Prevailing Winds Sound Study

Prevailing Winds, LLC.

Prevailing Winds Wind Farm
Project No. 91343

Revision 0
06/27/2016

Prevailing Winds Sound Study

prepared for

Prevailing Winds, LLC.
Prevailing Winds Wind Farm
Avon, South Dakota

Project No. 91343

Revision 0
06/27/2016

prepared by

Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri

TABLE OF CONTENTS

Page No.

1.0 EXECUTIVE SUMMARY 1-1

2.0 ACOUSTICAL TERMINOLOGY 2-1

3.0 REGULATIONS 3-1

4.0 SOUND MODELING 4-1
4.1 Wind Turbine and Transformer Sound Characteristics 4-1
4.2 Model Inputs and Settings 4-1
4.3 Acoustical Modeling Results 4-5

5.0 CONCLUSION 5-1

APPENDIX A – RECEIVER LOCATIONS
APPENDIX B – MODELED SOUND PRESSURE LEVELS

LIST OF TABLES

Page No.

Table 2-1: Typical Sound Pressure Levels Associated with Common Sound Sources 2-2
Table 4-1: GE 2.3-116 Maximum Sound Power Levels 4-4

LIST OF FIGURES

Page No.

Figure 4-1: Project Location 4-3

LIST OF ABBREVIATIONS

Abbreviation	**Term/Phrase/Name**
Burns & McDonnell	Burns & McDonnell Engineering Company, Inc.
CadnaA	Computer Aided Design for Noise Abatement
dB	decibel
dBA	A-weighted decibels
dBC	C-weighted decibels
DEM	Digital Elevation Model
Facility	Jinro Power Plant
GE	General Electric
Hz	hertz
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
L_{eq}	equivalent-continuous sound level
L_x	exceedance sound level
LWES	Large Wind Energy System
Prevailing Winds	Prevailing Winds, LLC.
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WES	Wind Energy System

1.0 EXECUTIVE SUMMARY

Prevailing Winds, LLC (Prevailing Winds) is proposing to construct the Prevailing Winds Wind Farm, a 200-MW wind energy facility, near Avon, South Dakota in both Bon Homme and Charles Mix Counties (Project). This sound assessment consisted of 87, 2.3-MW General Electric (GE) 2.3-116 wind turbines. This sound assessment was completed to determine if the Project can operate in compliance with the applicable sound regulation once operational.

Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) conducted a sound modeling study for the proposed Project. There were several objectives in this study, which included:

- Identification of any applicable county, city, state, or federal noise ordinances and other applicable sound guidelines
- Estimation of the operational sound levels from the hypothetical Project layout using the three-dimensional sound modeling program CadnaA, and
- Determination if the wind farm can operate in compliance with the identified applicable regulatory standards

There are no federal noise regulations that apply to this Project. In 2008 the State of South Dakota adopted a model Wind Energy Systems (WES) siting ordinance. The model ordinance states that noise produced by Large Wind Energy Systems (LWES) shall not exceed 55 dBA, average A-weighted sound pressure at the perimeter of occupied residences existing at the time the permit application is filed, unless a signed waiver or easement is obtained from the owner of the residence.

Bon Homme County has adopted a zoning ordinance that pertains to wind energy systems. The ordinance limits sound levels of WES to 45 dBA at occupied receptors. Charles Mix County appears to have a zoning ordinance as well, but there does not appear to be any numerical sound level limits. Therefore, the Bon Homme County ordinance sound level limit was used as a design goal for both counties.

The wind turbines were modeled using manufacturer-specified sound power levels. Sound pressure levels were predicted at all receivers within and surrounding the project area. A number of conservative assumptions were applied to provide worst-case predicted sound pressure level results. The loudest model-predicted sound level at any receiver in this study is 44.8 dBA, satisfying the State and County ordinance limits. Therefore, Prevailing Winds could use any of the hypothetical wind turbine locations without expecting to exceed the sound limits identified for the Project.

2.0 ACOUSTICAL TERMINOLOGY

The term "sound level" is often used to describe two different sound characteristics: sound power and sound pressure. Every source that produces sound has a sound power level. The sound power level is the acoustical energy emitted by a sound source and is an absolute number that is not affected by the surrounding environment. The acoustical energy produced by a source propagates through media as pressure fluctuations. These pressure fluctuations, also called sound pressure, are what human ears hear and microphones measure.

Sound is physically characterized by amplitude and frequency. The amplitude of sound is measured in decibels (dB) as the logarithmic ratio of a sound pressure to a reference sound pressure (20 microPascals). The reference sound pressure corresponds to the typical threshold of human hearing. To the average listener, a 3-dB change in a continuous broadband sound is generally considered "just barely perceptible"; a 5-dB change is generally considered "clearly noticeable"; and a 10-dB change is generally considered a doubling (or halving, if the sound is decreasing) of the apparent loudness.

Sound waves can occur at many different wavelengths, also known as the frequency. Frequency is measured in hertz (Hz), and is the number of wave cycles per second that occur. The typical human ear can hear frequencies ranging from approximately 20 to 20,000 Hz. Normally, the human ear is most sensitive to sounds in the middle frequencies (1,000 to 8,000 Hz) and is less sensitive to sounds in the lower and higher frequencies. As such, the A-weighting scale was developed to simulate the frequency response of the human ear to sounds at typical environmental levels. The A-weighting scale emphasizes sounds in the middle frequencies and de-emphasizes sounds in the low and high frequencies. Any sound level to which the A-weighting scale has been applied is expressed in A-weighted decibels, or dBA. For reference, the A-weighted sound pressure level and subjective loudness associated with some common sound sources are listed in Table 2-1.

