Timber Road III Wind Farm
Acoustic Assessment

Paulding County, Ohio

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Prepared for

TIMBER ROAD
WIND FARM

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ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
AGL	above ground level
ANSI	American National Standards Institute
CadnaA	Computer-Aided Noise Abatement Program
dB	decibel
dBA	A-weighted decibel
dBL	linear decibel
EDPR	EDP Renewables North America LLC
Hz	Hertz
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
kHz	kilohertz
L_{eq}	equivalent sound level
L_{max}	maximum instantaneous sound level
L_p	sound pressure levels
L_W	sound power level
m	meter
ML	monitoring location
m/s	velocity in meters per second
mph	miles per hour
MVA	megavolt ampere
MW	megawatt
NEMA	National Electrical Manufacturers Association
NIST	National Institute of Standards and Technology
NSA	noise sensitive area
OPSB	Ohio Power Siting Board
µPa	micropascals
Project	Timber Road III Wind Farm
pW	picowatt
Tetra Tech	Tetra Tech, Inc.
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
W	watt
WTG	wind turbine generator

1.0 INTRODUCTION

EDP Renewables North America LLC (EDPR) currently operates the existing Timber Road II Wind Farm and proposes to construct and operate the Timber Road III Wind Farm (Project) in Paulding County, Ohio. The Project wind turbine generator (WTG) layout, dated November 13, 2015, includes locations for 35 Gamesa G114 2.1-megawatt (MW) WTGs. The rotor-diameters for the Gamesa G114 is 374 feet (114 meters) and has a hub height of 305 feet (93 meters). The Project infrastructure also includes a 138-kilovolt transmission line, which connects the Project to the American Electric Power (AEP) transmission system. Operational sound associated with the transmission line was analyzed and provided in a separate submittal to the Ohio Power Siting Board (OPSB). There is also a Project substation located centrally within the Project area near the intersection of County Roads 33 and 124. Substation data were obtained from EDPR assuming the on-site transformer rated at 173-megavolt ampere (MVA). To characterize the existing acoustic environment within the Project area, Tetra Tech, Inc. (Tetra Tech) completed a baseline sound survey. In addition, an acoustic modeling analysis was conducted to review operational sound levels resulting from the Project and compliance was assessed at nearby noise sensitive areas (NSAs) (e.g., residences) relative to the OPSB noise requirements. The results of the baseline sound survey and modeling analysis are documented in this Acoustic Assessment report.

1.1 Project Area

The Timber Road III Wind Farm is located within Paulding County, in northwestern Ohio, with Van Wert County bordering the Project to the south and the state of Indiana bordering the Project to the west. The topography of Paulding County, and the Project Area, is characterized as level to gently sloping. The highest elevation in the county, about 236 meters (775 feet) above sea level, is along U.S. Highway 30 in the southwestern portion of the county. The lowest elevation, about 209 meters (685 feet) above sea level, is at the point where the Maumee River flows into Defiance County. The uniformity of the landscape is broken only by the dissecting nature of the Auglaize and Maumee Rivers and their tributaries, as well as other creeks in the area (e.g., Blue Creek, Wildcat Creek, Cunningham Creek, etc.). These bodies of water are responsible for most of the gently sloping to steep relief in the county.

The Project is located on privately owned lands approximately 2.4 kilometers (1.5 mile) south of the Town of Antwerp and just northwest of the Town of Payne. The main Project area is bounded by U.S. Highway 24 to the north, Ohio State Route 613 to the south, the Ohio-Indiana border to the west, and Ohio State Route 49 to the east. Land use within Paulding County is primarily agricultural. The primary enterprises within the Project site are grain farming and some livestock production and dairying. Residences are widely scattered throughout the Project site with 571 identified within 1 mile radius of the Project site. Patches of trees and shrubs exist throughout and are found primarily between agricultural fields, in drainages, and as shelter belts around homesteads. Figure 1-1 presents the locations of the current Project wind turbines and discrete NSAs that were included in the modeling analysis. Noise monitoring stations and on-site meteorological stations used in the baseline sound survey are also identified.

Legend

- Gamesa G114 Wind Turbine
- Timber Road III Baseline Monitoring Location
- Noise Sensitive Areas
- On-site Meteorological Station
- Timber Road III Substation

N

0 0.5 1
Miles

FIGURE 1-1
TIMBER ROAD III WIND FARM
PROJECT LAYOUT

PAULDING COUNTY, OHIO

R:\PROJECTS\TIMBER_ROAD_III_5444\NOISE\TimberRd_III\Turbines\Figure 1-1_TRIII_Layout.mxd

1.2 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 Ohio Estimates of noise sources and outdoor acoustic environments, and the comparison of relative loudness are presented in Table 1-1. Table 1-2 provides additional reference information on acoustic terminology.

Table 1-1. 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	Moderate	1/2 as loud
Passenger car at 65 mph (25 ft)	65		
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 1-2. 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

The OPSB Rule §4906-17-08(A)(2) provides certification requirements for noise that must be adequately addressed during both Project construction and operation. The OPSB does not prescribe numerical decibel limits within the rules, but limits were provided within the Opinion, Order and Certificate issued to the Timber Road II/III Wind Farm on November 18, 2010. There are no noise requirements at the county or local levels.

2.1 OPSB Application Filing Requirements for Wind-Powered Electric Generation Facilities

The OPSB has adopted rules that implement certification requirements for wind energy facilities. Subsection (A) Health and safety of Sec. 4906-17-08 Social and ecological data, require the applicant to address the following:

- 4906-17-08(A)(2)(a): construction noise levels expected at the nearest property boundary including:

  (i) Dynamiting activities.
  (ii) Operation of earth moving equipment.
  (iii) Driving of piles.
  (iv) Erection of structures.
  (v) Truck traffic.
  (vi) Installation of equipment.

- 4906-17-08(A)(2)(b): For each turbine, evaluate and describe the operational noise levels expected at the property boundary closest to that turbine, under both day and nighttime conditions. Evaluate and describe the cumulative operational noise levels for the wind facility at each property boundary for each property adjacent to the project area, under both day and nighttime operations. The applicant shall use generally accepted computer modeling software (developed for wind turbine noise measurement) or similar wind turbine noise methodology, including consideration of broadband, tonal, and low-frequency noise levels expected at the nearest property boundary during both day and nighttime conditions.

- 4906-17-08(A)(2)(c): Indicate the location of any noise-sensitive areas within one mile of the proposed facility.

- 4906-17-08(A)(2)(d): Describe equipment and procedures to mitigate the effects of noise emissions from the proposed facility during construction and operation.

2.2 OPSB Recommended Conditions of Certificate

The OPSB does not prescribe numerical decibel limits within the rules, but limits were provided within the Opinion, Order and Certificate issued to the Timber Road II/III Wind Farm on November 18, 2010. The recommended conditions of certificate pertaining to noise were the following:

(37) That at least thirty (30) days prior to the pre-construction conference and subject to staff review and approval, Paulding Wind II shall model the expected project noise

contribution at the exterior of all non-participating residences within one mile of the facility boundary at critical wind speed calculated in accordance with ISO 9613-2 standard day conditions assuming moderate downwind sound propagation.

(38) If pre-construction acoustic modeling indicates a facility contribution that exceeds the facility area nighttime L_{eq} (41 dBA) by greater than five dBA at the exterior of any non-participating residences within one mile of the facility boundary, the project shall be subject to further study of potential impact and possible mitigation prior to construction. Mitigation, if required, shall consist of either reducing the impact so that the project contribution does not exceed the facility ambient nighttime L_{eq} (41 dBA) by greater than five dBA, or other means of mitigation approved by staff and Paulding Wind II in consultation with the affected receptor(s).

