Attachment E

2019 Updated Pre-Construction Noise Analysis

Pre-Construction Noise Analysis (V120 Turbine)

for the proposed

Freeborn Wind Farm

August 19, 2019

FREEBORN
WIND FARM

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HANKARD ENVIRONMENTAL
ACOUSTICS AND VIBRATION CONSULTING

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1. Introduction

This report describes the results of a pre-construction noise analysis conducted by Hankard Environmental for the proposed Freeborn Wind Farm (Project). This report supersedes other noise analysis reports that have been submitted as part of this Project, including the report issued prior to permitting (*Pre-Construction Noise Analysis for the Freeborn Wind Farm,* Hankard Environmental, June 5, 2017).

The purpose of the current report is to demonstrate that noise from the operation of the Project will comply with the limits imposed by the Minnesota Public Utilities Commission's December 19, 2018 *Order Issuing Site Permit and Taking Other Action* (Order). As demonstrated through the analysis described herein, noise emissions from the Project, now comprised of Vestas V120-2.0 and V110-2.0 turbines, are expected to be well under both the State of Minnesota's noise regulations and the noise limits contained in the Order.

The following sections describe the noise-related requirements of the Order, the proposed Project and its environs, the methods and results of the noise modeling analysis, and an assessment of compliance with the standards contained in the Order. See the June 5, 2017 noise report for information regarding the results of the pre-construction ambient noise measurements.

2. Noise-Related Requirements of the Order

Attachment 2 (Site Permit) of the Order specifies the following noise-related actions:

Section 4.3 Noise (Setbacks and Site Layout Restrictions)
The wind turbine towers shall be placed such that the Permittee shall, at all times, comply with noise standards established by the Minnesota Pollution Control Agency as of the date of this permit and at all appropriate locations. The noise standards are found in Minnesota Rules Chapter 7030. Turbine operation shall be modified or turbines shall be removed from service if necessary to comply with these noise standards. The Permittee or its contractor may install and operate turbines as close as the minimum setback required in this permit, but in all cases shall comply with Minnesota Pollution Control Agency [MPCA] noise standards. The Permittee shall be required to comply with this condition with respect to all homes or other receptors in place as of the time of construction, but not with respect to such receptors built after construction of the towers.

Section 6.1 Pre-Construction Noise Modeling (Special Conditions)
Freeborn Wind Energy LLC shall file a plan, including modeling and/or proposed mitigation, at least 60 days prior to the pre-construction meeting that demonstrates it will not cause or significantly contribute to an exceedance of the MPCA Noise Standards. To ensure that the turbine-only noise does not cause or significantly contribute to an exceedance of the MPCA Noise Standards, modeled wind turbine-only sound levels (NARUC[1] ISO 9613-2 with 0.5 ground) at receptors shall not exceed 47 dB(A) L_{50}-one hour. Given this, at no time will turbine-only noise levels exceed the MPCA Noise Standards, and when total sound does exceed the limits it will be primarily the result of wind or other non-turbine noise sources. Under these conditions, the contribution of the turbines will be less than 3 dB(A), which is the generally recognized minimum detectible change in environmental noise levels (non-laboratory setting). For example, when nighttime background sound levels are at 50 dB(A) L_{50}-one hour, a maximum turbine-only contribution of 47 dB(A) L_{50}-one hour would result in a non-significant increase in total sound of less than 3 dB(A).

This report demonstrates satisfaction of both of these requirements. As shown by the noise modeling results described herein, the Project has been designed such that noise levels at all residences in the area, both those participating in the Project and those that are not, are expected to be less than the State of Minnesota's 50 dBA nighttime standard (Minnesota Administrative Rules Part 7030.0040), and less than the 47 dBA limit specified in the Order.

[1] "NARUC" refers to *Assessing Sound Emissions from Proposed Wind Farms and Measuring the Performance of Completed Projects,* David M. Hessler, 2011, produced for The National Association of Regulatory Utility Commissioners (NARUC)

3. Project Site

The proposed Project will be located in a primarily agricultural area in southern Freeborn County, Minnesota and northern Worth County, Iowa. Figure 3-1 shows the general location of the Minnesota portion of the Project. The Project will have a nameplate capacity of up to 84 megawatts (MW) in Minnesota, including 41 turbine sites. The remaining turbines would be located in Worth County, Iowa. The Project proposes to use a combination of Vestas V120-2.0 and Vestas V110-2.0 turbine models.

A detailed field reconnaissance survey and review of aerial photographs was conducted by the Project to identify all noise-sensitive receptors located in Minnesota and within approximately two kilometers of any turbine or the Project substation. Noise levels at more distant receptors will be lower than those reported herein and therefore also in compliance with the applicable limits. In Minnesota, a total of 260 Noise Area Classification (NAC) 1 receptors were identified, including 258 residences and two churches. Three NAC-2 receptors were identified in Minnesota, including one town hall and two businesses.

The current layout of the proposed Freeborn Wind Farm is shown in Figures 5-1 and 5-2, as well as in the figures in Appendix A. Figures 5-1 and 5-2 show the whole site, along with noise contours. The figures in Appendix A show more detail, including turbine and receptor numbers. Included in the figures are the locations of the 41 proposed turbines in Minnesota, the northernmost proposed turbines in Iowa (47 nearest Iowa turbines are included in the analysis), the location of the proposed collector substation, and the location of each receptor where noise levels were predicted. The geographic coordinates of each Project noise source (turbines and substation transformers) and each receptor are provided in Appendices B and C, respectively.

