

**Brady Wind Energy Center
Acoustic Assessment
Stark County, North Dakota**

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Prepared for



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ACRONYMS AND ABBREVIATIONS

AGL	above ground level
Applicant	NextEra Energy Resources, LLC
Brady Wind	
CadnaA	Computer-Aided Noise Abatement Program
dB	decibel
dBA	A-weighted decibel
dB L	unweighted decibel
GE	General Electric
HH	hub height
Hz	Hertz
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
kHz	kilohertz
L _{eq}	equivalent sound level
L _{max}	maximum sound level
L _p	sound pressure level
L _w	sound power level
m/s	meters per second
mph	miles per hour
MVA	megavolt ampere
MW	megawatt
NEMA	National Electrical Manufacturers Association
Project	Brady Wind Energy Center
PSC	Public Service Commission
pW	picowatt
RD	rotor diameter
Tetra Tech	Tetra Tech, Inc.
μPa	microPascal
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
W	watt
WTG	wind turbine generator

EXECUTIVE SUMMARY

Tetra Tech, Inc. (Tetra Tech) has completed an acoustic assessment for the proposed Brady Wind Energy Center located in Stark County, North Dakota. A screening-level analysis was completed to evaluate the expected sound levels resulting from the Project wind turbine generators (WTGs) and substation. The Project would consist of up to 87 WTGs. Two site layout scenarios were analyzed, one referred to as the "With Alternates" scenario and the other referred to as the "No Alternates" scenario. Analysis of the "With Alternates" scenario should be considered conservative since only 87 WTGs will be built as part of the Project. The overall objective of this study was to determine the feasibility of the Project to operate in compliance with the applicable North Dakota Public Service Commission (PSC) 50 dBA noise limit.

Wind turbine sound source data was obtained from General Electric (GE), the manufacturer of the GE 1.7-103 (1.7 megawatts (MW)) and 1.79-100 (1.79 MW) WTGs as documented in each turbine's noise specification (GE 2013 and 2014). Substation data were obtained Brady Wind, LLC (Brady Wind) based on a 170 megavolt ampere (MVA) transformer. It is expected that the GE WTGs and substation equipment installed will have similar sound profiles to what was used in the acoustic modeling analysis; however, it is possible that the final warranty sound power levels may vary slightly. Sound propagation modeling was conducted using the Computer-Aided Noise Abatement (CadnaA) program (version 4.5.151), a comprehensive 3-dimensional acoustic modeling computer simulation software, with calculations made in accordance with the International Organization for Standardization (ISO) standard 9613-2 "Attenuation of Sound during Propagation Outdoors". This acoustic modeling software is widely used by acoustical engineers due to its adaptability to evaluate complex acoustic scenarios.

The results of the acoustic modeling analysis were compared to the North Dakota PSC 50 dBA noise limit within 100 feet of an inhabited residence. Acoustic modeling results showed that the Project will not generate exceedances of the North Dakota PSC noise limit at any occupied receptor locations.

1.0 INTRODUCTION

Brady Wind, LLC (Brady Wind), a wholly-owned, indirect subsidiary of NextEra Resources, LLC (NextEra), proposes to construct and operate the Brady Wind Energy Center (Project) in Stark County, North Dakota. Brady Wind is proposing to construct up to 87 wind turbine generators (WTGs). The site layout dated November 6, 2015 includes 80 GE 1.7-103 WTGs and 7 GE 1.79-100 WTGs, as well as 8 alternate WTG locations for GE 1.7-103 WTGs. While no more than 87 WTGs will be built, one or more of the alternate WTG locations could be activated in the event that any of the primary WTG locations is eliminated. The rotor diameters (RD) for the GE 1.7-103 and GE 1.79-100 WTGs are 338 feet (103 meters) and 328 feet (100 meters), respectively, and both WTG models have a hub height (HH) of 80 meters. The proposed Project infrastructure also includes a collection substation to enable interconnection to Basin Electric Power Cooperative's transmission system. The substation would be located near the center of the Project Area adjacent to 109th Avenue SW near its intersection with 52nd Street SW. Substation data were obtained from Brady Wind based on a 170 megavolt ampere (MVA) transformer similar to the HICO 170 MVA transformer in use at other NextEra energy facilities.

An acoustic modeling analysis was completed for the Project, evaluating two site layout scenarios, one referred to as the "With Alternates" scenario and the other referred to as the "No Alternates" scenario. Analysis of the "With Alternates" scenario should be considered conservative since only 87 WTGs will be built as part of the Project. Operational sounds levels resulting from the Project were analyzed at existing noise-sensitive receptors (e.g., residential structures) and compliance was assessed relative to the North Dakota Public Service Commission (PSC) noise limit.

1.1 Project Area

The Brady Project Area encompasses approximately 29,981 acres (47 square miles) in southern Stark County. County and township (section line) roads characterize the existing roadway infrastructure in and around the Project Area. The Project Area is accessed via I-94, U.S. Highway 85, State Highway 22, State Highway 8, and other local two-lane paved and gravel county roads. The land in Stark County within the Project Area boundary is primarily agricultural with scattered farmstead residences. The Project will be located on privately-owned land in southern Stark County, approximately 15 miles south of Dickinson. This region of North Dakota has topography that can be described as level to rolling plains with isolated sandstone buttes or badlands formations to the west of the Project Area. Gentle slopes characterize most of the Project Area and local relief ranges from less than 800 to over 850 feet. Current land use within the Project Area is primarily agricultural, supporting both crops and livestock grazing and some limited oil/gas production.

Occupied and unoccupied structures are scattered throughout the Project Area. Potential noise sensitive receptor locations within the Project Area and in the vicinity of proposed turbine locations were included in the acoustical analysis. Of these 160 receptors identified, 108 are occupied structures and 52 are unoccupied. Brady Wind designed the Project to be compliant with Stark County's 2,000-foot setback requirement for occupied residences. Figure 1 presents the Brady Project, as well as the noise sensitive receptor locations.

1.2 Existing Acoustic Environment

Southern Stark County would generally be considered a rural agricultural area. Existing ambient sound levels are expected to be relatively low, although sound levels would be higher near roadways such as I-94, U.S. Highway 85, State Highway 22, State Highway 8. Additional noise is likely a result of equipment and trucks associated with oil exploration in the area. Other human activity such as agricultural operations would seasonally contribute to sound levels in the area associated with crop harvests. Background sound levels are expected to vary both spatially and temporally depending on proximity to area sound sources such as roadways and natural sounds. Typically, background sound levels are quieter during the night than during the daytime, except during periods when evening and nighttime insect noise may contribute to the soundscape, predominantly in the warmer seasons.

1.3 Acoustic Terminology

Airborne sound is described as the rapid fluctuation or oscillation of air pressure above and below atmospheric pressure, creating a sound wave. Sound is characterized by properties of the sound waves, which are frequency, wavelength, period, amplitude, and velocity. Noise is defined as unwanted sound. A sound source is defined by a sound power level (L_w), which is independent of any external factors. The acoustic sound power is the rate at which acoustical energy is radiated outward and is expressed in units of watts (W). Sound energy travels in the form of a wave, a rapid fluctuation or oscillation of air pressure above and below atmospheric pressure. A sound pressure level (L_p) is a measure of this fluctuation and can be directly determined with a microphone or calculated from information about the source sound power level and the surrounding environment through predictive acoustic modeling. While the sound power of a source is strictly a function of the total amount of acoustic energy being radiated by the source, the sound pressure levels produced by a source are a function of the distance from the source and the effective radiating area or physical size of the source. In general, the magnitude of a source's sound power level is always considerably higher than the observed sound pressure level near a source due to the fact that the acoustic energy is being radiated in various directions.

Sound levels are presented on a logarithmic scale to account for the large pressure response range of the human ear, and are expressed in units of decibels (dB). A dB is defined as the ratio between a measured value and a reference value usually corresponding to the lower threshold of human hearing defined as 20 micropascals (μPa). Conversely, sound power is commonly referenced to 1 picowatt (pW), which is one trillionth of a watt. Broadband sound includes sound energy summed across the frequency spectrum. In addition to broadband sound pressure levels, analysis of the various frequency components of the sound spectrum is often completed to determine tonal characteristics. The unit of frequency is Hertz (Hz), which corresponds to the rate in cycles per second that sound pressure waves are generated. Typically, a sound frequency analysis examines 11 octave (or 33 1/3 octave) bands ranging from 20 Hz (low) to 20,000 Hz (high). This range encompasses the entire human audible frequency range. Since the human ear does not perceive every frequency with equal loudness, spectrally varying sounds are often adjusted with a weighting filter. The A-weighted filter is applied to compensate for the frequency response of the human auditory system. Sound exposure in acoustic assessments is commonly

measured and calculated as A-weighted dB (dBA). Unweighted sound levels are referred to as linear. Linear dB are used to determine a sound's tonality and to engineer solutions to reduce or control noise as techniques are different for low and high frequency noise. Sound levels that are linear in this report are presented as dBL.