(39) After commencement of commercial operation, Paulding Wind II shall conduct further review of the impact and possible mitigation of all facility noise complaints. Mitigation shall be required if the facility contribution at the exterior of any non-participating residences within one mile of the facility boundary exceeds the greater of: (1) the project ambient nighttime L_{eq} (41 dBA) plus five dBA; or (2) the validly measured ambient L_{eq} at the location of the complaint during the same time of day or night as that identified in the compliant plus five dBA. Mitigation, if required, shall consist of either reducing the impact so that the project contribution does not exceed the greater of: (1) the project ambient nighttime L_{eq} (41 dBA) plus five dBA; or (2) the validly measured ambient L_{eq} plus five dBA, or other means of mitigation approved by staff and the applicant in consultation with the affected receptor(s).

The above conditions were based on the ambient nighttime L_{eq} sound level as documented during the 2010 baseline sound survey conducted to support permitting of the Timber Road II/III Wind Farm. For the purposes of assessing compliance in this analysis, the not to exceed design target for Timber Road III Wind Farm has been set at 48 dBA, L_{eq} (41 dBA) plus five dBA.

3.0 EXISTING ACOUSTIC CONDITIONS

Tetra Tech conducted a long-term baseline sound survey to characterize the existing acoustic environment in the vicinity of the Project. The baseline sound survey commenced on April 28, 2010 with data logged continuously over a two-week period ending May 12, 2010.

A long-term baseline survey is requisite to provide a statistically relevant data set, covering the full range of wind speeds that would occur under the future WTG operational scenarios that were considered. This section summarizes the methodologies used by Tetra Tech to conduct the sound survey, describes the measurement locations, and presents the measured ambient sound levels.

3.1 Field Methodology

Ambient sound level measurements were conducted using a Larson Davis Model 831 precision integrating sound-level analyzer that meets the requirements of American National Standards Institute (ANSI) Standards for Type 1 instruments. This instrument has an operating range of 5 to 140 dB and an overall frequency range of 8 to 20,000 Hz. The Larson Davis 831 sound level analyzer is designed for service as a long-term environmental sound level data logger measuring the A-weighted sound level. Each analyzer used was enclosed in a weatherproof case and equipped with a self-contained microphone tripod. During the measurements, the microphone and windscreen were tripod-mounted at an approximate height of 1.5 to 1.7 meters (4.9 to 5.6 feet) above grade. The sound level meter was calibrated at the beginning and end of the measurement period using a Larson Davis Model CAL200 acoustic calibrator following procedures that are traceable to the National Institute of Standards and Technology (NIST). Table 3-1 lists the measurement equipment employed during the survey. The analyzers were programmed to sample and store A-weighted and octave band sound level data, including equivalent (L_{eq}).

Table 3-1. Measurement Equipment

Description	Manufacturer	Type
Signal Analyzer	Larson Davis	831
Preamplifier	Larson Davis	PRM902
Microphone	PCB	377B02
Windscreen	ACO Pacific	7-inch
Calibrator	Larson Davis	CAL200

3.2 Monitoring Locations

Monitoring locations were selected with the assistance of EDPR to be representative of residences that would be located in proximity to WTGs. Measurements were made in ten-minute intervals at each location and those measurements were correlated with wind speed data collected by on-site meteorological towers as shown in Figure 1-1. The wind speed data sets were then scaled up to hub height using the site-specific roughness length coefficient assuming a logarithmic wind profile. The average surface roughness length coefficient of the

Project sites was calculated by month using the U.S. Environmental Protection Agency's AERSURFACE program. The average surface roughness length for the Project area was calculated as 0.12775 meters.

Using the sound level measurement and wind speed data, a regression analysis was conducted for each monitoring location and the best fit correlation coefficient using a second order polynomial equation was evaluated. The 10-minute L_{eq} sound levels were divided into daytime (7:00 am to 10:00 pm) and nighttime (10:00 pm to 7:00 am) periods to show diurnal variation at a monitoring position. The scattering and R^2 coefficient is expected and likely caused by noise associated with periodic aircraft flyovers and short-term natural sounds such as wildlife and cattle, in addition to anthropogenic activity. Short-term agricultural activities such as harvesting may also act as contributing factors to the scatter seen at the monitoring sites.

Additional descriptions of the monitoring locations and field observations are provided in Sections 3.2.1 to 3.2.3. Time history and regression analysis plots are also given for each monitoring location.

3.2.1 Monitoring Location 1

Monitoring location 1 was situated at a residence at 1464 Road 106 in Payne, Ohio (UTM Zone 16N: 685172, 4552926). Larson Davis 831, Serial No. 0001711, was used to collect data at this location. The distance to the closest WTG is approximately 695 meters. Observations during deployment were that the location was relatively quiet with agricultural activities and sporadic roadway noise potentially contributing to ambient sound levels. Figure 3-1 includes photographs of the monitoring location relative to one of the residential structures and the viewpoint from the monitoring in the direction of the Project. Figure 3-2 provides the time history and Figure 3-3 provides the regression analyses of ambient sound levels during daytime and nighttime monitoring periods.

Figure 3-1. Photographs of ML-1

View towards the Project

View towards the Residence

Figure 3-2. ML-1 Time History Plot

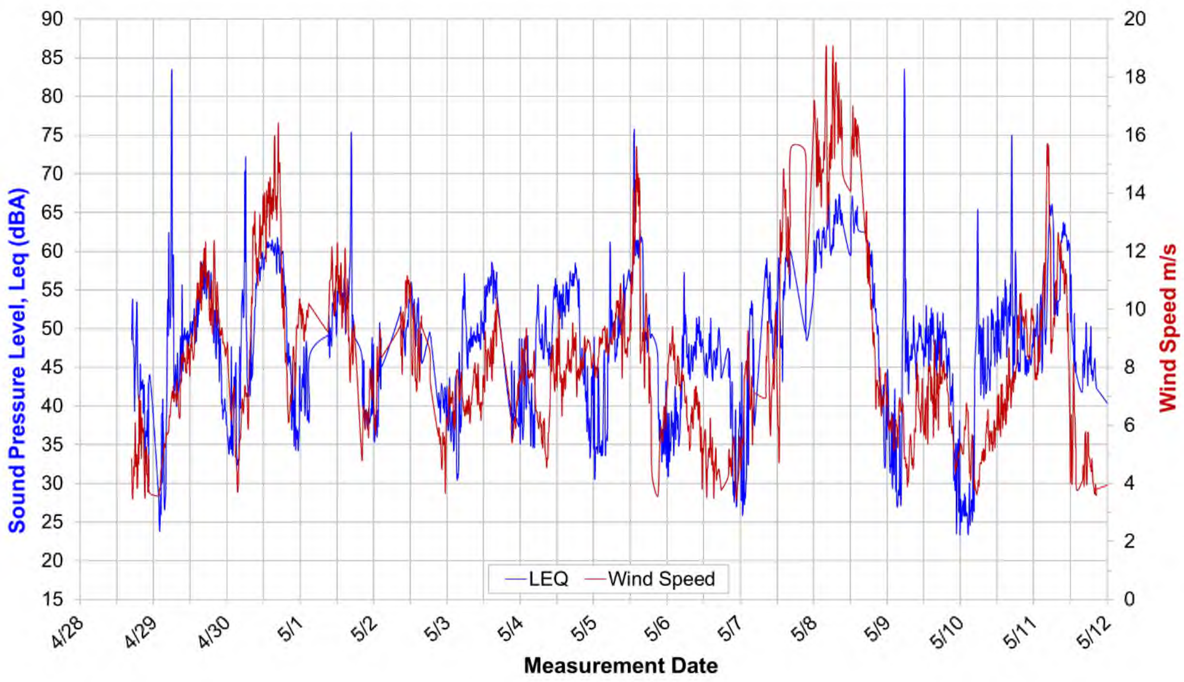
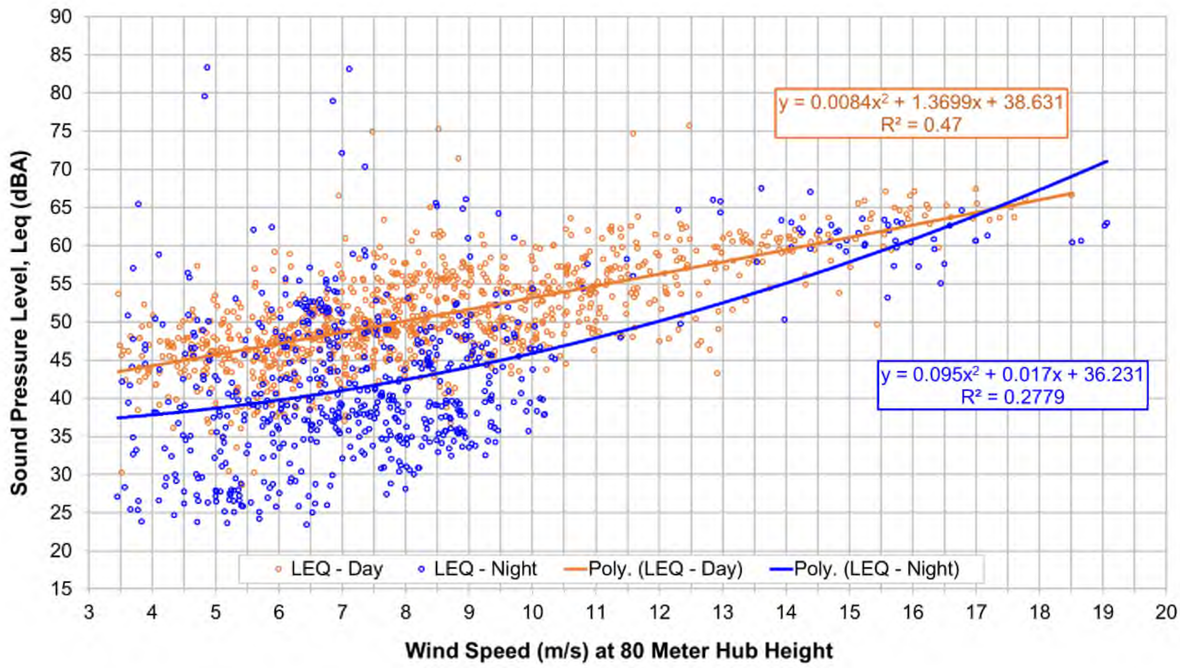