Table 2-1: Typical Sound Pressure Levels Associated with Common Sound Sources

Sound Pressure Level (dBA)	Subjective Evaluation	Environment	
		Outdoor	Indoor
140	Deafening	Jet aircraft at 75 feet	--
130	Threshold of pain	Jet aircraft during takeoff at a distance of 300 feet	--
120	Threshold of feeling	Elevated train	Hard rock band
110	--	Jet flyover at 1,000 feet	Inside propeller plane
100	Very loud	Power mower, motorcycle at 25 feet, auto horn at 10 feet, crowd sound at football game	--
90	--	Propeller plane flyover at 1,000 feet, noisy urban street	Full symphony or band, food blender, noisy factory
80	Moderately loud	Diesel truck (40 mph) at 50 feet	Inside auto at high speed, garbage disposal, dishwasher
70	Loud	B-757 cabin during flight	Close conversation, vacuum cleaner
60	Moderate	Air-conditioner condenser at 15 feet, near highway traffic	General office
50	Quiet	--	Private office
40	--	Farm field with light breeze, birdcalls	Soft stereo music in residence
30	Very quiet	Quiet residential neighborhood	Inside average residence (without TV and stereo)
20	--	Rustling leaves	Quiet theater, whisper
10	Just audible	--	Human breathing
0	Threshold of hearing	--	--

Source: Adapted from *Architectural Acoustics*, M. David Egan, 1988, and *Architectural Graphic Standards*, Ramsey and Sleeper, 1994.

Sound in the environment is constantly fluctuating, as when a car drives by, a dog barks, or a plane passes overhead. Therefore, sound metrics have been developed to quantify fluctuating environmental sound levels. These metrics include the exceedance sound level. The exceedance sound level, L_x, is the sound level exceeded during “x” percent of the sampling period and is also referred to as a statistical sound level. The arithmetic average of the varying sound over a given time period is called the equivalent-continuous sound level and is noted as L_{eq}.

3.0 REGULATIONS

Federal, state, and county regulations were reviewed to determine the applicable overall sound level limits for the Project.

The Noise Control Act of 1972 (the Act) (U.S.C. 4901) mandated a national policy "to promote an environment for all Americans free from noise that jeopardizes their health or welfare, to establish a means for effective coordination of Federal research activities in noise control, to authorize the establishment of Federal noise emission standards for products distributed in commerce, and to provide information to the public respecting the noise emission and noise reduction characteristics of such products."

As required by the Act, the EPA established criteria for protecting the public health and wellbeing. However, these criteria do not constitute enforceable federal regulations or standards. The EPA has since delegated regulatory authority to local entities. Therefore, there are no federal noise regulations that apply to this Project.

In 2008, the State of South Dakota adopted a model Wind Energy Systems (WES) siting ordinance. The model ordinance states that noise produced by Large Wind Energy Systems (LWES) shall not exceed 55 dBA, average A-weighted sound pressure at the perimeter of occupied residences existing at the time the permit application is filed, unless a signed waiver or easement is obtained from the owner of the residence.

Bon Homme County has adopted a zoning ordinance that pertains to wind energy systems. The ordinance limits sound levels of WES to 45 dBA at occupied receptors. Charles Mix County appears to have a zoning ordinance as well, but there does not appear to be any numerical sound level limits. Therefore, the Bon Homme County ordinance sound level limit was used as a design goal for both counties.

4.0 SOUND MODELING

4.1 Wind Turbine and Transformer Sound Characteristics

The sound commonly associated with a wind turbine is described as a rhythmic "whoosh" caused by aerodynamic processes. This sound is created as air flow interacts with the surface of rotor blades. As air flows over the rotor blade, turbulent eddies form in the surface boundary layer and wake of the blade. These eddies are where most of the "whooshing" sound is formed. Additional sound is generated from vortex shedding produced by the tip of the rotor blade. Air flowing past the rotor tip creates alternating low-pressure vortices on the downstream side of the tip causing sound generation to occur. Older wind turbines, built with rotors which operate downwind of the tower (downwind turbines), often have higher aerodynamic impulse sound levels. This is caused by the interaction between the aerodynamic lift created on the rotor blades and the turbulent wake vortices produced by the tower. Modern wind turbine rotors are mostly built to operate upwind of the tower (upwind turbines). Upwind wind turbines are not impacted by wake vortices generated by the tower and, therefore, overall sound levels can be as much as 10 dBA less. The rhythmic fluctuations of the overall sound level are less perceivable the farther one gets from the turbine. Additionally, multiple turbines operating at the same time will create the whooshing sound at different times. These non-synchronized sounds will blend together to create a more constant sound to an observer at most distances from the turbines. Another phenomenon that reduces perceivable noise from turbines is the wind itself. Higher wind speed produces noise in itself that tends to mask (or drown out) the sounds created by wind turbines.