Sound can be measured, modeled, and presented in various formats, with the most common metric being the equivalent sound level (L_{eq}). The equivalent sound level has been shown to provide both an effective and uniform method for comparing time-varying sound levels and is widely used in acoustic assessments in the State of North Dakota. Estimates of noise sources and outdoor acoustic environments, and the comparison of relative loudness are presented in Table 1. Table 2 provides additional reference information on acoustic terminology.

Table 1. Sound Pressure Levels (L_p) and Relative Loudness of Typical Noise Sources and Soundscapes

Noise Source or Activity	Sound Level (dBA)	Subjective Impression	Relative Loudness (perception of different sound levels)
Jet aircraft takeoff from carrier (50 ft)	140	Threshold of pain	64 times as loud
50-hp siren (100 ft)	130		32 times as loud
Loud rock concert near stage or Jet takeoff (200 ft)	120	Uncomfortably loud	16 times as loud
Float plane takeoff (100 ft)	110		8 times as loud
Jet takeoff (2,000 ft)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 ft)	90		2 times as loud
Garbage disposal, food blender (2 ft), or Pneumatic drill (50 ft)	80	Loud	Reference loudness
Vacuum cleaner (10 ft)	70		1/2 as loud
Passenger car at 65 mph (25 ft)	65	Moderate	
Large store air-conditioning unit (20 ft)	60		1/4 as loud
Light auto traffic (100 ft)	50	Quiet	1/8 as loud
Quiet rural residential area with no activity	45		
Bedroom or quiet living room or Bird calls	40	Faint	1/16 as loud
Typical wilderness area	35		
Quiet library, soft whisper (15 ft)	30	Very quiet	1/32 as loud
Wilderness with no wind or animal activity	25	Extremely quiet	
High-quality recording studio	20		1/64 as loud
Acoustic test chamber	10	Just audible	
	0	Threshold of hearing	

Adapted from: Beranek 1988; EPA 1971

Table 2. Acoustic Terms and Definitions

Term	Definition
Noise	Typically defined as unwanted sound. This word adds the subjective response of humans to the physical phenomenon of sound. It is commonly used when negative effects on people are known to occur.
Sound Pressure Level (L _p)	Pressure fluctuations in a medium. Sound pressure is measured in decibels referenced to 20 microPascals, the approximate threshold of human perception to sound at 1,000 Hz.
Sound Power Level (L _w)	The total acoustic power of a noise source measured in decibels referenced to picowatts (one trillionth of a watt). Noise specifications are provided by equipment manufacturers as sound power as it is independent of the environment in which it is located. A sound level meter does not directly measure sound power.
A-Weighted Decibel (dBA)	Environmental sound is typically composed of acoustic energy across all frequencies. To compensate for the auditory frequency response of the human ear, an A-weighting filter is commonly used for describing environmental sound levels. Sound levels that are A-weighted are presented as dBA in this report.
Unweighted Decibels (dBL)	Unweighted sound levels are referred to as linear. Linear decibels are used to determine a sound's tonality and to engineer solutions to reduce or control noise as techniques are different for low and high frequency noise. Sound levels that are linear are presented as dBL in this report.
Propagation and Attenuation	Propagation is the decrease in amplitude of an acoustic signal due to geometric spreading losses with increased distance from the source. Additional sound attenuation factors include air absorption, terrain effects, sound interaction with the ground, diffraction of sound around objects and topographical features, foliage, and meteorological conditions including wind velocity, temperature, humidity, and atmospheric conditions.
Octave Bands	The audible range of humans spans from 20 to 20,000 Hz and is typically divided into center frequencies ranging from 31 to 8,000 Hz for noise modeling evaluations.
Broadband Sound	Noise which covers a wide range of frequencies within the audible spectrum, i.e., 200 to 2,000 Hz.
Masking	Interference in the perception of one sound by the presence of another sound. At elevated wind speeds, leaf rustle and noise made by the wind itself can mask wind turbine sound levels, which remain relatively constant.
Frequency (Hz)	The rate of oscillation of a sound, measured in units of Hz or kilohertz (kHz). One hundred Hz is a rate of one hundred times (or cycles) per second. The frequency of a sound is the property perceived as pitch: a low-frequency sound (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate. For comparative purposes, the lowest note on a full range piano is approximately 32 Hz and middle C is 261 Hz.

Note: Compiled by Tetra Tech from multiple technical and engineering resources.

2.0 NOISE REGULATIONS AND GUIDELINES

A review was conducted of noise regulations applicable to the Project at the federal, state, county, and local levels. There are no federal environmental noise requirements specific to this Project. At the state level, the PSC has established regulations applicable to wind energy facilities. Stark County also provides noise limits applicable to the Project via their zoning ordinance. The controlling regulation for the Project is the PSC's noise limit, which is more stringent than the requirements prescribed by Stark County. Both the State's and County's noise regulations are summarized in the subsections that follow.

2.1 State of North Dakota Public Service Commission Noise Regulations

North Dakota adopted noise regulations for wind energy facilities under the PSC Chapter 69-06-08-01(4) as follows:

A wind energy conversion facility site must not include a geographic area where, due to operation of the facility, the sound levels within one hundred feet of an inhabited residence or a community building will exceed fifty dBA. The sound level avoidance area criteria may be waived in writing by the owner of the occupied residence or the community building.

Sound levels resulting from the Project within 100 feet of all identified receptors located in the vicinity of the Project were assessed against the 50 dBA limit to determine whether compliance was achieved. The PSC noise limit is absolute and independent of the existing acoustic environment; therefore, a baseline sound survey is not required to assess conformity.

2.2 Stark County Zoning Ordinance

The Stark County zoning ordinance includes maximum day and night sound level limits in Section 6.7 that are applicable to the Project, specifically:

Section 6.7—Sustained noise of over eighty (80) decibels (dB) during the day and seventy (70) decibels (dB) at night is prohibited.

The 70 dBA nighttime limit prescribed by Stark County is less conservative than that prescribed by the PSC, so by achieving compliance with the PSC requirements, compliance with the Stark County Zoning Ordinance is also obtained.

3.0 ACOUSTIC MODELING METHODOLOGY AND RESULTS

Sound generated by an operating WTG is comprised of both aerodynamic and mechanical sound with the dominant sound component from modern utility scale WTGs being largely aerodynamic. Aerodynamic sound refers to the sound produced from air flow and the interaction with the WTG tower structure and moving rotor blades. Mechanical sound is generated at the gearbox, generator, and cooling fan, and is radiated from the surfaces of the nacelle and machinery enclosure and by openings in the nacelle casing. Due to the improved design of WTG mechanical components and the use of improved noise damping materials within the nacelle, including elastomeric elements supporting the generator and gearbox, mechanical noise emissions have been minimized. Sound reduction elements designed as a part of the WTGs include impact noise insulation of the gearbox and generator, sound reduced gearbox, sound reduced nacelle, and rotor blades designed to minimize noise generation.

Wind energy facilities, in comparison to other energy-related facilities, are somewhat unique in that the sound generated by each individual WTG will increase as the wind speed across the site increases. Wind turbine sound is negligible when the rotor is at rest, increases as the rotor tip speed increases, and is generally constant once rated power output and maximum rotational speed are achieved. Under this condition, the WTG maximum sound power level will be reached at approximately 7 meters per second [m/s], according to the GE specifications. It is important to recognize as wind speeds increase, the background ambient sound level will generally increase as well, resulting in acoustic masking effects; however, this trend is also affected by local contributing sound sources. The net result is that during periods of elevated wind speeds when higher WTG sound emissions occur, the sound produced from a WTG operating at maximum rotational speed may be largely or fully masked due to wind generated sound in foliage or vegetation. In practical terms, this means a nearby receptor would tend to hear leaves or vegetation rustling rather than WTG noise. This relationship is expected to further minimize the potential for any adverse noise effects of the Project. Conversely, these acoustic masking effects may be limited during periods of unusually high wind shear or at receiver locations that are sheltered from the prevailing wind direction.

3.1 Acoustic Modeling Software and Calculation Methods

The operational acoustic assessment was performed using the proposed Project WTG layout dated November 6, 2015. Two scenarios were modeled, a "With Alternates" scenario consisting of 95 WTG locations (87 planned WTG locations and an additional 8 alternate locations), and a "No Alternates" scenario consisting of 87 WTG locations. The layout includes two WTG models, the GE 1.7-103 and the GE 1.79-100 with rotor diameters of 338 feet (103 meters) and 328 feet (100 meters), respectively, and both WTG models have a hub height of 262.5 feet (80 meters). The Project would also include a collection substation with a 170 MVA transformer. WTG sound source data were obtained from GE (GE 2013 and 2014) and substation transformer data were obtained from Brady Wind.