Figure 3-3. ML-1 Regression Analysis



3.2.2 Monitoring Location 2

Monitoring location 2 was situated at a residence along 5397 State Route 49 in Payne, Ohio (UTM Zone 16N: 691000, 4547196). Larson Davis 831, Serial No. 0001350, was used to collect data at this location. The distance to the closest WTG is approximately 3,860 meters. Observations during deployment were that the location was relatively quiet with agricultural activities and sporadic roadway noise potentially contributing to ambient sound levels. Figure 3-4 includes photographs of the monitoring location relative to one of the residential structures and the viewpoint from the monitoring in the direction of the Project. Figure 3-5 provides the time history and Figure 3-6 provides the regression analyses of ambient sound levels during daytime and nighttime monitoring periods.

Figure 3-4. Photographs of ML-2

View towards the Project

View towards the Residence

Figure 3-5. ML-2 Time History Plot

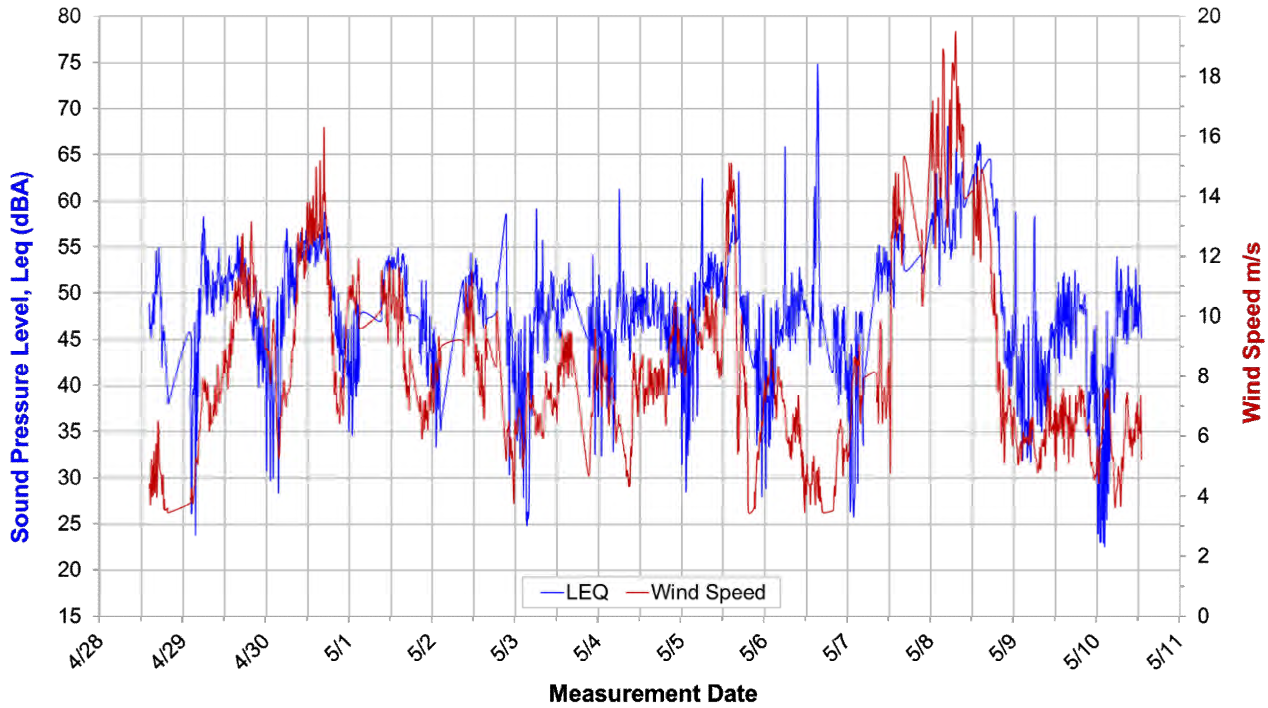
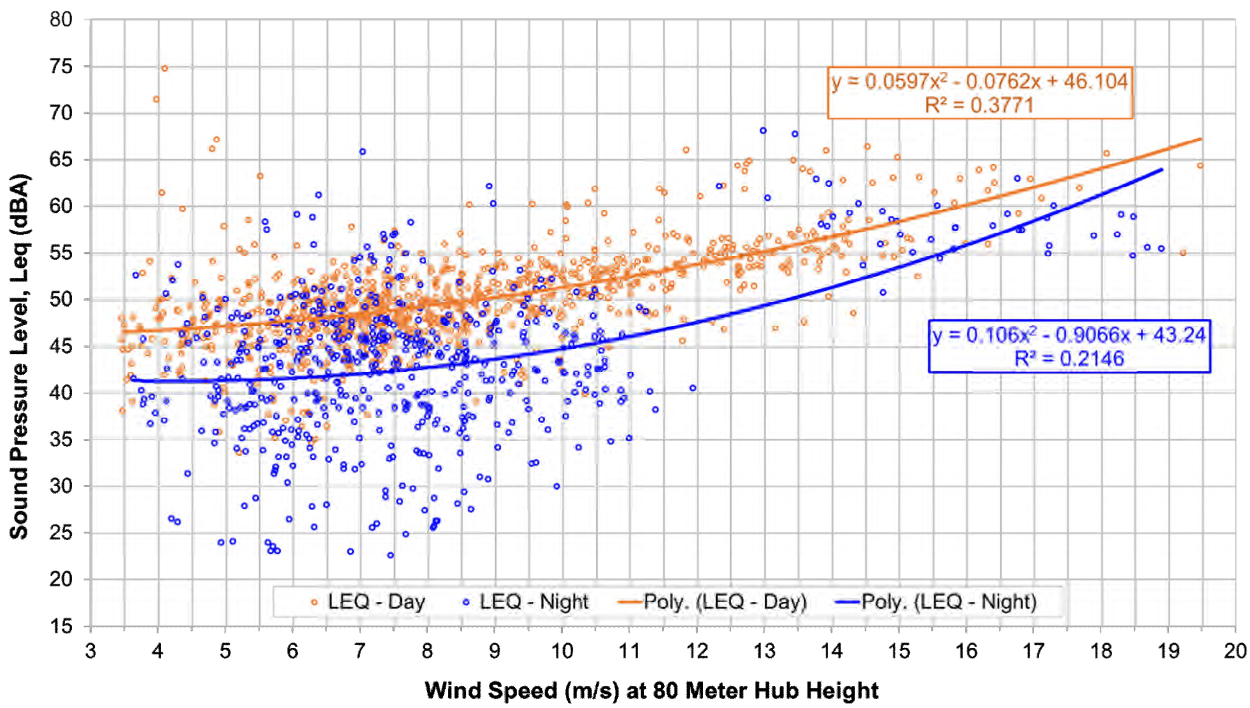