Advancement in wind turbine technology has reduced pure tonal emissions of modern wind turbines. Manufacturers have reduced distinct tonal sounds by reshaping turbine blades and adjusting the angle at which air contacts the blade. Pitching technology allows the angle of the blade to adjust when the maximum rotational speed is achieved, which allows the turbine to maintain a constant rotational velocity. Therefore, sound emission levels remain constant as the velocity remains the same.

Wind turbines can create noise in other ways as well. Wind turbines have a nacelle where the mechanical portions of the turbine are housed. The current generation of wind turbines uses multiple techniques to reduce the noise from this portion of the turbine: vibration isolating mounts, special gears, and acoustic insulation. In general, all moving parts and the housing of the current generation wind turbines have been designed to minimize the noise they generate.

4.2 Model Inputs and Settings

Predicted sound levels were modeled using industry-accepted sound modeling software. The program used to model the turbines was the Computer Aided Design for Noise Abatement (CadnaA), Version

4.3.143, published by DataKustik, Ltd., Munich, Germany. The CadnaA program is a scaled, three-dimensional program that takes into account air absorption, terrain, ground absorption, and ground reflection for each piece of noise-emitting equipment and predicts downwind sound pressure levels. The model calculates sound propagation based on International Organization for Standardization (ISO) 9613-2:1996, General Method of Calculation. ISO 9613, and therefore CadnaA, assesses the sound pressure levels based on the Octave Band Center Frequency range from 31.5 to 8,000 Hz. Compliance with the regulations for all turbines operating should ensure compliance for any combination of the turbines operating.

Project Layout

Prevailing Winds' hypothetical layout contains 87 wind turbines. Predictive modeling was conducted to determine the impacts at the occupied residences shown in Figure 4-1.

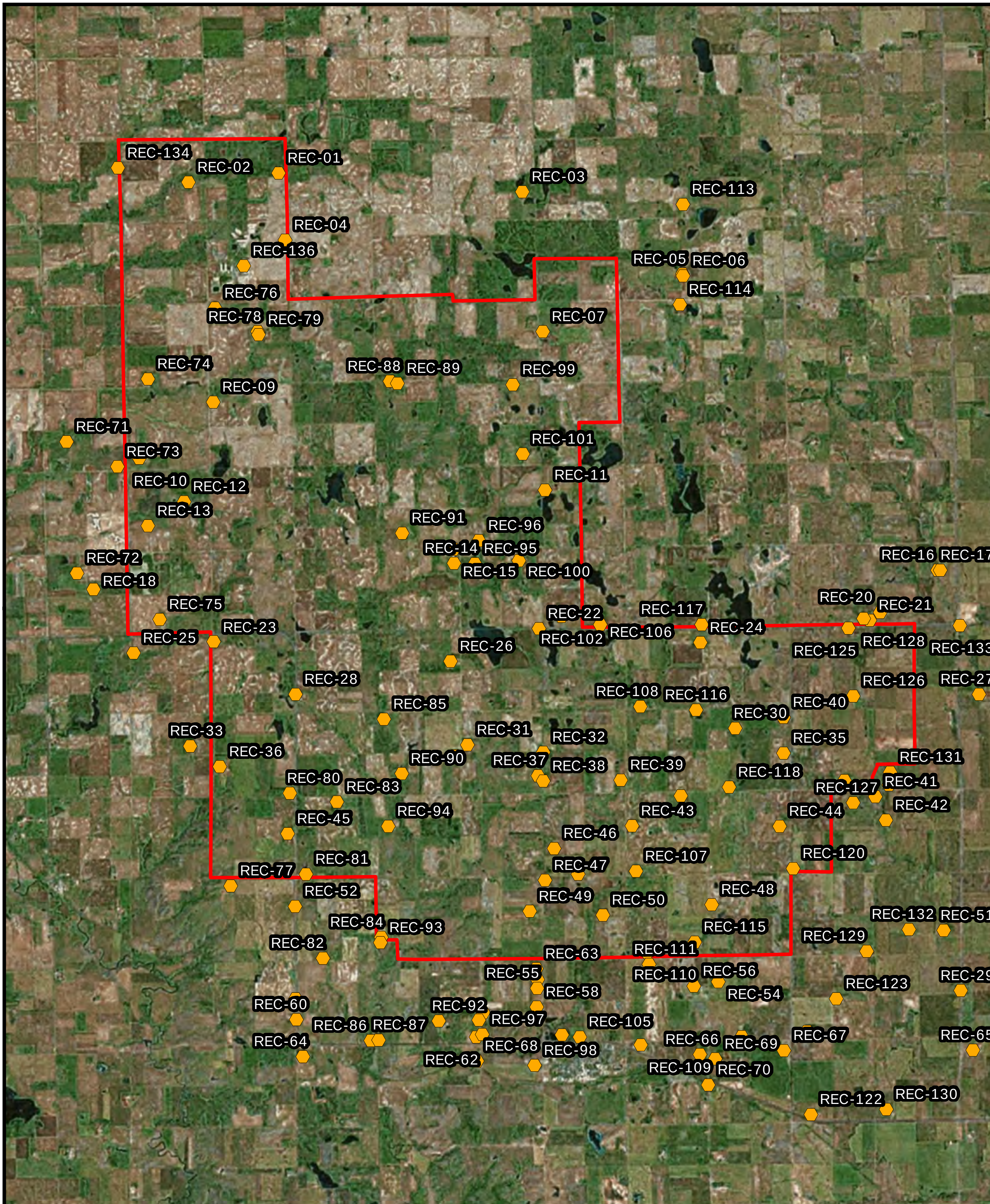
Terrain and Vegetation

Terrain and attenuation from ground absorption can have a significant impact on sound transmission.