The acoustic modeling analysis was conducted using the most recent version of DataKustic GmbH's computer-aided noise abatement program or CadnaA (v 4.5.151). CadnaA is a

comprehensive 3-dimensional acoustic software model that conforms to the International Organization for Standardization (ISO) standard ISO 9613-2 "Attenuation of Sound during Propagation Outdoors." The engineering methods specified in this standard consist of full (1/1) octave band algorithms that incorporate geometric spreading due to wave divergence, reflection from surfaces, atmospheric absorption, screening by topography and obstacles, ground effects, source directivity, heights of both sources and receptors, seasonal foliage effects, and meteorological conditions. Topographical information was imported into the acoustic model using the official United States Geological Survey (USGS) digital elevation dataset to accurately represent terrain in three dimensions. Terrain conditions, vegetation type, ground cover, and the density and height of foliage can also influence the absorption that takes place when sound waves travel over land. The ISO 9613-2 standard accounts for ground absorption rates by assigning a numerical coefficient of $G=0$ for acoustically hard, reflective surfaces and $G=1$ for absorptive surfaces and soft ground. If the ground is hard-packed dirt, typically found in industrial complexes, pavement, bare rock or for sound traveling over water, the absorption coefficient is defined as $G=0$ to account for reduced sound attenuation and higher reflectivity. In contrast, ground covered in vegetation, including suburban lawns, livestock and agricultural fields (both fallow with bare soil and planted with crops), will be acoustically absorptive and aid in sound attenuation (i.e., $G=1.0$). A mixed (semi-reflective) ground factor of $G=0.5$ was used in the Project acoustic modeling analysis. In addition to geometrical divergence, attenuation factors include topographical features, terrain coverage, and/or other natural or anthropogenic obstacles that can affect sound attenuation and result in acoustical screening. To be conservative, sound attenuation through foliage and diffraction around and over existing anthropogenic structures such as buildings was not included in the model.

Sound attenuation by the atmosphere is not strongly dependent on temperature and humidity; however, the temperature of 10°Celsius (50°Fahrenheit) and 70 percent relative humidity parameters were selected as reasonably representative of conditions favorable to sound propagation. Atmospheric absorption depends on temperature and humidity and is most important at higher frequencies. Over short distances, the effects of atmospheric absorption are minimal. The ISO 9613-2 standard calculates attenuation for meteorological conditions favorable to propagation, i.e., downwind sound propagation or what might occur typically during a moderate atmospheric ground level inversion. Though a physical impracticality, the ISO 9613-2 standard simulates omnidirectional downwind propagation. For receivers located between discrete WTG locations or WTG groupings, the acoustic model may result in over-prediction. In addition, the acoustic modeling algorithms essentially assume laminar atmospheric conditions, in which neighboring layers of air do not mix. This conservative assumption does not take into consideration turbulent eddies and micrometeorological inhomogeneities that may form when winds change speed or direction, which can interfere with the sound wave propagation path and increase attenuation effects.

Conversely, there may be meteorological conditions from time to time that will aid in the long-range propagation of sound. These anomalous meteorological conditions may include well-developed moderate ground-based temperature inversions, such as commonly occurs at nighttime and during early morning hours, and wind gradients which can bend sound downwards,

which may occur any time depending on weather conditions. Per ISO 9613-2, the effects of meteorological conditions on sound propagation are small for short distances, and also small for longer distances at greater source and receptor heights. Over extended distances when the influences of wind or temperature gradients are most prevalent, atmospheric effects may cause fluctuations in received sound levels, but will typically attenuate noise to levels below those predicted. Propagation for anomalous meteorological conditions are presented to show that for comparatively short periods of time received sound levels may be higher than the mean.

3.2 Acoustic Modeling Input Parameters

In order to assist project developers and acoustical engineers, wind turbine manufacturers report WTG sound power data at integer wind speeds referenced to the effective hub height, ranging from cut-in to full rated power per International Electrotechnical Commission (IEC) standard IEC 61400-11:2006 Wind Turbine Generator Systems—Part 11: Acoustic Noise Measurement Techniques. This accepted IEC standard was developed to ensure consistent and comparable sound emission data of utility-scale WTGs between manufacturers. Table 3 presents a summary of sound power data during normal operations correlated to 10 meter height integer wind speeds 10 meter above ground level (AGL) with a stated roughness length of 0.05 meters, which is representative of level grass-covered terrain (GE 2013 and 2014). The roughness length describes the vertical wind profile per IEC specification in a neutral atmosphere with the wind profile following a logarithmic curve.

The specification for the WTGs includes an expected warranty confidence interval, or k-factor, of 2 dB, which was added to the nominal sound power level in the acoustic model. This confidence interval incorporates the uncertainty in independent sound power level measurements conducted, the applied probability level and standard deviation for test measurement reproducibility, and product variability.

Table 3. Broadband Sound Power Levels (dBA) Correlated with Wind Speed

10-meter AGL Wind Speed	WTG L_{max} Sound Power Level (L_w) at Reference Wind Speed							
	11.2 mph (5 m/s)	12.3 mph (5.5 m/s)	13.4 mph (6 m/s)	14.5 mph (6.5 m/s)	15.9 mph (7 m/s)	17.9 mph (8 m/s)	20.1 mph (9 m/s)	22.4 mph (10 m/s)
GE 1.7-103	100.3	102.6	104.9	106.9	107.0	107.0	107.0	107.0
GE 1.79- 100	98.6	101.0	103.2	105.5	107.2	107.5	107.5	107.5

Wind turbines can be somewhat directional, radiating more sound in some directions than others. The IEC test measurement protocol requires that sound measurements are made for the maximum downwind directional location when reporting apparent sound power levels. Thus, it is assumed that WTG directivity and sound generating efficiencies are inherently incorporated in the sound source data and used in acoustic model development. A summary of sound power data by octave band center frequency for WTGs operating at maximum rotation are presented in Table 4

(1/1 octave band frequency data provided with stated intended use limited for informational purposes only).

Table 4. Sound Power Level by Octave Band Center Frequency

Frequency (Hz)	Octave Band Sound Power Level (dBA)								Broadband (dBA)
	63	125	250	500	1000	2000	4000	8000	
GE 1.7-103	90.5	95.7	97.7	100.3	102.6	99.6	91.4	74.1	107.0
GE 1.79-100	91.0	96.1	98.0	100.8	103.3	100.0	90.3	70.6	107.5

3.3 Acoustic Modeling Results

Acoustic modeling was completed for WTG cut-in and maximum rotational operating conditions, thereby describing resultant sound pressure levels over the entire operational range of the Project for both the "With Alternates" and "No Alternates" scenarios. In addition, sound energy contribution from the Project substation was included in the acoustic modeling analysis. When calculating received sound levels, it was assumed that the Project substation and all WTGs were operating concurrently at the given operating condition. Sound contour plots displaying Project operational sound levels in color-coded isopleths are provided in Figures 2 through 7. Figures 2 and 3 display the broadband operational sound levels under low-level wind speeds sufficient for the WTGs to operate at initial cut-in rotational speeds. Figures 4 and 5 display broadband operational sound levels at wind speeds sufficient to sustain WTG operation at maximum rotational speeds for moderate downwind propagation. Figures 6 and 7 display broadband operational sound levels at wind speeds sufficient to sustain WTG operation at maximum rotational speeds under anomalous meteorological conditions.

Table 5 presents the results of the Brady Wind Energy Center acoustic modeling analysis and includes the ID, Universal Transverse Mercator (UTM) coordinates, receptor status and the received sound levels at each receptor for both scenarios. Received sound levels are rounded to the nearest whole decimal for consistency with the State of North Dakota noise limit absolute value of 50 dBA. In addition, a 100-foot buffer was included around the receptors, corresponding to the point of compliance identified in the PSC 50 dBA noise limit.

The acoustic modeling results shown in Table 5 demonstrate that received sound levels are all below the PSC 50 dBA noise limit at all occupied receptors. The only potential exceedances of the PSC noise limit occur at receptors 811228 and 811231; however, both of those receptors were identified as unoccupied structures; therefore, they are not considered noise sensitive and demonstrating compliance with the limit is not required.