Figure 3-6. ML-2 Regression Analysis



3.2.3 Monitoring Location 3

Monitoring location 3 was situated at a residence along 1729 State Route 114 in Payne, Ohio (UTM Zone 16N: 685857, 4533150). Larson Davis 831, Serial No. 0001702, was used to collect data at this location. The distance to the closest WTG is approximately 7,560 meters. Observations during deployment were that the location was relatively quiet with agricultural activities and sporadic roadway noise potentially contributing to ambient sound levels. Figure 3-7 includes photographs of the monitoring location relative to one of the residential structures and the viewpoint from the monitoring in the direction of the Project. Figure 3-8 provides the time history and Figure 3-9 provides the regression analyses of ambient sound levels during daytime and nighttime monitoring periods.

Figure 3-7. Photographs of ML-3

View towards the Project

View towards the Residence

Figure 3-8. ML-3 Time History Plot

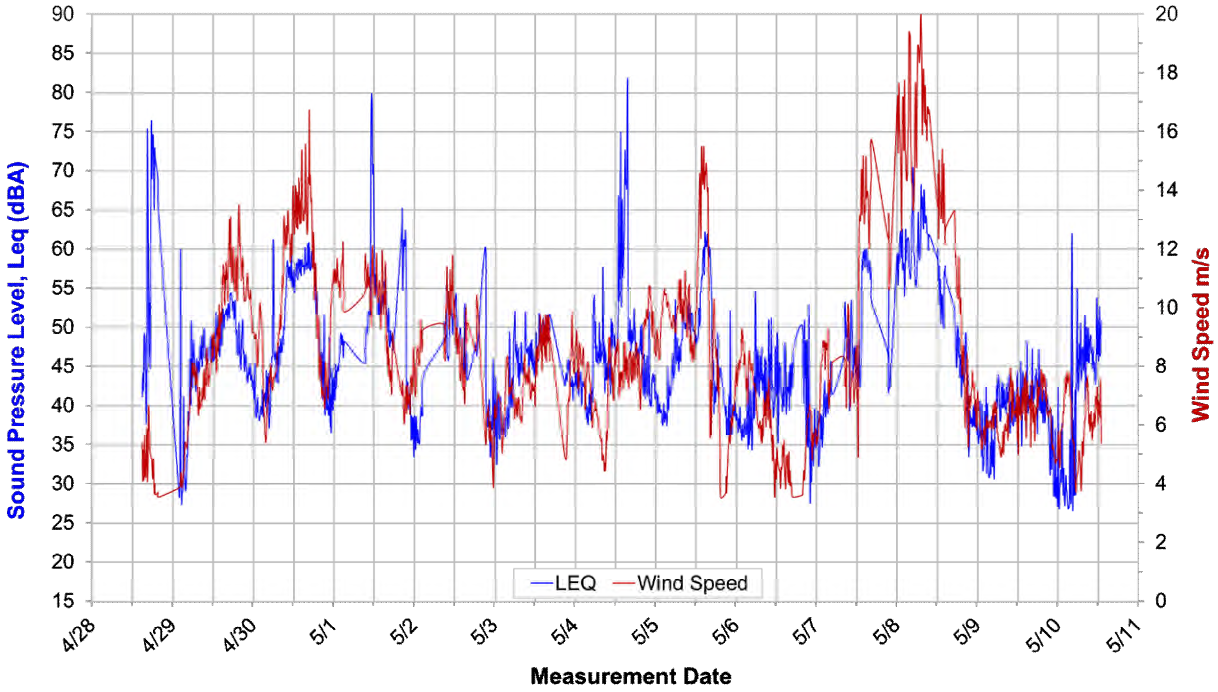
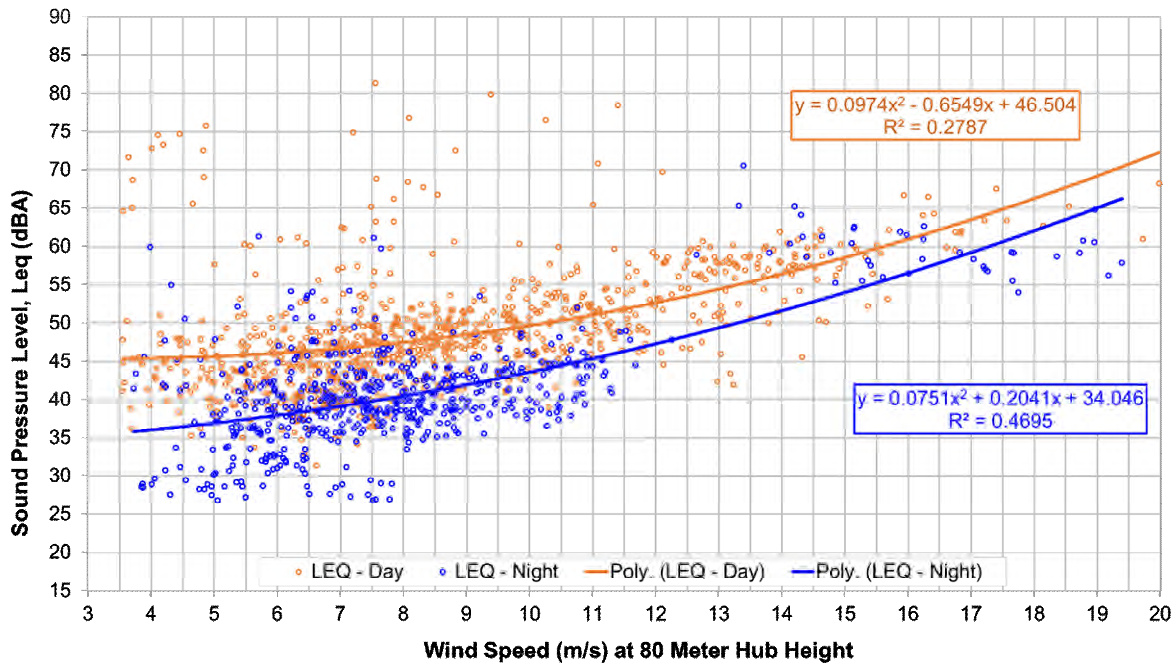


Figure 3-9. ML-3 Regression Analysis



3.3 Baseline Sound Survey Results

Table 3-2 provides the results of the regression analyses for each monitoring location and cumulatively for all locations, representing the ambient sound levels across the Project area. Table 3-2 displays daytime and nighttime ambient sound levels for each monitoring location and the Timber Road III Wind Farm Project area as a whole for wind speed conditions ranging from calm to maximum rotational wind speed. The results show a generally homogenous ambient acoustic environment throughout the Project area with limited variation in measured sound levels.

Table 3-2. Baseline Sound Survey Results, L_{eq} (dBA)

Monitoring Location	Coordinates (UTM Zone 16N)		Time Period	Wind Speed (m/s)										
	Easting (m)	Northing (m)		3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
ML-1	685172	4552926	Day	43	44	44	45	46	46	47	48	49	49	50
			Night	37	37	38	38	39	39	40	40	41	42	42
ML-2	691000	4547196	Day	46	47	47	47	47	47	48	48	48	49	49
			Night	41	41	41	41	41	41	42	42	42	42	43
ML-3	685857	4543150	Day	45	45	45	46	46	46	46	46	47	47	47
			Night	35	36	36	36	37	37	38	39	39	40	40
Timber Road III Wind Farm Project Site			Day	45	45	45	46	46	47	47	48	48	49	49
			Night	38	38	38	39	39	39	40	40	41	41	42

4.0 ACOUSTIC MODELING METHODOLOGY

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 Gamesa 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.