United States Geological Survey (USGS) Digital Elevation Model (DEM) contours were imported into the model to account for topographic variations around the Project. The contours were overlaid onto high resolution, digital orthoimagery obtained from the United States Department of Agriculture (USDA) to visually ensure proper contour positioning. The terrain around the proposed Project is mostly rural with few minor changes in elevation. The land is primarily used for agricultural purposes. As such, vegetation is mostly low-lying with some small areas of trees. Therefore, vegetation was excluded from the analysis to maintain conservativeness in the model. Ground attenuation is expected to be fairly high, due to the "soft ground" of the surrounding areas; however, a conservative value was used in the model.

Sound Propagation and Directivity

CadnaA calculates downwind sound propagation using ISO 9613 standards, which use omnidirectional downwind sound propagation and worst-case directivity factors. In other words, the model assumes that each turbine propagates its maximum sound level in all directions at all times. While this may seem to over-predict upwind sound levels, this approach has been validated by field measurements. Under most normal circumstances, wind turbine noise is not significantly directional, but tends to radiate uniformly in all directions.



Project Area

Occupied Residences

NORTH

1 0.5 0 1

Miles

BURNS McDONNELL

Figure 4-1
Project Location
Prevailing Winds
Energy Facility
Environmental Assessment

Source: ESRI, Burns & McDonnell Engineering Company, Inc., South Dakota GIS

Issued: 6/27/2016

Path: Z:\Clients\ESP\PrevailingWi\91343_PermittingStudies\Geospatial\DataFiles\ArcDocs\Noise_Figure 4-1.mxd jbell 6/27/2016

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Atmospheric Conditions

Atmospheric conditions were based on program defaults. Layers in the atmosphere often form where temperature increases with height (temperature inversions). Sound waves can reflect off of the temperature inversion layer and return to the surface of the earth. This process can increase sound levels at the surface, especially if the height of the inversion begins near the surface of the earth. Temperature inversions tend to occur mainly at night when winds are light or calm, usually when wind turbines are not operating. CadnaA calculates the downwind sound in a manner which is favorable for propagation (worst-case scenario) by assuming a well-developed moderate ground-based temperature inversion such as can occur at night. Therefore, predicted sound level results tend to be higher than would actually occur.

The atmosphere does not flow smoothly and tends to have swirls and eddies, also known as turbulence. Turbulence is basically formed by two processes: thermal turbulence and mechanical turbulence. Thermal turbulence is caused by the interaction of heated air rapidly rising from the heated earth's surface with cooler air descending from the atmosphere. Mechanical turbulence is caused as moving air interacts with objects such as trees, buildings, and wind turbines. Turbulent eddies generated by wind turbines and other objects can cause sound waves to scatter, which in turn, provides sound attenuation between the wind turbine and the receiver. The acoustical model assumes laminar air flow which minimizes sound attenuation that would occur in a realistic inhomogeneous atmosphere. This assumption also causes the predicted sound levels to be higher than would actually occur.

Sound Emission Data

Acoustical modeling was conducted for the entire Project. Wind turbine heights and acoustical emissions were input into the model. The nacelles of each wind turbine are mounted on a tower 80 meters high. The expected worst-case sound power levels for the GE 2.3-116 turbines were contained in a confidential document provided by GE and were based on various wind speeds at heights of 10 meters (32.8 feet) above grade. The sound emissions data supplied was developed using the International Electrotechnical Commission (IEC) 61400-11 acoustic measurement standards. The expected sound power level for each turbine is displayed in Table 4-1.

Table 4-1: GE 2.3-116 Maximum Sound Power Levels

Equipment	dB at Octave Band Frequency (Hz)									Total Sound Power Level (dBA)
	31.5	63	125	250	500	1000	2000	4000	8000	
GE 2.3-116	79.0	89.0	95.2	99.9	102.9	102.5	97.8	89.2	69.1	105.7

A point source at the hub was used to model sound emissions from the wind turbines. This approach is appropriate for simulating wind turbine noise emissions due to the large distances between the turbines and the receivers as compared to the dimensions of the wind turbines. The corresponding sound levels from the table above were applied to every point source.

Figure 4-1 displays the entire wind farm layout. Locations of receivers and wind turbines around the Project area were provided by the developer and are listed in Appendix A. Each receiver was assumed to have a height of 1.52 meters (5.0 feet) above ground level. Compliance with the regulation was assessed at the physical residence (each receiver).

The following assumptions were made to maintain the inherent conservativeness of the model and to estimate the worst case modeled sound levels:

- Attenuation was not included for sound propagation through wooded areas, existing barriers, and shielding
- All turbines were assumed to be operating at maximum power output (and therefore, maximum sound levels) at all times to represent worst-case noise impacts from the wind farm as a whole

4.3 Acoustical Modeling Results

Sound pressure levels were predicted for the identified receivers in the CadnaA noise modeling software using the manufacturer-specified sound power levels at each frequency and the assumptions listed above. CadnaA modeling results have been demonstrated in previous studies to conservatively approximate real-life measured noise from a source when extraneous noises are not present.