Table 5. Summary of Acoustic Modeling Results

Receptor ID	Receptor Status	UTM Coordinates (NAD83 UTM Zone 13 meters)				Project with Alternate WTG Locations			Project with No Alternate WTG Locations		
		Easting (m)	Northing (m)	Cut-in Rotation (dBA)	Maximum Rotation (dBA)	Maximum Rotation under Anomalous (dBA)	Cut-in Rotation (dBA)	Maximum Rotation (dBA)	Maximum Rotation under Anomalous (dBA)		
400006	Unoccupied	680072	5176797	26	33	35	26	32	35		
400037	Unoccupied	681527	5177443	30	36	38	29	36	38		
500002	Occupied	680618	5158589	<1	<1	<1	<1	<1	<1		
500006	Occupied	679633	5157936	<1	<1	<1	<1	<1	<1		
500012	Occupied	679628	5157991	<1	<1	<1	<1	<1	<1		
500016	Unoccupied	679508	5163376	21	28	31	21	28	30		
500018	Occupied	679256	5165366	28	35	38	28	35	37		
500022	Occupied	677510	5165047	27	35	37	27	34	37		
500028	Occupied	677401	5165136	28	35	37	28	35	37		
500032	Unoccupied	677690	5161966	20	27	30	20	27	30		
500033	Unoccupied	674884	5159598	10	17	19	10	17	19		
500035	Occupied	673147	5158516	<1	<1	<1	<1	<1	<1		
500039	Occupied	671766	5158495	<1	<1	<1	<1	<1	<1		
500053	Occupied	672221	5159146	4	11	13	4	11	13		
500054	Unoccupied	671612	5161365	12	19	22	12	19	21		
500055	Unoccupied	670870	5158304	<1	<1	<1	<1	<1	<1		
500059	Occupied	669892	5159454	1	8	11	1	8	11		
500064	Occupied	669899	5159550	2	8	11	2	8	11		
500068	Unoccupied	669196	5158847	<1	<1	<1	<1	<1	<1		
500076	Unoccupied	666743	5158531	<1	<1	<1	<1	<1	<1		
800308	Occupied	667354	5158391	<1	<1	<1	<1	<1	<1		
800311	Occupied	667332	5158349	<1	<1	<1	<1	<1	<1		
501000	Occupied	684105	5172245	24	31	33	24	31	33		
501012	Occupied	681646	5173097	38	44	45	38	44	45		

Table 5. Summary of Acoustic Modeling Results

Receptor ID	Receptor Status	UTM Coordinates (NAD83 UTM Zone 13 meters)			Project with Alternate WTG Locations			Project with No Alternate WTG Locations		
		Easting (m)	Northing (m)		Cut-in Rotation (dBA)	Maximum Rotation (dBA)	Maximum Rotation under Anomalous (dBA)	Cut-in Rotation (dBA)	Maximum Rotation (dBA)	Maximum Rotation under Anomalous (dBA)
501019	Occupied	680468	5175745		31	38	40	30	37	39
501022	Occupied	680563	5175382		34	41	42	32	39	40
501030	Occupied	679723	5174632		34	40	42	33	39	41
501037	Occupied	679731	5171167		37	44	45	37	44	45
501040	Occupied	678406	5173332		38	45	46	38	45	45
501050	Occupied	678419	5173433		37	44	45	37	44	45
501053	Occupied	678555	5173259		38	45	46	38	45	45
501059	Occupied	678568	5173250		38	45	46	38	45	45
501065	Occupied	678822	5170399		37	44	45	37	44	45
501068	Occupied	677851	5169797		40	47	48	39	47	48
501073	Occupied	681345	5169634		34	41	42	34	41	42
501081	Occupied	681279	5169706		34	40	41	34	40	41
501082	Occupied	675433	5171946		30	37	39	30	37	39
501083	Unoccupied	666768	5166374		27	33	35	27	33	35
501085	Occupied	672965	5164410		23	30	32	23	30	32
501096	Occupied	672947	5164396		23	30	32	23	30	32
501097	Unoccupied	667485	5163313		22	29	31	22	28	31
800364	Unoccupied	669001	5162054		14	21	23	14	20	23
501099	Occupied	675017	5163411		24	31	34	24	31	33
501104	Occupied	675027	5163439		24	31	34	24	31	33
501108	Occupied	670613	5160034		7	13	16	7	13	16
501118	Occupied	659777	5163091		23	29	32	22	29	31
501122	Occupied	661117	5163653		21	27	30	20	27	29
501126	Occupied	663477	5163902		22	29	31	22	29	32

Table 5. Summary of Acoustic Modeling Results

Receptor ID	Receptor Status	UTM Coordinates (NAD83 UTM Zone 13 meters)			Project with Alternate WTG Locations			Project with No Alternate WTG Locations		
		Easting (m)	Northing (m)	Maximum Rotation (dBA)	Cut-in Rotation (dBA)	Maximum Rotation under Anomalous (dBA)	Maximum Rotation (dBA)	Cut-in Rotation (dBA)	Maximum Rotation under Anomalous (dBA)	
501131	Occupied	664747	5163175	19	26	28	19	25	28	
501138	Occupied	664349	5164755	24	31	33	24	31	33	
800288	Unoccupied	664145	5164372	22	29	31	22	28	31	
800292	Unoccupied	664102	5164281	22	29	31	21	28	30	
501141	Occupied	665128	5163747	20	26	29	19	26	28	
501147	Occupied	665442	5161863	14	21	24	14	21	23	
501156	Occupied	674657	5162748	20	27	30	20	27	30	
610001	Occupied	657943	5169457	31	38	39	31	37	39	
811285	Unoccupied	657284	5169323	30	37	39	30	36	38	
610009	Occupied	657243	5168249	35	41	43	35	41	42	
610014	Occupied	657329	5168365	35	41	42	34	41	42	
610018	Unoccupied	657481	5167671	40	46	47	40	46	47	
610021	Occupied	658588	5168791	37	44	45	37	44	45	
501175	Occupied	661018	5169979	31	37	39	30	37	39	
610025	Occupied	659083	5169071	35	42	43	35	42	43	
610031	Occupied	660171	5167459	39	46	47	39	46	46	
610042	Occupied	662190	5167946	40	46	47	39	45	46	
610045	Occupied	662204	5167951	40	46	47	39	45	46	
610049	Occupied	662204	5167996	40	46	47	38	45	46	
610053	Occupied	660882	5167398	39	46	46	38	45	45	
420119	Occupied	660825	5167514	39	46	46	38	45	45	
610057	Occupied	660875	5167437	39	46	46	38	45	45	
610059	Unoccupied	662665	5165804	36	43	43	36	42	43	
610063	Unoccupied	661981	5166658	41	48	48	41	48	48	

Table 5. Summary of Acoustic Modeling Results

Receptor ID	Receptor Status	UTM Coordinates (NAD83 UTM Zone 13 meters)		Project with Alternate WTG Locations			Project with No Alternate WTG Locations		
		Easting (m)	Northing (m)	Cut-in Rotation (dBA)	Maximum Rotation (dBA)	Maximum Rotation under Anomalous (dBA)	Cut-in Rotation (dBA)	Maximum Rotation (dBA)	Maximum Rotation under Anomalous (dBA)
610079	Unoccupied	661962	5163992	27	34	36	26	33	36
610084	Occupied	666867	5164930	23	29	32	22	29	32
610089	Occupied	668413	5169125	28	35	37	28	35	37
610091	Unoccupied	668196	5169582	28	34	37	27	34	36
610094	Occupied	663473	5168761	39	46	46	37	44	45
610098	Occupied	664446	5167109	39	45	46	39	45	46
610102	Occupied	669505	5169577	28	34	37	28	34	36
610108	Occupied	669518	5169514	28	35	37	28	35	37
610111	Occupied	670742	5169632	33	39	41	32	39	40
610116	Unoccupied	671898	5169600	38	44	45	37	44	45
610118	Unoccupied	671916	5169648	37	44	45	37	44	45
610121	Occupied	672258	5168851	39	46	46	38	45	45
610125	Unoccupied	672486	5169786	36	43	45	36	43	45
610130	Unoccupied	673973	5169036	36	42	43	35	42	42
610134	Unoccupied	674002	5169040	36	42	43	35	42	43
610139	Occupied	675979	5170362	34	41	42	33	40	42
610144	Unoccupied	675675	5169238	34	42	43	34	41	43
610145	Unoccupied	675358	5166322	33	40	41	33	40	40
610149	Occupied	674773	5165354	30	37	39	30	37	39
610155	Unoccupied	669944	5164888	26	32	35	25	32	34
610164	Unoccupied	669993	5164876	26	32	35	26	32	35
610170	Occupied	667574	5164565	21	28	31	21	28	30
610181	Occupied	670466	5167264	36	43	43	36	43	43
610185	Occupied	670516	5167245	37	43	44	37	43	44