4.1 Acoustic Modeling Software and Calculation Methods

The operational Acoustic Assessment was performed using the Project WTG layout dated November 13, 2015, consisting of 35 proposed WTG locations using the Gamesa G114 2.1-MW WTG model. The Project would also include a collection substation with a 173 MVA transformer to connect to the AEP transmission system. WTG sound source data were obtained from Gamesa (Gamesa 2014) and substation transformer data were obtained from EDPR.

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 ignored.

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. 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.

4.2 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 4-1 presents a summary of sound power data correlated to wind speeds 10 meter above ground level (AGL) using a roughness length coefficient of 0.05 meter. 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 4-1. Broadband Sound Power Levels (dBA) Correlated with Wind Speed

	WTG L_{max} Sound Power Level (L_W) at Reference Wind Speed (m/s)										
Wind Speed	3 .0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
Gamesa G114	95.8	95.8	96.8	99.5	101.9	104.1	106.2	106.6	106.6	106.6	106.6

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 4-2 (1/1 octave band frequency data provided with stated intended use limited for informational purposes only).

Table 4-2. Sound Power Level by Octave Band Center Frequency

Frequency	Octave Band Sound Power Level (dBA)								Broadband
(Hz)	63	125	250	500	1000	2000	4000	8000	(dBA)
Gamesa G114	84.3	91.7	97.6	101.3	101.7	99.0	92.7	81.2	106.6

4.3 Critical Design Wind Speed

The critical design wind speed is defined as the operational condition when the greatest differential occurs between the pre-construction background sound level and the wind turbine sound power level at the corresponding given wind speed. Although not initially intuitive, the operational noise condition that results in the greatest incremental increase relative to baseline may not occur at full-rated power when the wind turbine is at its maximum noise emission level. Table 4-3 identifies the critical design wind speed for the Gamesa G114 by comparing the net differential between the wind turbine sound power level and the background nighttime L_{eq} sound level measured during the 2015 survey and at a 93-meter hub height. Table 4-3 shows that for the Gamesa G114, the critical design wind speed occurs at the reference wind speed range of 6.5 m/s (14.5 miles per hours [mph]) to 7 m/s (15.7 mph). Acoustic modeling was completed for Project operation at the critical design wind speed, where the sound power octave band data was scaled accordingly. The results from modeling this scenario were then used to evaluate the feasibility of the Project to operate within OPSB criterion.

Table 4-3. Gamesa G114 Critical Design Operational Condition

10-meter AGL Wind Speed	3 m/s	3.5 m/s	4 m/s	4.5 m/s	5 m/s	5.5 m/s	6 m/s	**6.5 m/s**	**7 m/s**	7.5 m/s	8 m/s
Gamesa G114 L_{max} Sound Power Level at Reference Wind Speed	95.8	95.8	96.8	99.5	101.9	104.1	106.2	**106.6**	**106.6**	106.6	106.6
Background Nighttime L_{eq}	38	38	38	39	39	39	40	**40**	**41**	41	42
Net Differential	58	58	58	61	63	65	66	**66**	**66**	65	65

Bold type indicates critical design wind speeds.

4.4 Acoustic Modeling Results and Compliance

Acoustic modeling was completed for WTG cut-in (3 m/s) and critical design wind speed (6.5 – 7 m/s) operating conditions. 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 4-1 and 4-2. Figure 4-1 is a map of the broadband operational sound levels under low-level wind speeds sufficient for the WTGs to operate at initial cut-in rotational speeds. Figure 4-2 shows broadband (dBA) operational sound levels at wind speeds sufficient to sustain wind turbine operation at the critical design wind speed. Table A-1 (Appendix A) presents the results of the Timber Road III Wind Farm acoustic modeling analysis and includes the ID, Universal Transverse Mercator (UTM) coordinates, NSA status (participant or non-participant) and the received sound levels at each NSA. The tabulated results and contour plots are independent of the existing acoustic environment and are representative of expected Project sound levels only.

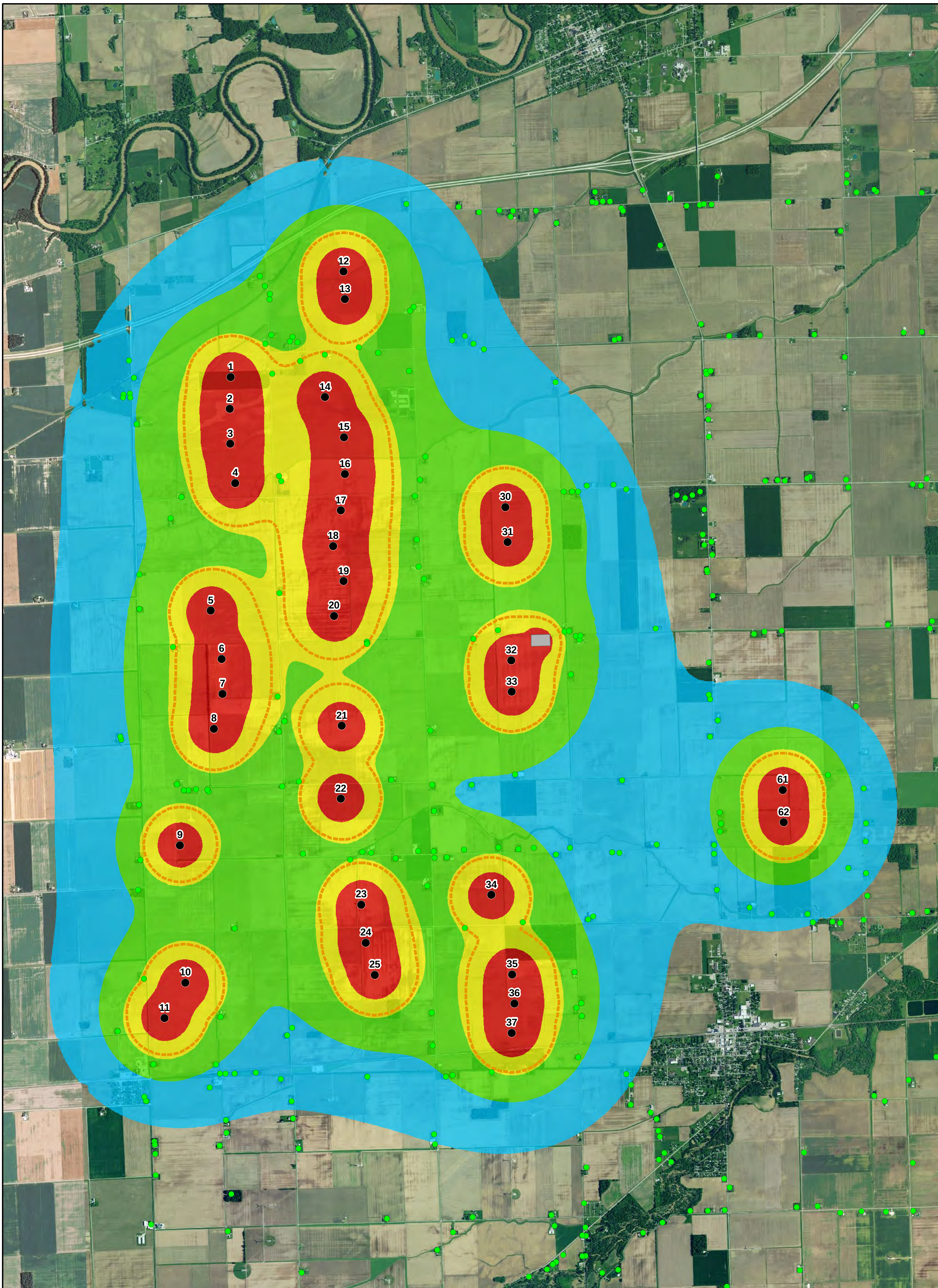
Acoustic modeling results indicate that there are 13 potential exceedances of the OPSB 46 dBA noise criterion, at NSA IDs 118, 119, 120, 131, 132, 209, 210, 211, 212, 213, 344, 345, and 352. However, demonstration of compliance with the standard is not required at a number of those NSAs for different reasons including:

- NSA IDs 118, 120, and 209 have participating agreement signed;
- NSA ID 352 is located in Indiana, outside of the jurisdiction of the OPSB; and
- NSA IDs 131, 212 and 213 are non-residential structures (i.e., barns, garages, etc.).