As previously mentioned, decibels are a logarithmic ratio of a sound pressure to a reference sound pressure. Therefore, they must be logarithmically added to determine a cumulative impact (i.e., logarithmically adding 50 dBA and 50 dBA results in 53 dBA). Logarithmically adding each of the individual turbine's impacts together at each receiver provides an overall Project impact at each receiver. The highest model-predicted value at any receptor was 44.8 dBA.

The maximum model-predicted L_{eq} sound pressure levels at each receiver (the logarithmic addition of sound levels from each frequency from every turbine) are included in Appendix B. These values represent only the noise emitted by the wind turbines and do not include any extraneous noises (traffic, etc.) that could be present during physical noise measurements. Extraneous sounds (grain dryers, traffic, etc.) may make the overall sound level higher than 45.0 dBA in some circumstances, but the turbines alone are not expected to cause that to happen.

5.0 CONCLUSION

Burns & McDonnell conducted a predictive sound assessment study for the proposed Prevailing Winds Wind Farm. The study included identification of applicable sound regulations and predictive modeling to estimate Project-related sound levels in the surrounding community.

Sound pressure levels were predicted at occupied receivers within and surrounding the Project Area using manufacturer-specified sound power levels for each wind turbine. A number of conservative assumptions were applied to provide worst-case predicted sound pressure levels. Those results were then compared to the identified applicable regulations. There are no expected exceedances of the identified regulations due to operation of any of the hypothetical wind turbine locations of the Project.

APPENDIX A – RECEIVER LOCATIONS

Occupied Receivers	Coordinates			Receiver
	Easting (m)	Northing (m)	Base Elev (m)	Height (m)
REC-01	570706.40	4779232.68	534.41	1.52
REC-02	568954.92	4779049.93	517.66	1.52
REC-03	575450.96	4778869.67	571.47	1.52
REC-04	570834.43	4777923.92	539.65	1.52
REC-05	578568.31	4777265.47	526.26	1.52
REC-06	578578.94	4777228.45	526.01	1.52
REC-07	575847.58	4776145.51	556.23	1.52
REC-09	569437.95	4774776.35	523.15	1.52
REC-10	567999.72	4773683.50	489.65	1.52
REC-100	575384.42	4771695.61	512.91	1.52
REC-101	575459.57	4773771.95	534.89	1.52
REC-102	576210.31	4770611.18	524.03	1.52
REC-103	576223.65	4762474.81	488.00	1.52
REC-104	576537.52	4765598.06	499.61	1.52
REC-105	576567.72	4762434.13	489.18	1.52
REC-106	576971.43	4770447.24	534.89	1.52
REC-107	577659.69	4765661.22	486.43	1.52
REC-108	577747.37	4768859.92	514.75	1.52
REC-109	577752.28	4762280.60	492.22	1.52
REC-11	575893.85	4773069.05	524.82	1.52
REC-110	577878.24	4764078.53	491.19	1.52
REC-111	577915.85	4763844.06	491.20	1.52
REC-112	578531.67	4767119.28	504.42	1.52
REC-113	578575.67	4778618.52	525.75	1.52
REC-114	578514.65	4776677.36	519.63	1.52
REC-115	578804.05	4764274.93	501.37	1.52
REC-116	578827.98	4768793.31	522.70	1.52
REC-117	578943.49	4770454.51	522.70	1.52
REC-118	579475.34	4767289.07	506.65	1.52
REC-119	579720.64	4762441.83	480.03	1.52
REC-12	568870.35	4772837.61	510.51	1.52
REC-120	580720.17	4765706.10	490.00	1.52
REC-121	580991.94	4762540.89	477.23	1.52
REC-122	581061.68	4760924.20	463.66	1.52
REC-123	581560.41	4763175.20	469.30	1.52
REC-124	581721.12	4767420.32	484.37	1.52
REC-125	581794.35	4770381.50	494.48	1.52
REC-126	581890.50	4769063.10	495.27	1.52
REC-127	581882.94	4766984.50	479.11	1.52
REC-128	582089.90	4770568.08	488.79	1.52
REC-129	582148.44	4764102.27	471.96	1.52
REC-13	568170.58	4772373.09	491.50	1.52
REC-130	582530.28	4761029.16	461.75	1.52
REC-131	582609.65	4767582.94	483.08	1.52
REC-132	582970.69	4764519.85	462.37	1.52
REC-133	583963.39	4770430.23	460.33	1.52
REC-134	567589.19	4779328.12	501.37	1.52
REC-135	582577.80	4767332.36	480.03	1.52
REC-136	570034.28	4777428.87	531.85	1.52
REC-14	574122.73	4771641.66	505.86	1.52
REC-15	574117.98	4771913.43	507.96	1.52
REC-16	583526.95	4771508.69	467.69	1.52
REC-17	583582.55	4771511.54	468.46	1.52
REC-18	567115.19	4771132.04	470.89	1.52
REC-19	569455.79	4770885.60	499.44	1.52
REC-20	582409.59	4770691.28	487.30	1.52
REC-21	582205.90	4770538.43	489.18	1.52
REC-22	575769.37	4770370.26	522.67	1.52
REC-23	569450.78	4770122.57	499.40	1.52
REC-24	578915.96	4770106.59	519.65	1.52
REC-25	567890.47	4769896.98	472.45	1.52
REC-26	574057.84	4769738.20	530.34	1.52
REC-27	584331.35	4769092.56	461.02	1.52
REC-28	571038.40	4769099.63	510.21	1.52
REC-29	583980.93	4763335.60	447.49	1.52
REC-30	579594.59	4768433.69	510.51	1.52
REC-31	574388.42	4768112.11	502.96	1.52
REC-32	575856.91	4767968.51	510.22	1.52
REC-33	568988.11	4768088.17	487.56	1.52
REC-34	574139.54	4767903.27	507.27	1.52