Table 5. Summary of Acoustic Modeling Results

Receptor ID	Receptor Status	UTM Coordinates (NAD83 UTM Zone 13 meters)			Project with Alternate WTG Locations			Project with No Alternate WTG Locations		
		Easting (m)	Northing (m)	Maximum Rotation (dBA)	Cut-in Rotation (dBA)	Maximum Rotation (dBA)	Maximum Rotation under Anomalous (dBA)	Cut-in Rotation (dBA)	Maximum Rotation (dBA)	Maximum Rotation under Anomalous (dBA)
800304	Unoccupied	670346	5166290	32	39	40	32	38	40	
610188	Unoccupied	668519	5166787	28	34	37	28	34	36	
610190	Unoccupied	669313	5167829	29	36	38	29	35	37	
610194	Unoccupied	669326	5167878	29	36	38	29	36	38	
610197	Unoccupied	673253	5168730	42	48	48	40	47	47	
610203	Unoccupied	670759	5168861	37	44	45	37	44	44	
706192	Unoccupied	656694	5166353	36	43	43	36	43	43	
811069	Unoccupied	682736	5175254	42	49	49	42	49	49	
811201	Occupied	680019	5177169	25	32	34	25	32	34	
811205	Occupied	679691	5178020	21	28	30	21	27	30	
811210	Occupied	680887	5178421	24	31	33	24	31	33	
811214	Unoccupied	680759	5178424	24	31	33	24	30	33	
811217	Unoccupied	680753	5178482	24	31	33	24	31	33	
811224	Unoccupied	680747	5178483	24	31	33	24	31	33	
811228	Unoccupied	682023	5174120	48	55	55	48	55	55	
811231	Unoccupied	682042	5174165	50	57	57	50	57	57	
811236	Unoccupied	682274	5174639	43	50	50	43	49	50	
811237	Unoccupied	679990	5178775	20	27	29	20	27	30	
880001	Occupied	680270	5173773	40	47	47	40	47	47	
900002	Occupied	661988	5161930	16	23	26	16	23	25	
900007	Occupied	662323	5161469	18	25	27	18	25	27	
900011	Occupied	662065	5161089	16	23	26	16	22	25	
900015	Occupied	658130	5161120	19	26	29	19	26	28	
900019	Occupied	658166	5161105	19	26	29	19	26	28	

Table 5. Summary of Acoustic Modeling Results

Receptor ID	Receptor Status	UTM Coordinates (NAD83 UTM Zone 13 meters)			Project with Alternate WTG Locations			Project with No Alternate WTG Locations		
		Easting (m)	Northing (m)	Maximum Rotation (dBA)	Cut-in Rotation (dBA)	Maximum Rotation (dBA)	Maximum Rotation under Anomalous (dBA)	Cut-in Rotation (dBA)	Maximum Rotation (dBA)	Maximum Rotation under Anomalous (dBA)
900025	Unoccupied	666717	5161478	13	20	22	13	19	22	
900027	Occupied	664500	5161670	17	24	27	17	24	26	
900031	Occupied	665522	5158935	<1	4	7	<1	4	7	
900035	Occupied	665494	5159171	8	15	18	8	15	18	
900039	Occupied	665496	5159110	9	16	19	9	16	19	
900042	Unoccupied	666233	5158189	<1	<1	<1	<1	<1	<1	
800317	Occupied	662260	5158285	<1	<1	<1	<1	<1	<1	
900047	Occupied	663971	5160025	9	16	18	9	16	18	
900053	Occupied	664011	5160036	9	16	18	9	16	18	
900056	Unoccupied	664009	5160071	9	16	18	9	16	18	
900059	Occupied	665090	5160153	14	21	23	14	21	23	
900063	Unoccupied	665463	5160848	12	19	21	12	19	21	
900068	Unoccupied	665093	5160747	16	22	25	16	22	25	
800268	Unoccupied	670007	5160023	6	13	16	6	13	16	
800342	Unoccupied	670035	5161380	12	19	21	12	18	21	
900070	Occupied	679567	5171280	39	46	46	39	46	46	
420117	Occupied	654920	5169153	20	27	29	20	27	29	
811287	Occupied	655467	5168218	23	30	32	23	29	31	
811290	Occupied	650090	5167200	4	11	13	4	11	13	
420090	Occupied	662974	5171187	27	33	36	26	32	34	
420100	Occupied	662342	5170932	28	35	37	27	34	36	
420108	Occupied	662543	5170920	28	35	37	27	34	36	
420116	Occupied	662765	5170601	29	36	38	28	35	37	
501172	Occupied	662856	5171199	27	34	36	26	33	35	

Table 5. Summary of Acoustic Modeling Results

Receptor ID	Receptor Status	UTM Coordinates (NAD83 UTM Zone 13 meters)			Project with Alternate WTG Locations			Project with No Alternate WTG Locations		
		Easting (m)	Northing (m)	Maximum Rotation (dBA)	Cut-in Rotation (dBA)	Maximum Rotation under Anomalous (dBA)	Maximum Rotation (dBA)	Cut-in Rotation (dBA)	Maximum Rotation under Anomalous (dBA)	
501173	Occupied	661884	5171096	34	27	36	26	33	35	
501174	Occupied	661893	5171077	34	27	36	26	33	35	
501176	Occupied	660668	5170916	34	27	36	27	34	36	
420051	Occupied	664044	5171213	35	28	37	27	34	36	
420069	Occupied	663975	5171244	34	28	37	27	33	36	
420076	Occupied	663894	5171299	33	26	35	25	32	34	
420089	Occupied	663065	5171180	34	27	36	27	33	36	
420039	Occupied	667891	5171580	32	25	34	24	31	34	
420047	Occupied	667886	5171532	31	25	34	24	31	33	
420002	Occupied	668875	5171095	32	25	34	25	31	34	
501165	Occupied	668751	5170669	33	26	35	26	32	35	
420023	Occupied	668410	5170735	32	26	35	25	32	34	
420029	Occupied	668316	5170507	33	26	35	26	32	35	
501162	Occupied	666164	5171091	32	25	34	25	32	34	
501168	Occupied	666562	5170280	38	32	40	31	38	39	
420065	Occupied	664088	5171360	34	27	36	26	33	35	

4.0 OTHER SOUND CONSIDERATIONS

4.1 Substation Noise

Substations have switching, protection and control equipment and typically one or more transformers, which generate the sound generally described as a low humming. There are three main sound sources associated with a transformer: core noise, load noise and noise generated by the operation of the cooling equipment. The core vibrational noise is the principal noise source and does not vary significantly with electrical load. Transformers are designed and catalogued by MVA ratings. Just as horsepower ratings designate the power capacity of an electric motor, a transformer's MVA rating indicates its maximum power output capacity. The National Electrical Manufacturers Association (NEMA) published NEMA Standards TR1-1993 (R2000), which establish the maximum noise level allowed for transformers, voltage regulators, and shunt reactors based on the equipment's method of cooling its dielectric fluid (air-cooled vs. oil-cooled) and the electric power rating.

Transformer noise is generated and will attenuate with distance at different rates depending on the transformer dimensions, voltage rating, and design. The noise produced by substation transformers is primarily caused by the load current in the transformer's conducting coils (or windings) and consequently the main frequency of this sound is twice the supply frequency. The characteristic humming sound consists of tonal components generated at harmonics of 120 Hz. Most of the acoustical energy resides in the fundamental tone (120 Hz) and the first 3 or 4 harmonics (240, 360, 480, 600 Hz). In addition to core vibration noise, transformer cooling fans may generate broadband noise, limited to periods when high heat loads require additional cooling capacity. The resulting audible sound is a combination of core noise and the broadband fan noise. Circuit-breaker operations may also cause audible noise, particularly the operation of air-blast breakers which is characterized as an impulsive sound event of very short duration. This is expected to occur only a few times throughout the year, and was therefore not considered in this analysis.

The proposed Brady electrical substation would be located approximately 600 feet (183 meters) south of 52nd Street SW and immediately adjacent to 109th Avenue SW. The transformer at this substation location was modeled using the latest version of CadnaA implementing ISO 9613-2. Transformer sound source levels for the Brady substation were provided based on a 170 MVA transformer similar to the HICO 170 MVA transformer in use at other NextEra energy facilities. Table 6 presents the transformer sound source data by octave band center frequency calculated based on the estimated transformer NEMA and MVA ratings using standardized engineering guidelines.

Table 6. Transformer Sound Power Level

Frequency (Hz)	Octave Band Sound Power Level (dB)								Broadband (dBA)
	63	125	250	500	1000	2000	4000	8000	
170 MVA Transformer	93	99	101	94	90	85	80	73	97

Transformers the size of the one proposed for the Project can present a noise concern if the separation distance is less than a few hundred feet between the transformer and noise-sensitive receptors. The proposed Brady transformer location is approximately 1,050 feet (320 meters) from the nearest noise sensitive receptor and poses little concern from a noise perspective. That being said, transformer noise may be periodically audible at nearby receptors on occasions when background sound levels are very low.

4.3 Construction Noise

The development of Brady Wind Energy Center will involve construction to establish access roads, excavate and form WTG foundations, prepare the site for crane-lifting and assemble and commission the WTGs. Work on large-scale wind projects such as Brady Wind Energy Center is generally divided into four phases consisting of the following:

1. *Site Clearing*: The initial site mobilization phase includes the establishment of temporary site offices, workshops, stores, and other on-site facilities. Installation of erosion and sedimentation control measures will be completed as well as the preparation of initial haulage routes.
2. *Grading*: This phase would begin with the grading and formation of access roads and preparation of laydown areas. Excavation for the concrete turbine foundations would also be completed.
3. *Foundation Work*: Construction of the reinforced concrete turbine foundations would take place in addition to installation of the internal transmission network.
4. *WTG Installation*: Delivery of the turbine components would occur followed by their installation and commissioning.

Work on these construction activities is expected to overlap. It is likely that the WTGs will be erected in small groupings. Each grouping may undergo periodic testing and commissioning prior to commencement of full commercial operation. Other construction activities include those for the supporting infrastructure such as the substation, maintenance building, and the overhead transmission line.