Landowners at NSA IDs 132, 344 and 345 have previously participated in Project and EDPR is currently working with those landowners to reinstate the participating agreement. For the remaining NSAs (119, 210, and 211), mitigation options are being evaluated by EDPR including, but not limited to entering into a participating agreement with the landowner. Mitigation options include either reducing the impact so that the Project contribution does not exceed the facility ambient nighttime L_{eq} (41 dBA) by greater than 5 dBA, or other means of mitigation approved by OPSB staff and the Applicant in consultation with the affected NSAs. In accordance with the ISO 9613-2 calculation standard and OPSB modeling directives, compliance with the OPSB noise criterion at all other NSAs has effectively been demonstrated.

FIGURE 4-1
TIMBER ROAD III WIND FARM
RECEIVED SOUND LEVELS:
WIND TURBINES AT CUT-IN ROTATION

PAULDING COUNTY, OHIO



Legend

- Gamesa G114 Wind Turbine
- Noise Sensitive Areas
- Timber Road III Substation
- Sound Level Exceeding 46 dBA OPSB Noise Criterion

Sound Level Contour Ranges (dBA):

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

N

0 0.5 1
Miles

FIGURE 4-2
TIMBER ROAD III WIND FARM
RECEIVED SOUND LEVELS:
WIND TURBINES AT MAXIMUM ROTATION

PAULDING COUNTY, OHIO

R:\PROJECTS\TIMBER_ROAD_III_5444\NOISE\TimberRd_III\Turbines\Figure 4-2_TRIII_Max.mxd

5.0 OTHER SOUND CONSIDERATIONS

5.1 5.1 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 Timber Road III electrical substation would be located near the intersection of County Roads 33 and 124. The transformer at this substation was modeled using the latest version of CadnaA implementing ISO 9613-2. Transformer sound source levels for the Timber Road III substation were derived based on a 173 MVA rating. Table 5-4 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 5-4. Transformer Sound Power Level

	Octave Band Sound Power Level (dB)								Broadband (dBA)
Frequency (Hz)	63	125	250	500	1000	2000	4000	8000	
Transformer	93	99	101	96	90	85	80	73	97

Transformers the size of the one proposed for the Timber Road III Wind Farm can present a noise concern if the separation distance is less than a few hundred feet between the transformer and NSAs. The proposed Timber III transformer location is approximately 274 meters (900 feet) from the nearest NSA and poses little concern from a noise perspective. That being said, transformer noise may be periodically audible at nearby NSAs on occasions when background sound levels are very low.

5.2 Construction Noise

The development of Timber Road III Wind Farm 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 the Timber Road III Wind Farm 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. *Excavation*: This phase would begin with the excavation 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. *Wind Turbine 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 5-5.

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 NSAs 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.

Table 5-5. 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

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.

6.0 CONCLUSIONS

Project operational sound has been calculated and compared to the OPSB noise criterion of 46 dBA L_{eq}, which is consistent with guidance provided in the Opinion, Order and Certificate issued to the Timber Road II/III Wind Farm. Acoustic modeling analysis per ISO 9613-2 and inclusive of a number of conservative assumptions and under critical design (6.5 – 7.0 m/s) wind speed operational conditions demonstrates the Project will result in 13 potential exceedance at NSA IDs 118, 119, 120, 131, 132, 209, 210, 211, 212, 213, 344, 345, and 352. However, compliance with the standard is not required at a number of those NSAs for different reasons including:

- NSA IDs 118, 120, and 209 have participating agreement signed;
- NSA ID 352 is located in Indiana, outside of the jurisdiction of the OPSB; and
- NSA IDs 131, 212 and 213 are non-residential structures (i.e., barns, garages, etc.).

Landowners at NSA IDs 132, 344 and 345 have previously participated in the Project and EDPR is currently working with those landowners to reinstate the participating agreement. For the remaining NSAs (119, 210, and 211), mitigation options are being evaluated by EDPR including, but not limited to entering into a participating agreement with the landowner. Mitigation options include either reducing the impact so that the Project contribution does not exceed the facility ambient nighttime L_{eq} (41 dBA) by greater than 5 dBA, or other means of mitigation approved by OPSB staff and the Applicant in consultation with the affected NSAs. The results show that at all other NSAs, in accordance with ISO 9613-2 and OPSB modeling directives, demonstrate compliance with the OPSB noise criterion.

7.0 REFERENCES

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Appendix A

Tabulated Acoustic Modeling Results by NSA

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
1	696194	4539850	2	12
2	696146	4539991	2	13
3	695851	4540169	2	13
4	694804	4541440	4	15
5	694868	4541453	4	15
6	694865	4541526	4	15
7	696040	4540809	3	13
8	695792	4541850	4	14
9	695997	4541852	4	14
10	694886	4540643	3	14
11	694050	4540185	3	14
12	692912	4539696	3	14
13	692859	4540871	4	15
14	692934	4540958	4	15
15	692795	4541087	5	15
16	693258	4541787	5	16
17	692647	4541792	5	16
18	692095	4541693	5	16
19	691733	4541675	6	16
20	691161	4541670	5	16
21	691201	4542328	7	17
22	690515	4541716	6	17
23	690164	4541712	6	17
24	689954	4541704	6	17
25	689607	4542097	7	18
26	689533	4542278	7	18
27	690793	4540285	4	15
28	690353	4540100	4	15
29	689594	4540068	5	15
30	689686	4540814	5	16
31	688428	4539956	5	15
32	687244	4539606	4	15
33	687232	4539948	5	15
34	687128	4540700	5	16
35	686383	4540092	5	16
36	687128	4542289	7	18
37	687195	4542202	7	18
38	686342	4541668	7	17
39	686343	4541323	6	17

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
40	684701	4541632	6	17
41	690246	4559027	18	29
42	687400	4559489	27	38
43	687984	4559459	24	35
44	688213	4559396	23	34
45	688441	4559416	22	33
46	688597	4559410	21	32
47	688570	4559347	22	33
48	688852	4559414	21	31
49	689081	4559275	20	31
50	689811	4559445	18	29
51	689811	4559445	18	29
52	689832	4559411	18	29
53	689685	4559520	18	29
54	689602	4559521	18	29
55	689526	4559503	19	29
56	689482	4559514	19	29
57	689515	4559625	18	29
58	690048	4559647	17	28
59	690355	4559556	17	28
60	690542	4559470	17	27
61	690690	4559478	16	27
62	690734	4559487	16	27
63	690822	4559482	16	27
64	690886	4559800	15	26
65	691684	4559516	14	25
66	692267	4559188	14	25
67	692448	4559621	13	24
68	692337	4559726	13	24
69	692337	4559817	13	24
70	692671	4559632	13	23
71	692642	4559651	13	23
72	693179	4559615	12	23
73	694035	4559563	11	22
74	695522	4556755	11	22
75	695467	4557635	10	21
76	695431	4558729	10	20
77	695543	4558081	10	21
78	694887	4557958	11	22