Occupied Receivers	Coordinates			
	Easting (m)	Northing (m)	Base Elev (m)	Receiver Height (m)
REC-35	580534.75	4767955.77	498.32	1.52
REC-36	569570.52	4767693.73	494.05	1.52
REC-37	575753.59	4767511.52	511.89	1.52
REC-38	575853.92	4767408.85	513.56	1.52
REC-39	577365.54	4767429.45	498.32	1.52
REC-40	580534.93	4768649.61	504.36	1.52
REC-41	582314.18	4767105.01	478.15	1.52
REC-42	582517.64	4766647.49	470.89	1.52
REC-43	577581.91	4766535.38	502.50	1.52
REC-44	580459.53	4766528.35	498.17	1.52
REC-45	570892.00	4766384.10	499.95	1.52
REC-46	576071.91	4766099.10	512.21	1.52
REC-47	575888.47	4765484.03	506.35	1.52
REC-48	579136.06	4765003.57	501.37	1.52
REC-49	575594.26	4764877.78	512.22	1.52
REC-50	577014.96	4764806.12	483.08	1.52
REC-51	583651.67	4764503.89	452.60	1.52
REC-52	571034.71	4764976.49	483.08	1.52
REC-53	575751.76	4763553.72	505.60	1.52
REC-54	579261.02	4763508.83	494.13	1.52
REC-55	575738.19	4763383.18	504.42	1.52
REC-56	578784.40	4763423.45	495.27	1.52
REC-57	571041.09	4763173.37	469.16	1.52
REC-58	575728.70	4763020.56	500.16	1.52
REC-59	574689.98	4762905.51	489.18	1.52
REC-60	571059.19	4762771.64	462.52	1.52
REC-61	574608.88	4762765.31	484.29	1.52
REC-62	574555.81	4762430.83	468.94	1.52
REC-63	575719.36	4763758.78	507.93	1.52
REC-64	571186.80	4762047.31	455.65	1.52
REC-65	584214.95	4762180.68	443.46	1.52
REC-66	578906.77	4762093.13	492.22	1.52
REC-67	580540.52	4762168.87	473.94	1.52
REC-68	574569.43	4761969.13	468.39	1.52
REC-69	579206.69	4762012.00	489.18	1.52
REC-70	579069.07	4761500.64	483.07	1.52
REC-71	566590.17	4774005.26	470.89	1.52
REC-72	566794.52	4771446.01	467.84	1.52
REC-73	567575.59	4773523.26	480.73	1.52
REC-74	568169.85	4775221.75	494.39	1.52
REC-75	568402.45	4770548.21	483.08	1.52
REC-76	569474.73	4776605.15	528.20	1.52
REC-77	569782.41	4765373.88	494.33	1.52
REC-78	570301.18	4776152.11	534.38	1.52
REC-79	570320.64	4776086.07	530.86	1.52
REC-80	570930.65	4767169.47	502.83	1.52
REC-81	571246.87	4765598.42	488.04	1.52
REC-82	571575.08	4763967.43	465.18	1.52
REC-83	571847.73	4767001.23	510.51	1.52
REC-84	572712.41	4764371.30	476.98	1.52
REC-85	572760.45	4768609.65	493.34	1.52
REC-86	572501.37	4762365.36	453.15	1.52
REC-87	572659.60	4762376.14	460.37	1.52
REC-88	572875.14	4775183.93	528.80	1.52
REC-89	573023.77	4775137.74	528.80	1.52
REC-90	573104.38	4767558.80	488.11	1.52
REC-91	573114.23	4772228.16	513.28	1.52
REC-92	573830.00	4762741.66	472.61	1.52
REC-93	572689.83	4764269.58	474.28	1.52
REC-94	572840.24	4766532.05	483.85	1.52
REC-95	574527.24	4771635.20	509.85	1.52
REC-96	574606.23	4772084.46	516.53	1.52
REC-97	574671.53	4762479.03	470.15	1.52
REC-98	575690.29	4761882.93	492.69	1.52
REC-99	575265.41	4775117.32	553.18	1.52