The construction of the Project may cause short-term but unavoidable noise impacts. The sound levels resulting from construction activities vary significantly depending on several factors such as the type and age of equipment, the specific equipment manufacturer and model, the operations being performed, and the overall condition of the equipment and exhaust system mufflers. The list of construction equipment that may be used on the Project and estimates of near and far sound source levels are presented in Table 7.

Table 7. Estimated L_{max} Sound Pressure Levels from Construction Equipment

Equipment*	Estimated Sound Pressure Level at 50 feet (dBA)	Estimated Sound Pressure Level at 2000 feet (dBA)
Crane	85	53
Forklift	80	48
Backhoe	80	48
Grader	85	53
Man basket	85	53
Dozer	83–88	51–56
Loader	83–88	51–56
Scissor Lift	85	53
Truck	84	52
Welder	73	41
Compressor	80	48
Concrete Pump	77	45

Source: FHWA 2006; Bolt et al. 1977

Sounds generated by construction activities are typically exempt from state and local noise oversight provided that they occur within weekday, daytime periods as may be specified under local zoning or legal codes. All reasonable efforts will be made to minimize the impact of noise resulting from construction activities. As the design of the Project progresses and construction scheduling is finalized, the construction engineer normally notifies the community via public notice or alternative method of the expected Project construction commencement and duration to help minimize the effects of construction noise. In addition, the location of stationary equipment and the siting of construction laydown areas will be carefully selected to be as far removed from existing noise-sensitive receptors as is practical. Candidate construction noise mitigation measures include scheduling louder construction activities during daytime hours and equipping internal combustion engines with appropriate sized muffler systems to minimize noise excessive emissions.

Construction activity will generate traffic having potential noise effects, such as trucks travelling to and from the site on public roads. At the early stage of the construction phase, equipment and materials will be delivered to the site, such as hydraulic excavators and associated spreading and compacting equipment needed to form access roads and foundation platforms for each turbine. Once the access roads are constructed, equipment for lifting the towers and turbine components will arrive. Traffic noise is categorized into two categories: (1) the noise that will occur during the initial temporary traffic movements related to turbine delivery, haulage of components and remaining construction; and (2) maintenance and ongoing traffic from staff and contractors, which is expected to be minor.

5.0 CONCLUSIONS

Project operational sound has been calculated and compared to the 50 dBA PSC noise limit. Acoustic modeling analysis per ISO 9613-2 and inclusive of a number of conservative assumptions under operational conditions demonstrates the Project will not generate exceedances of the PSC noise limit at any occupied receptor location under either the "With Alternates" or "No Alternates" scenarios. In addition, predicted noise impacts associated with the "With Alternates" scenario should be considered conservative since only 87 WTGs will actually be built as part of the Project.

It is expected that received sound levels at noise-sensitive receptors will be consistent with sound generated at similar wind energy projects successfully sited throughout the state of North Dakota employing the same or similar criteria. However, while the Project has demonstrated compliance with the requirements, the Project may result in periodically audible sound within adjacent areas under certain operational and meteorological conditions.

6.0 TECHNICAL REFERENCES

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Technical Documentation: Wind Turbine Generator Systems GE 1.7-103—50Hz and 60Hz, Noise emission characteristics Normal operation according to IEC, GE Wind Energy GmbH, 2014.

Figures

NEXTERA ENERGY
 RESOURCES, LLC
 BRADY WIND PROJECT
 STARK COUNTY
 NORTH DAKOTA

FIGURE 2
 WITH ALTERNATES:
 RECEIVED SOUND LEVELS -
 WIND TURBINES AT CUT-IN
 WIND SPEED
 JANUARY 2016

Proposed Turbine Array (11/6/2015)

- GE 1.7 MW Turbine
- GE 1.7 MW Turbine (Alt)
- GE 1.75 MW Turbine

Receptors

- Occupied
- Unoccupied
- △ Substation

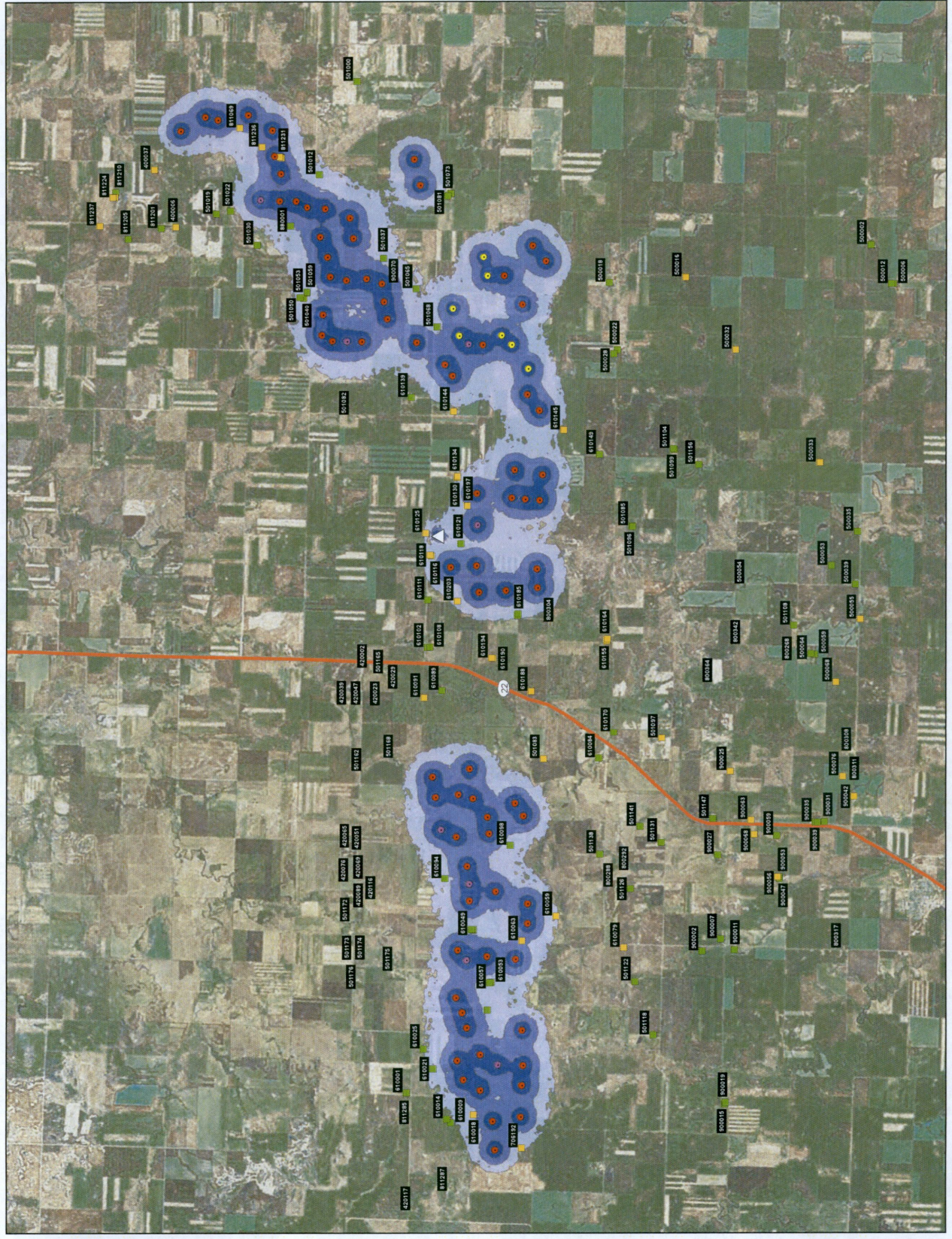
Sound Level Contour Ranges (dBA)

- 35-40
- >40-45
- >45-50
- >50



0 0.5 1 1.5 2 MILES

REFERENCE MAP



NEXTERA ENERGY
 RESOURCES, LLC
 BRADY WIND PROJECT
 STARK COUNTY
 NORTH DAKOTA

FIGURE 3

NO ALTERNATES:
 RECEIVED SOUND LEVELS -
 WIND TURBINES AT CUT-IN
 WIND SPEED

JANUARY 2016

Proposed Turbine Array (11/6/2015)