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
79	693647	4558040	13	24
80	693585	4558029	13	24
81	693179	4558058	13	24
82	692974	4558050	14	25
83	692314	4557770	15	26
84	690791	4556883	20	31
85	690783	4557078	20	31
86	690791	4557230	20	30
87	690706	4557343	20	31
88	690776	4557597	19	30
89	690758	4557612	19	30
90	690758	4557612	19	30
91	690763	4557582	19	30
92	690808	4557618	19	30
93	691972	4558025	16	27
94	691365	4558017	17	28
95	691020	4558008	18	29
96	690706	4558140	18	29
97	689731	4557967	21	32
98	689784	4557986	21	32
99	689073	4557494	25	35
100	688270	4557864	26	37
101	688156	4557922	27	37
102	688058	4558010	27	38
103	687915	4557962	28	38
104	687441	4558292	31	42
105	687482	4558333	31	42
106	687433	4557617	31	42
107	685870	4558484	32	42
108	685865	4558420	32	42
109	685814	4558571	31	42
110	685761	4558679	30	41
111	686185	4557940	34	45
112	686124	4558001	34	45
113	686096	4557947	34	45
114	685889	4558019	34	44
115	685819	4557925	35	45
116	687085	4557821	33	44
117	686868	4557885	34	45

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
118	686490	4557799	37	47
119	686215	4557731	36	47
120	685897	4557587	37	48
121	684293	4557735	28	39
122	684346	4557542	29	39
123	684232	4557355	28	39
124	684228	4557321	28	39
125	684304	4557364	29	40
126	684307	4557318	29	40
127	684381	4557026	30	40
128	684883	4556206	33	44
129	684760	4555966	31	42
130	684883	4556206	33	44
131	686000	4556386	37	47
132	685973	4556438	37	48
133	687616	4556660	32	43
134	687498	4556215	33	44
135	687556	4556401	33	44
136	687517	4555729	33	44
137	687537	4555426	33	44
138	687599	4555286	32	43
139	690737	4556067	22	32
140	690822	4555706	22	32
141	690828	4555557	22	33
142	690737	4555668	22	33
143	690724	4555784	22	33
144	690838	4555100	22	33
145	690776	4555364	22	33
146	690769	4555390	22	33
147	689163	4556266	31	42
148	689260	4556269	30	41
149	689327	4556267	29	40
150	689425	4556334	28	39
151	689722	4556345	26	37
152	689865	4556293	25	36
153	690693	4556268	21	32
154	690606	4556226	22	33
155	690527	4556198	22	33
156	690432	4556229	23	33

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
157	691641	4556388	18	29
158	691560	4556396	19	29
159	691427	4556385	19	30
160	691920	4556430	18	29
161	691890	4556414	18	29
162	692327	4556398	17	28
163	692356	4556315	17	28
164	693075	4556351	16	26
165	693167	4556335	15	26
166	693235	4556408	15	26
167	693818	4556359	14	25
168	694260	4556411	13	24
169	694648	4556424	13	23
170	694777	4556375	12	23
171	694771	4556337	12	23
172	694985	4556353	12	23
173	694988	4556446	12	23
174	695542	4556511	11	22
175	695541	4556486	11	22
176	695541	4556486	11	22
177	695540	4556474	11	22
178	695496	4556454	11	22
179	695470	4556453	11	22
180	695426	4556450	11	22
181	695398	4556451	11	22
182	695376	4556449	11	22
183	695353	4556388	11	22
184	694014	4555545	15	25
185	695576	4554840	12	23
186	694880	4554736	14	24
187	694831	4554755	14	24
188	694618	4554810	14	25
189	693472	4554816	17	28
190	693421	4554817	17	28
191	693293	4554817	17	28
192	693267	4554733	18	28
193	692795	4554775	19	30
194	694108	4554354	16	27
195	690792	4554351	24	35

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
196	690804	4553939	25	36
197	690890	4553703	26	37
198	690805	4553521	27	38
199	691610	4554709	22	32
200	691413	4554699	22	33
201	691296	4554673	22	33
202	690195	4554734	25	36
203	689175	4554698	35	45
204	689226	4554703	33	44
205	689299	4554646	32	43
206	689341	4554605	32	43
207	689352	4554651	32	43
208	689246	4554214	33	44
209	688426	4554712	38	49
210	688154	4554619	36	47
211	686958	4554588	37	47
212	686963	4554571	36	47
213	686958	4554561	36	47
214	685977	4555131	35	46
215	684411	4555338	30	40
216	684408	4554953	31	41
217	684785	4554526	35	46
218	684209	4553487	29	40
219	684197	4553519	29	40
220	685959	4553969	35	46
221	685974	4553577	34	45
222	686037	4553692	34	45
223	687669	4553590	31	41
224	688622	4553099	29	40
225	689818	4553031	26	37
226	690913	4552669	31	42
227	690928	4552545	31	42
228	690918	4552458	30	41
229	692440	4553859	24	35
230	692128	4553092	33	44
231	692527	4552940	28	39
232	692553	4552549	28	39
233	692547	4552347	27	38
234	693737	4553099	19	30

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
235	693413	4553167	20	31
236	694139	4553835	16	27
237	694131	4553976	16	27
238	694729	4553134	15	26
239	694442	4553077	16	27
240	694145	4553117	17	28
241	695604	4553678	12	23
242	695597	4554069	12	23
243	695733	4554015	12	23
244	695733	4552672	12	23
245	695641	4552529	12	23
246	695250	4552332	13	24
247	695273	4552268	13	24
248	694911	4552259	14	25
249	695059	4552185	14	24
250	694906	4552170	14	25
251	694810	4552194	15	25
252	694867	4552147	14	25
253	694816	4552121	14	25
254	694749	4552085	15	25
255	694685	4552062	15	26
256	694594	4552197	15	26
257	694511	4552075	15	26
258	694638	4551996	15	26
259	694512	4551954	15	26
260	694095	4552733	17	28
261	694185	4552113	17	27
262	694101	4552476	17	28
263	694181	4552381	17	28
264	694124	4551901	17	27
265	694145	4551825	16	27
266	694263	4551906	16	27
267	693867	4551846	17	28
268	694060	4551861	17	28
269	693998	4551857	17	28
270	693591	4551729	19	29
271	693550	4551713	19	29
272	693452	4551655	19	30
273	693389	4551580	19	30

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
274	693238	4551562	20	31
275	693072	4551541	20	31
276	692525	4551466	23	33
277	692570	4551734	24	35
278	692554	4551992	25	36
279	692353	4552048	28	38
280	692263	4551430	24	34
281	692174	4551444	24	35
282	691959	4551443	25	35
283	691897	4551531	26	36
284	691495	4551532	26	37
285	691249	4551604	26	37
286	690879	4551803	26	37
287	690850	4552307	29	40
288	690851	4552210	29	39
289	690203	4552313	25	36
290	689791	4552221	26	37
291	689709	4552225	26	37
292	689236	4552276	28	39
293	689079	4552197	29	40
294	688655	4552260	32	43
295	688433	4552281	33	43
296	687633	4551850	33	44
297	688046	4552253	32	43
298	687856	4552167	32	43
299	687715	4552165	32	42
300	687705	4552235	31	42
301	687532	4552241	31	42
302	687281	4552156	33	44
303	687006	4552219	34	45
304	686907	4552228	34	45
305	686769	4552143	35	45
306	686243	4552207	32	43
307	687691	4552979	30	41
308	687233	4553034	33	44
309	686197	4553016	35	46
310	686008	4552963	33	43
311	685187	4552906	33	43
312	685172	4552926	33	44

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
313	685043	4552931	33	44
314	684960	4552918	33	44
315	684906	4552921	33	43
316	684906	4552921	33	43
317	684833	4552986	32	43
318	684403	4552756	31	42
319	684419	4552138	34	45
320	684392	4551800	30	41
321	685475	4551373	30	41
322	694240	4551163	15	26
323	694217	4550702	15	25
324	695927	4551621	12	22
325	695778	4551615	12	23
326	695762	4551042	12	22
327	695710	4550592	11	22
328	695769	4550634	11	22
329	695808	4550635	11	22
330	695790	4550722	11	22
331	695827	4550779	11	22
332	694720	4549946	13	23
333	695708	4549981	11	22
334	695680	4550166	11	22
335	695253	4550012	12	22
336	695123	4549980	12	23
337	694241	4550205	14	25
338	693339	4549935	15	26
339	693989	4549882	14	25
340	693786	4549926	14	25
341	693029	4549676	16	26
342	692762	4549437	16	26
343	692643	4549495	16	27
344	688059	4551375	36	47
345	688707	4551440	36	47
346	689438	4551474	29	40
347	689493	4551507	28	39
348	689288	4550883	32	43
349	689364	4550531	32	43
350	689367	4550392	32	42
351	689304	4550481	33	43