APPENDIX B – MODELED SOUND PRESSURE LEVELS

Name	Coordinates			Predicted (dBA)	Limit Value (dBA)	Exceed? (Y/N)
	Easting (m)	Northing (m)	Base Elev (m)			
REC-26	574057.84	4769738.20	530.34	44.8	45.0	N
REC-83	571847.73	4767001.23	510.51	42.6	45.0	N
REC-28	571038.40	4769099.63	510.21	42.1	45.0	N
REC-48	579136.06	4765003.57	501.37	42.1	45.0	N
REC-85	572760.45	4768609.65	493.34	41.7	45.0	N
REC-99	575265.41	4775117.32	553.18	41.5	45.0	N
REC-49	575594.26	4764877.78	512.22	41.4	45.0	N
REC-22	575769.37	4770370.26	522.67	41.2	45.0	N
REC-37	575753.59	4767511.52	511.89	41.1	45.0	N
REC-38	575853.92	4767408.85	513.56	40.8	45.0	N
REC-12	568870.35	4772837.61	510.51	40.7	45.0	N
REC-31	574388.42	4768112.11	502.96	40.7	45.0	N
REC-91	573114.23	4772228.16	513.28	40.7	45.0	N
REC-108	577747.37	4768859.92	514.75	40.7	45.0	N
REC-76	569474.73	4776605.15	528.20	40.4	45.0	N
REC-30	579594.59	4768433.69	510.51	40.3	45.0	N
REC-09	569437.95	4774776.35	523.15	40.2	45.0	N
REC-106	576971.43	4770447.24	534.89	40.2	45.0	N
REC-39	577365.54	4767429.45	498.32	40.1	45.0	N
REC-32	575856.91	4767968.51	510.22	39.8	45.0	N
REC-77	569782.41	4765373.88	494.33	39.8	45.0	N
REC-07	575847.58	4776145.51	556.23	39.6	45.0	N
REC-80	570930.65	4767169.47	502.83	39.6	45.0	N
REC-46	576071.91	4766099.10	512.21	39.2	45.0	N
REC-44	580459.53	4766528.35	498.17	39.0	45.0	N
REC-115	578804.05	4764274.93	501.37	38.9	45.0	N
REC-45	570892.00	4766384.10	499.95	38.3	45.0	N
REC-63	575719.36	4763758.78	507.93	38.2	45.0	N
REC-118	579475.34	4767289.07	506.65	37.8	45.0	N
REC-36	569570.52	4767693.73	494.05	37.6	45.0	N
REC-47	575888.47	4765484.03	506.35	37.6	45.0	N
REC-78	570301.18	4776152.11	534.38	37.5	45.0	N
REC-79	570320.64	4776086.07	530.86	37.4	45.0	N
REC-34	574139.54	4767903.27	507.27	37.3	45.0	N
REC-43	577581.91	4766535.38	502.50	36.7	45.0	N
REC-19	569455.79	4770885.60	499.44	36.6	45.0	N
REC-81	571246.87	4765598.42	488.04	36.3	45.0	N
REC-102	576210.31	4770611.18	524.03	36.2	45.0	N
REC-40	580534.93	4768649.61	504.36	36.1	45.0	N
REC-35	580534.75	4767955.77	498.32	35.9	45.0	N
REC-10	567999.72	4773683.50	489.65	35.6	45.0	N
REC-15	574117.98	4771913.43	507.96	35.6	45.0	N
REC-14	574122.73	4771641.66	505.86	35.2	45.0	N
REC-53	575751.76	4763553.72	505.60	35.2	45.0	N
REC-110	577878.24	4764078.53	491.19	35.1	45.0	N
REC-101	575459.57	4773771.95	534.89	35.0	45.0	N
REC-107	577659.69	4765661.22	486.43	34.9	45.0	N
REC-13	568170.58	4772373.09	491.50	34.3	45.0	N
REC-74	568169.85	4775221.75	494.39	34.2	45.0	N
REC-88	572875.14	4775183.93	528.80	34.0	45.0	N
REC-104	576537.52	4765598.06	499.61	34.0	45.0	N
REC-89	573023.77	4775137.74	528.80	33.9	45.0	N
REC-112	578531.67	4767119.28	504.42	33.9	45.0	N
REC-116	578827.98	4768793.31	522.70	33.9	45.0	N
REC-95	574527.24	4771635.20	509.85	33.6	45.0	N
REC-23	569450.78	4770122.57	499.40	33.5	45.0	N
REC-55	575738.19	4763383.18	504.42	33.3	45.0	N
REC-90	573104.38	4767558.80	488.11	33.1	45.0	N
REC-94	572840.24	4766532.05	483.85	33.1	45.0	N
REC-96	574606.23	4772084.46	516.53	33.0	45.0	N
REC-33	568988.11	4768088.17	487.56	32.8	45.0	N
REC-111	577915.85	4763844.06	491.20	32.8	45.0	N
REC-24	578915.96	4770106.59	519.65	32.2	45.0	N
REC-120	580720.17	4765706.10	490.00	32.2	45.0	N
REC-50	577014.96	4764806.12	483.08	31.6	45.0	N
REC-52	571034.71	4764976.49	483.08	31.0	45.0	N
REC-73	567575.59	4773523.26	480.73	30.8	45.0	N
REC-117	578943.49	4770454.51	522.70	30.6	45.0	N
REC-58	575728.70	4763020.56	500.16	29.5	45.0	N
REC-56	578784.40	4763423.45	495.27	29.4	45.0	N