- GE 1.7 MW Turbine
- GE 1.79 MW Turbine

Receptors

- Occupied
- Unoccupied
- △ Substation

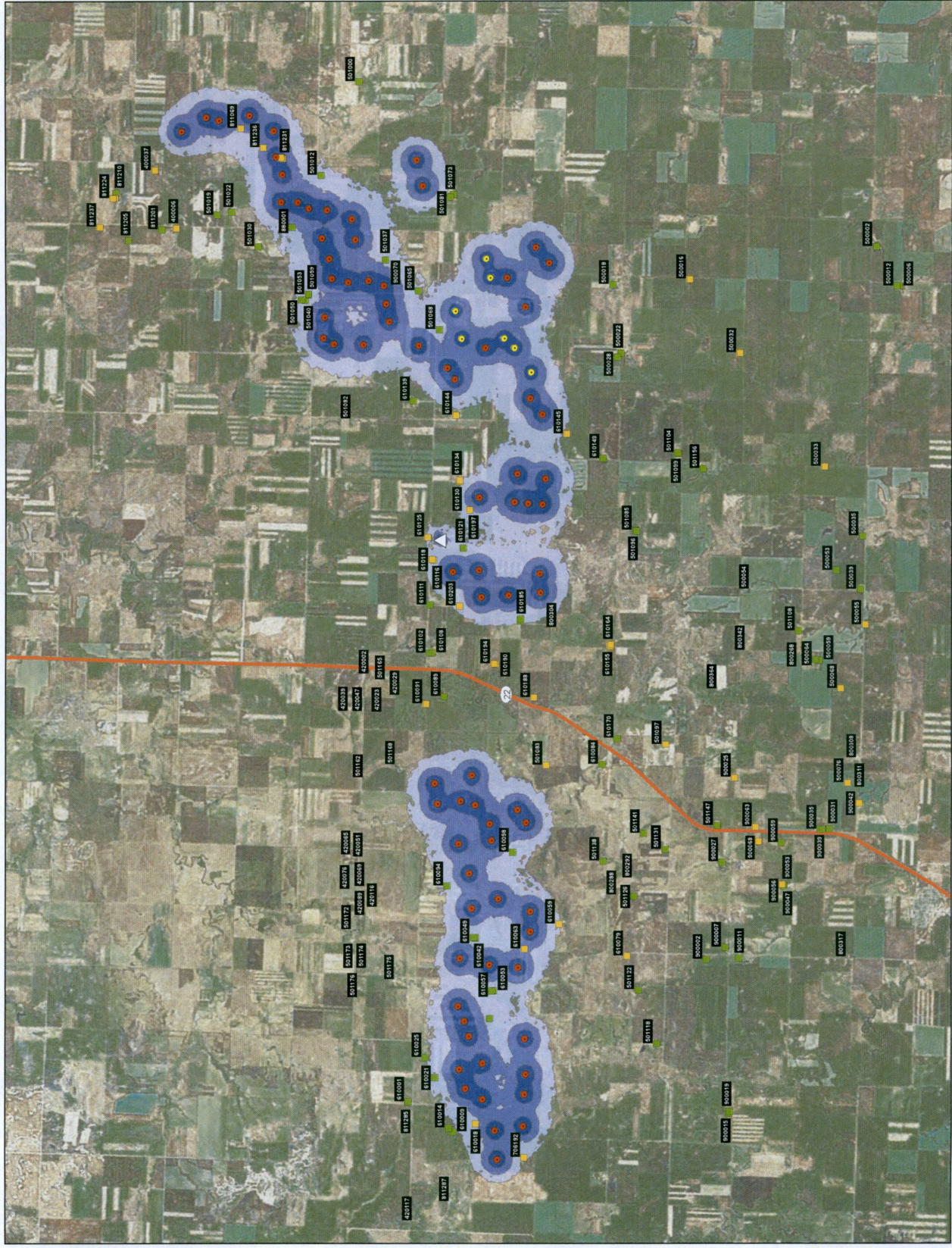
Sound Level Contour Ranges (dBA)

- 35-40
- >40-45
- >45-50
- >50



0 0.5 1 1.5 2 MILES

REFERENCE MAP



NEXTERA ENERGY
 RESOURCES, LLC
 BRADY WIND PROJECT
 STARK COUNTY
 NORTH DAKOTA

FIGURE 4
 WITH ALTERNATES:
 RECEIVED SOUND LEVELS -
 WIND TURBINES AT MAXIMUM
 ROTATIONAL WIND SPEED
 JANUARY 2016

Proposed Turbine Array (11/6/2015)

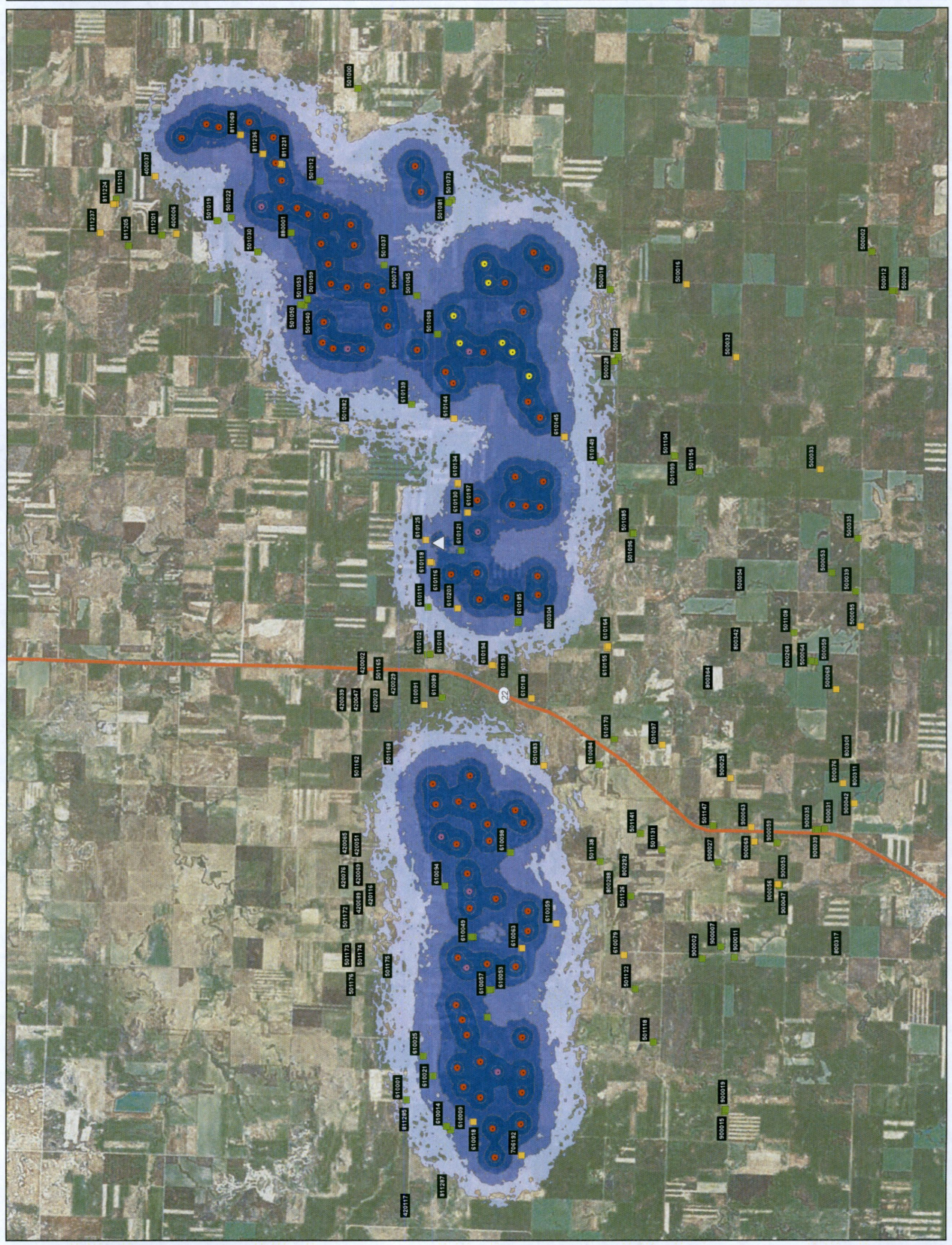
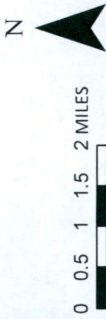
- GE 1.7 MW Turbine
- GE 1.7 MW Turbine (Alt)
- GE 1.79 MW Turbine

Receptors

- Occupied
- Unoccupied
- △ Substation

Sound Level Contour Ranges (dBA)

- 35-40
- >40-45
- >45-50
- >50



NEXTERA ENERGY
RESOURCES, LLC
BRADY WIND PROJECT
STARK COUNTY
NORTH DAKOTA

FIGURE 5

NO ALTERNATES:
RECEIVED SOUND LEVELS -
WIND TURBINES AT MAXIMUM
ROTATIONAL WIND SPEED

JANUARY 2016

Proposed Turbine Array (11/6/2015)

