	509
NPR186	Nonparticipating	50	50	4	400836	5075775	596
NPR187	Nonparticipating	9	40	4	410447	5071898	543
NPR188	Nonparticipating	17	28	4	408024	5076870	511
NPR189	Nonparticipating	17	25	4	408007	5076924	509
NPR191	Nonparticipating	17	24	4	408081	5076933	507
NPR192	Nonparticipating	43	44	4	404557	5067945	602
NPR194	Nonparticipating	23	25	4	406236	5079146	505
NPR195	Nonparticipating	22	25	4	406062	5079181	504
NPR196	Nonparticipating	53	53	4	400871	5075517	598
NPR197	Nonparticipating	46	46	4	401138	5073374	593
NPR198	Nonparticipating	46	46	4	401130	5073412	594
NPR199	Nonparticipating	47	47	4	400993	5073459	593
NPR200	Nonparticipating	47	47	4	401042	5073448	593
NPR201	Nonparticipating	46	46	4	400923	5073384	589
NPR202	Nonparticipating	19	20	4	400730	5079811	388
NPR203	Nonparticipating	26	28	4	404973	5060812	617
PR01	Participating	43	44	4	403413	5068275	602
PR02	Participating	43	44	4	403348	5068298	604
PR03	Participating	23	40	4	407172	5074595	538
PR04	Participating	32	44	4	405523	5068768	607
PR05	Participating	14	43	4	410359	5070477	551

Receiver ID	Receiver Type	Sound Pressure Level (dBA)		Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
		Phase 1	Both Phases		X (m)	Y (m)	
PR06	Participating	31	46	4	405574	5068689	606
PR07	Participating	24	46	4	408916	5069900	602
PR08	Participating	32	45	4	405557	5068739	606
PR09	Participating	15	45	4	410108	5070584	551
PR10	Participating	32	44	4	405549	5068794	606
PR11	Participating	25	40	4	407044	5074698	541
PR12	Participating	22	44	4	407046	5074365	540
PR13	Participating	23	41	4	407068	5074591	536
PR14	Participating	22	41	4	406995	5074666	537
PR15	Participating	23	41	4	407050	5074628	538
PR16	Participating	24	41	4	407095	5074634	539
PR17	Participating	33	45	4	405582	5068768	605
PR18	Participating	25	40	4	407073	5074687	542
PR19	Participating	43	43	4	403400	5068234	601
PR20	Participating	43	43	4	403320	5068265	603
PR21	Participating	22	48	4	408881	5068971	589
PR22	Participating	14	44	4	410294	5070601	547
PR23	Participating	14	44	4	410337	5070596	547
PR24	Participating	15	45	4	410093	5070582	552
PR25	Participating	45	45	4	403330	5067932	609
PR26	Participating	23	48	4	408862	5068997	590
PR27	Participating	23	41	4	407105	5074620	538
PR28	Participating	14	44	4	410385	5070587	546
PR29	Participating	14	44	4	410364	5070594	547
PR30	Participating	14	43	4	410397	5070463	551
PR31	Participating	25	46	4	409167	5069873	599
PR32	Participating	22	48	4	408857	5069033	589
PR33	Participating	24	48	4	408836	5068981	590
PR34	Participating	30	38	4	405838	5069645	576
PR35	Participating	43	43	4	403356	5068217	601
PR36	Participating	33	33	4	402793	5078512	525
PR37	Participating	40	40	4	403352	5073752	582
PR38	Participating	48	48	4	402650	5075673	597
PR39	Participating	40	41	4	403389	5073823	584

Receiver ID	Receiver Type	Sound Pressure Level (dBA)		Relative Height (m)	Coordinates (UTM NAD83 Z14N)		Elevation + Modeled Height (m)
		Phase 1	Both Phases		X (m)	Y (m)	
PR40	Participating	24	38	4	408386	5072922	528
PR41	Participating	47	47	4	402693	5075637	596
PR42	Participating	40	40	4	403364	5073737	581
PR43	Participating	40	41	4	403331	5073777	582
PR44	Participating	24	38	4	408350	5072912	527
PR45	Participating	47	47	4	402674	5075634	596
PR46	Participating	24	42	4	408139	5063466	598
PR47	Participating	40	41	4	403366	5073821	584
PR48	Participating	24	42	4	408120	5063420	598
PR165	Participating	46	47	4	404961	5066820	613
PR175	Participating	46	47	4	404925	5066876	615
PR179	Participating	46	47	4	404963	5066871	613
PR190	Participating	46	47	4	404936	5066865	615
PR193	Participating	46	47	4	404964	5066844	613