Name	Coordinates			Predicted (dBA)	Limit Value (dBA)	Exceed? (Y/N)
	Easting (m)	Northing (m)	Base Elev (m)			
REC-136	570034.28	4777428.87	531.85	28.9	45.0	N
REC-54	579261.02	4763508.83	494.13	28.5	45.0	N
REC-125	581794.35	4770381.50	494.48	28.4	45.0	N
REC-100	575384.42	4771695.61	512.91	27.5	45.0	N
REC-59	574689.98	4762905.51	489.18	27.4	45.0	N
REC-126	581890.50	4769063.10	495.27	27.3	45.0	N
REC-75	568402.45	4770548.21	483.08	27.1	45.0	N
REC-11	575893.85	4773069.05	524.82	26.3	45.0	N
REC-124	581721.12	4767420.32	484.37	26.3	45.0	N
REC-61	574608.88	4762765.31	484.29	26.0	45.0	N
REC-128	582089.90	4770568.08	488.79	25.6	45.0	N
REC-127	581882.94	4766984.50	479.11	25.2	45.0	N
REC-21	582205.90	4770538.43	489.18	24.7	45.0	N
REC-41	582314.18	4767105.01	478.15	21.6	45.0	N
REC-103	576223.65	4762474.81	488.00	21.2	45.0	N
REC-84	572712.41	4764371.30	476.98	21.0	45.0	N
REC-97	574671.53	4762479.03	470.15	18.9	45.0	N
REC-62	574555.81	4762430.83	468.94	18.6	45.0	N
REC-01	570706.40	4779232.68	534.41	-80.2	45.0	N
REC-02	568954.92	4779049.93	517.66	-80.2	45.0	N
REC-03	575450.96	4778869.67	571.47	-80.2	45.0	N
REC-04	570834.43	4777923.92	539.65	-80.2	45.0	N
REC-05	578568.31	4777265.47	526.26	-80.2	45.0	N
REC-06	578578.94	4777228.45	526.01	-80.2	45.0	N
REC-16	583526.95	4771508.69	467.69	-80.2	45.0	N
REC-17	583582.55	4771511.54	468.46	-80.2	45.0	N
REC-18	567115.19	4771132.04	470.89	-80.2	45.0	N
REC-20	582409.59	4770691.28	487.30	-80.2	45.0	N
REC-25	567890.47	4769896.98	472.45	-80.2	45.0	N
REC-27	584331.35	4769092.56	461.02	-80.2	45.0	N
REC-29	583980.93	4763335.60	447.49	-80.2	45.0	N
REC-42	582517.64	4766647.49	470.89	-80.2	45.0	N
REC-51	583651.67	4764503.89	452.60	-80.2	45.0	N
REC-57	571041.09	4763173.37	469.16	-80.2	45.0	N
REC-60	571059.19	4762771.64	462.52	-80.2	45.0	N
REC-64	571186.80	4762047.31	455.65	-80.2	45.0	N
REC-65	584214.95	4762180.68	443.46	-80.2	45.0	N
REC-66	578906.77	4762093.13	492.22	-80.2	45.0	N
REC-67	580540.52	4762168.87	473.94	-80.2	45.0	N
REC-68	574569.43	4761969.13	468.39	-80.2	45.0	N
REC-69	579206.69	4762012.00	489.18	-80.2	45.0	N
REC-70	579069.07	4761500.64	483.07	-80.2	45.0	N
REC-71	566590.17	4774005.26	470.89	-80.2	45.0	N
REC-72	566794.52	4771446.01	467.84	-80.2	45.0	N
REC-82	571575.08	4763967.43	465.18	-80.2	45.0	N
REC-86	572501.37	4762365.36	453.15	-80.2	45.0	N
REC-87	572659.60	4762376.14	460.37	-80.2	45.0	N
REC-92	573830.00	4762741.66	472.61	-80.2	45.0	N
REC-93	572689.83	4764269.58	474.28	-80.2	45.0	N
REC-98	575690.29	4761882.93	492.69	-80.2	45.0	N
REC-105	576567.72	4762434.13	489.18	-80.2	45.0	N
REC-109	577752.28	4762280.60	492.22	-80.2	45.0	N
REC-113	578575.67	4778618.52	525.75	-80.2	45.0	N
REC-114	578514.65	4776677.36	519.63	-80.2	45.0	N
REC-119	579720.64	4762441.83	480.03	-80.2	45.0	N
REC-121	580991.94	4762540.89	477.23	-80.2	45.0	N
REC-122	581061.68	4760924.20	463.66	-80.2	45.0	N
REC-123	581560.41	4763175.20	469.30	-80.2	45.0	N
REC-129	582148.44	4764102.27	471.96	-80.2	45.0	N
REC-130	582530.28	4761029.16	461.75	-80.2	45.0	N
REC-131	582609.65	4767582.94	483.08	-80.2	45.0	N
REC-132	582970.69	4764519.85	462.37	-80.2	45.0	N
REC-133	583963.39	4770430.23	460.33	-80.2	45.0	N
REC-134	567589.19	4779328.12	501.37	-80.2	45.0	N
REC-135	582577.80	4767332.36	480.03	-80.2	45.0	N

CREATE AMAZING.

Burns & McDonnell World Headquarters
9400 Ward Parkway
Kansas City, MO 64114
O 816-333-9400
F 816-333-3690
www.burnsmcd.com