- GE 1.7 MW Turbine
- GE 1.79 MW Turbine

Receptors

- Occupied
- Unoccupied
- △ Substation

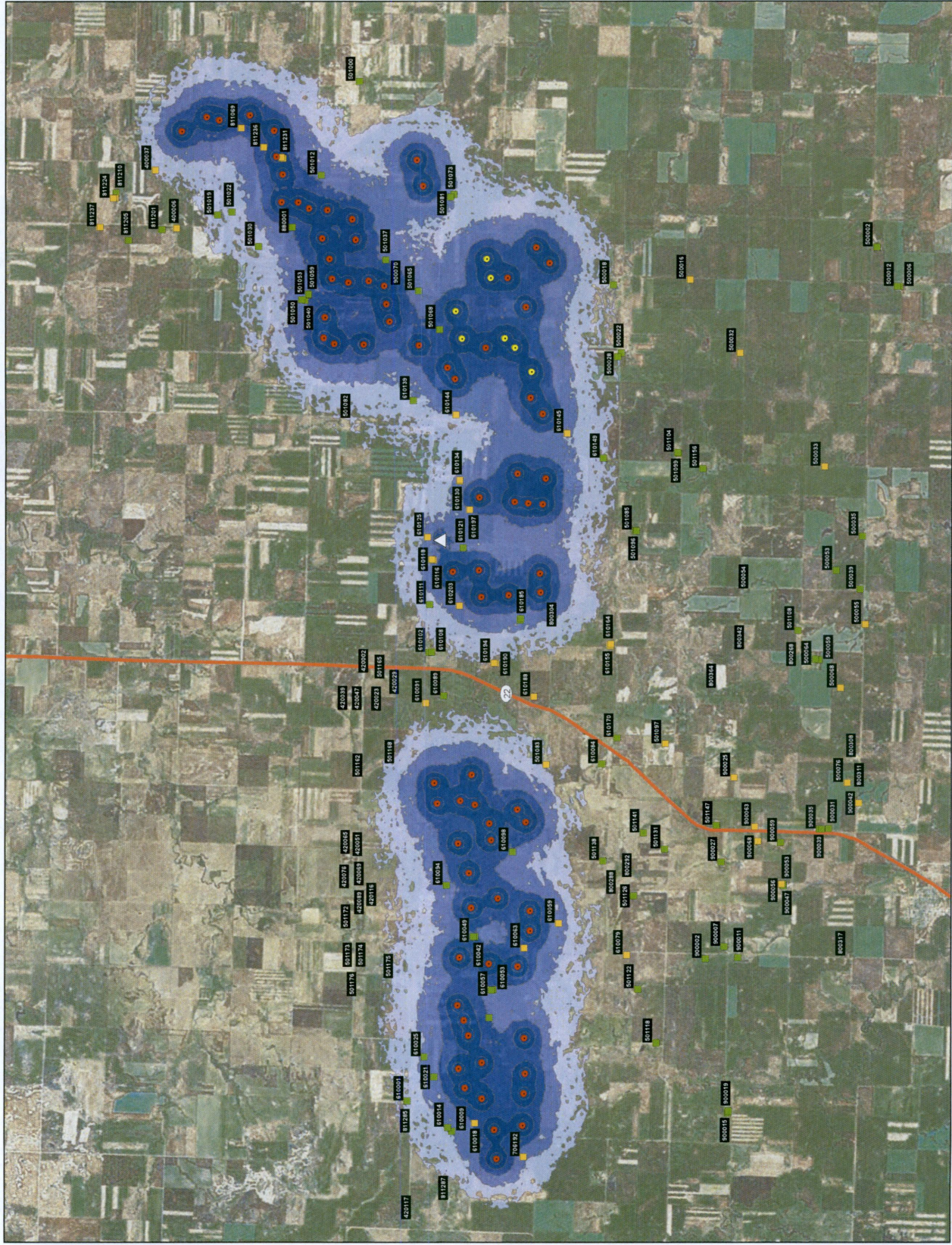
Sound Level Contour Ranges (dBA)

- 35-40
- >40-45
- >45-50
- >50



0 0.5 1 1.5 2 MILES

REFERENCE MAP



NEXTERA ENERGY
 RESOURCES, LLC
 BRADY WIND PROJECT
 STARK COUNTY
 NORTH DAKOTA

FIGURE 6
 WITH ALTERNATES:
 RECEIVED SOUND LEVELS -
 WIND TURBINES AT MAXIMUM
 ROTATIONAL WIND SPEED
 ANOMALOUS METEOROLOGICAL
 CONDITIONS

JANUARY 2016

Proposed Turbine Array (11/16/2015)

- GE 1.7 MW Turbine
- GE 1.7 MW Turbine (Alt)
- GE 1.79 MW Turbine

Receptors

- Occupied
- Unoccupied
- △ Substation

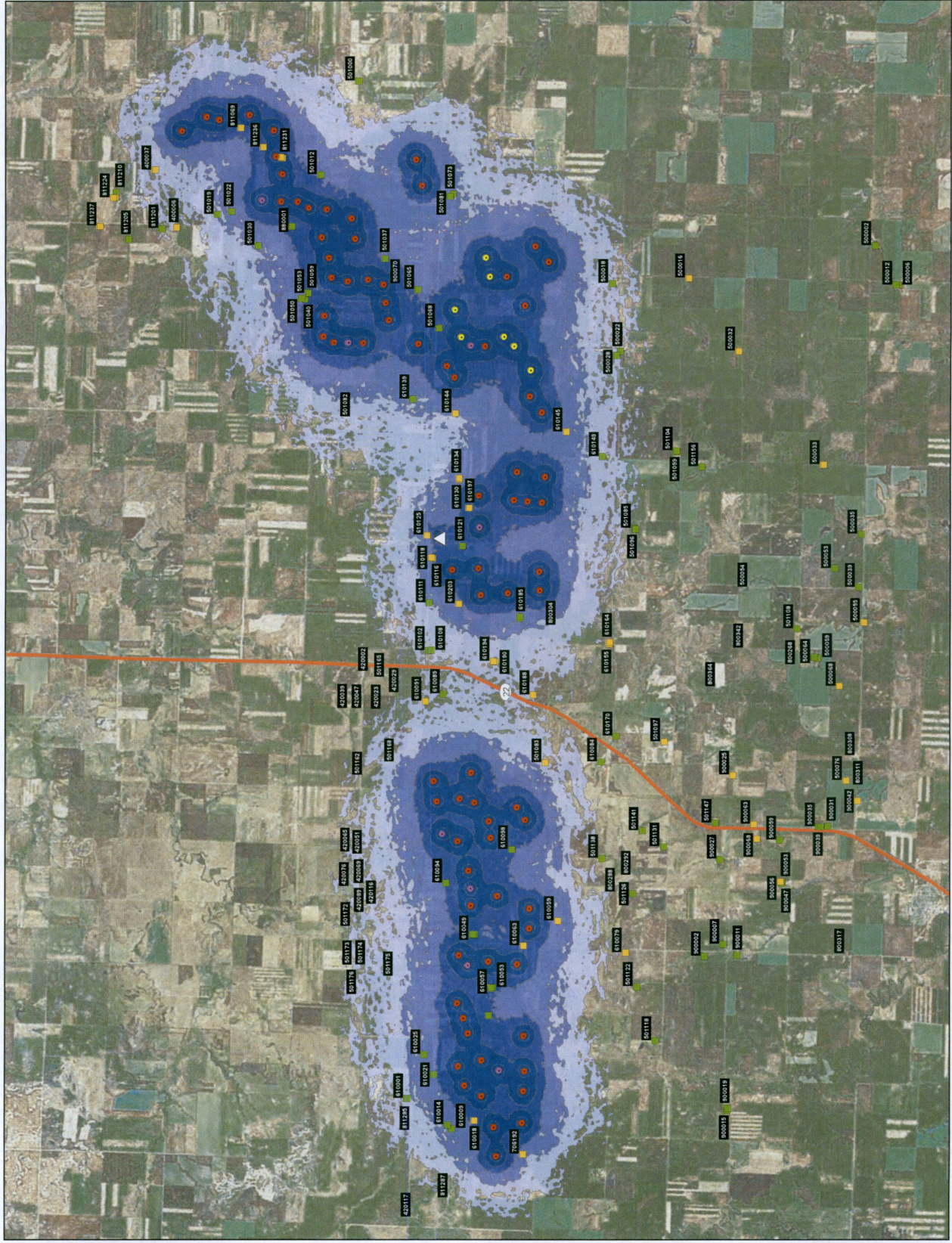
Sound Level Contour Ranges (dBA)

- 35-40
- >40-45
- >45-50
- >50



0 0.5 1 1.5 2 MILES

REFERENCE MAP



NEXTERA ENERGY
RESOURCES, LLC
BRADY WIND PROJECT
STARK COUNTY
NORTH DAKOTA

FIGURE 7
NO ALTERNATES
RECEIVED SOUND LEVELS -
WIND TURBINES AT MAXIMUM
ROTATIONAL WIND SPEED
ANOMALOUS METEOROLOGICAL
CONDITIONS

JANUARY 2016

Proposed Turbine Array (11/6/2015)

- GE 1.7 MW Turbine
- GE 1.79 MW Turbine

Receptors

- Occupied
- Unoccupied
- △ Substation

Sound Level Contour Ranges (dBA)

- 35-40
- >40-45
- >45-50
- >50



0 0.5 1 1.5 2 MILES

REFERENCE MAP