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
352	684460	4550807	37	47
353	684164	4550217	32	43
354	685996	4549686	26	37
355	685714	4549756	27	38
356	685479	4549745	28	38
357	685375	4549747	28	39
358	685316	4549747	28	39
359	685267	4549847	30	40
360	687688	4550424	32	43
361	687698	4550063	31	42
362	687841	4549709	29	40
363	687920	4549727	30	41
364	688355	4549760	35	45
365	687724	4548951	24	35
366	687713	4549064	25	36
367	687922	4547966	20	31
368	688144	4548137	21	31
369	687182	4548118	20	31
370	685318	4550378	34	44
371	686120	4550256	29	39
372	686064	4550171	28	39
373	686965	4549709	27	38
374	686116	4549436	25	36
375	686133	4549241	24	35
376	686191	4548905	23	33
377	685306	4548938	23	34
378	685385	4549079	24	34
379	685382	4549224	25	35
380	685199	4549589	28	38
381	684569	4549844	32	43
382	684493	4549433	27	37
383	684493	4549433	27	37
384	684481	4549441	27	37
385	684466	4549486	27	38
386	685443	4548391	20	31
387	684577	4548984	23	34
388	684580	4548946	23	34
389	684587	4548848	22	33
390	684593	4548608	21	32

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
391	684543	4548056	19	29
392	685402	4547975	19	30
393	686230	4547514	18	29
394	684642	4547156	16	27
395	684659	4546961	15	26
396	684643	4546824	15	26
397	689325	4549928	30	41
398	689864	4549742	25	36
399	689923	4549616	24	35
400	689918	4549395	23	34
401	690142	4549311	22	33
402	690203	4549237	22	32
403	690226	4549107	21	32
404	690241	4549039	21	32
405	690292	4548857	20	31
406	690229	4548780	20	31
407	690370	4548752	20	30
408	689419	4548694	22	33
409	689394	4548290	20	31
410	689063	4548038	20	30
411	689028	4548159	20	31
412	689407	4548021	19	30
413	689416	4547928	19	30
414	689372	4547933	19	30
415	689158	4547712	18	29
416	689077	4547634	18	29
417	689043	4547607	18	29
418	688974	4547552	18	29
419	688776	4547471	18	29
420	688580	4547257	16	27
421	688531	4547211	17	28
422	688530	4547275	17	28
423	688516	4547181	17	28
424	688508	4547258	17	28
425	688478	4547154	17	28
426	688464	4547211	17	28
427	687748	4547768	19	30
428	688158	4547028	17	27
429	688096	4546950	16	27

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
430	687787	4547148	17	28
431	687866	4546763	16	27
432	688053	4546452	15	26
433	687480	4546433	15	26
434	687349	4546490	15	26
435	687091	4546492	15	26
436	687116	4546479	15	26
437	687099	4545936	14	25
438	686674	4546398	15	26
439	686786	4546079	14	25
440	686202	4546078	14	25
441	685468	4545959	13	24
442	685572	4546048	14	25
443	684618	4545423	12	23
444	684623	4545411	12	23
445	689454	4546867	15	26
446	689452	4546809	15	26
447	689448	4546765	15	26
448	689460	4546680	15	26
449	689410	4547705	18	29
450	689373	4547699	18	29
451	689470	4547232	16	27
452	689594	4547512	17	28
453	689776	4547546	17	28
454	690053	4547960	18	29
455	690273	4548075	18	29
456	690580	4548204	17	28
457	690780	4548204	17	28
458	690967	4548218	17	28
459	691026	4548469	17	28
460	690964	4548568	18	28
461	690993	4547356	15	26
462	691000	4547196	14	25
463	691094	4547137	14	25
464	692116	4546631	12	23
465	691891	4547027	13	24
466	691895	4547302	13	24
467	691812	4547542	14	25
468	693083	4548204	13	24

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
469	692776	4548193	14	24
470	692502	4548199	14	25
471	692262	4548187	14	25
472	692010	4548254	15	26
473	691777	4548245	15	26
474	691855	4548863	16	27
475	693076	4548742	14	25
476	693577	4548229	12	23
477	693684	4548215	12	23
478	694202	4548876	12	23
479	694214	4548853	12	23
480	695170	4548275	10	21
481	694901	4548262	10	21
482	694821	4548265	11	21
483	694682	4548312	11	22
484	695761	4548929	10	21
485	696363	4548357	8	19
486	695808	4547727	9	19
487	695825	4547167	8	19
488	695881	4546924	8	19
489	695903	4546803	8	19
490	695935	4546429	7	18
491	693103	4547287	12	22
492	692626	4546661	11	22
493	693056	4546493	11	21
494	693047	4546586	11	22
495	693122	4546000	10	21
496	693804	4545804	9	20
497	691040	4545773	12	22
498	690729	4545795	12	23
499	690545	4545768	12	23
500	690353	4545711	12	23
501	689855	4545775	13	23
502	689496	4545508	12	23
503	695874	4545768	7	18
504	695955	4544938	6	17
505	695959	4545383	6	17
506	695753	4545046	6	17
507	695619	4545029	6	17

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
508	695030	4545083	7	18
509	694624	4545027	7	18
510	695959	4543015	4	15
511	695887	4543415	5	16
512	695887	4543415	5	16
513	695843	4543411	5	16
514	695918	4543463	5	16
515	695875	4543470	5	16
516	695830	4543480	5	16
517	695788	4543476	5	16
518	695471	4543411	5	16
519	694562	4543398	6	17
520	694131	4543371	6	17
521	694450	4543870	6	17
522	693604	4543342	6	17
523	693472	4543446	7	17
524	693230	4543419	7	17
525	692731	4543745	7	18
526	692692	4544139	8	19
527	691103	4543913	9	19
528	690041	4543261	8	19
529	689580	4543324	9	19
530	689580	4543324	9	19
531	687136	4543843	10	21
532	687466	4543185	9	20
533	687249	4543197	9	20
534	687214	4543201	9	20
535	687150	4543187	9	20
536	687109	4543197	9	20
537	687068	4543179	9	20
538	687005	4543196	9	20
539	686920	4543184	9	20
540	686711	4543183	9	19
541	686400	4543145	9	19
542	686354	4543150	9	19
543	685908	4543218	9	19
544	685857	4543150	9	19
545	685703	4543212	9	19
546	685489	4543131	8	19

Table A-1. Timber Road III Wind Farm - Summary of Acoustic Modeling Results

Receptor ID	UTM Coordinates (m)		Received Sound Levels (dBA L_{eq})	
	Easting (X)	Northing (Y)	Cut-in Wind Speed	Critical Design Wind Speed
547	685461	4543242	9	19
548	684890	4543203	8	19
549	684817	4543185	8	19
550	684780	4543185	8	19
551	684668	4543181	8	19
552	684596	4543114	8	19
553	684678	4543314	8	19
554	684720	4544104	10	20
555	684504	4544184	10	21
556	684297	4544108	10	20
557	684606	4544379	10	21
558	684642	4544764	11	22
559	685861	4544825	11	22
560	685789	4544778	11	22
561	686870	4544796	11	22
562	687113	4545108	12	23
563	688754	4544919	11	22
564	689218	4544920	11	22
565	689436	4544931	11	22
566	684408	4554953	31	41
567	684408	4554953	31	41
568	687713	4552684	30	41
569	688132	4552980	29	40
570	690789	4553992	25	36
571	688829	4552276	30	41