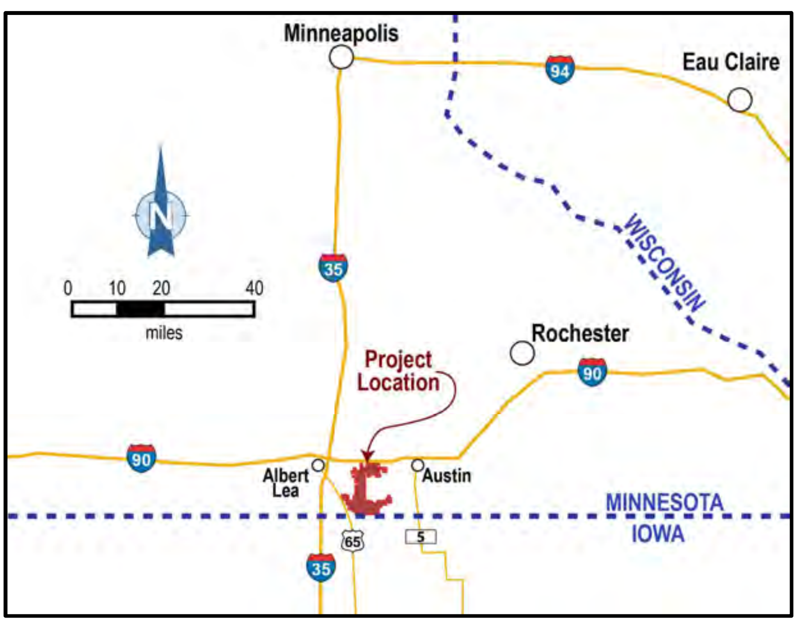

Figure 3-1. Location of the Proposed Freeborn Wind Farm (MN Portion)

4. Noise Modeling Methodology

Noise levels from the operation of the Project were predicted using the modeling method set forth in the International Organization for Standardization (ISO) Standard 9613-2:1996, *Attenuation of Sound During Propagation Outdoors - Part 2: General Method of Calculation*. The method was implemented using the SoundPLAN v7.4 acoustical modeling software program, and cross-checked with a spreadsheet calculation. A sample view of the SoundPLAN model is shown in Figure 4-1. There are a number of parameters in the ISO 9613-2:1996 method, including the location of the noise sources and receivers, noise source characteristics, terrain and ground type, and atmospheric propagation conditions. The ISO 9613-2:1996 method assumes optimal acoustic propagation in all directions, specifically that a "well-developed, moderate ground-based temperature inversion" is present, or that all receptors are downwind of all noise sources at all times. The specific ISO 9613-2:1996 settings used in the analysis are described below.

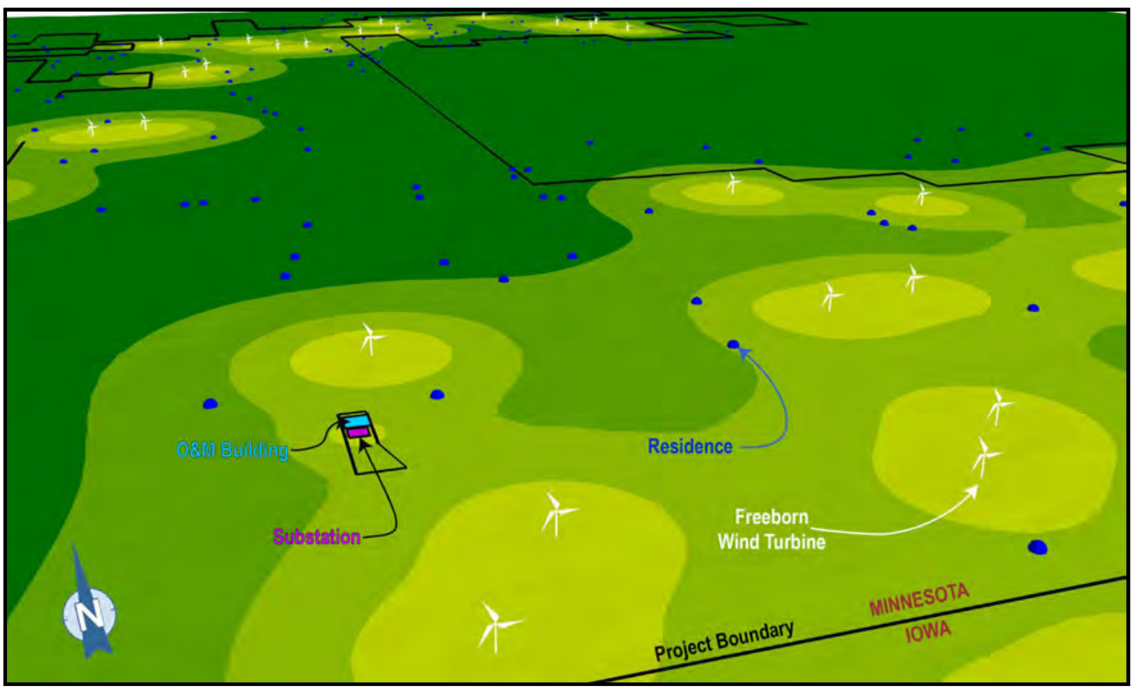

Figure 4-1. Sample View of SoundPLAN Noise Model

Receptors

In the SoundPLAN model, prediction points were located at each of the NAC-1 and NAC-2 receptors located in Minnesota within approximately two kilometers of any Project wind turbine or the substation. The geographic coordinates of these buildings were provided by the Project, and are based on a thorough on-site review of land use in the Project area. The ground elevation for each point was determined using Digital Elevation Model (DEM) data from the U.S. Geological Survey (USGS) National Elevation Dataset. In accordance with ISO 9613-2:1996, the height above the ground for each receiver was set to 1.5 meters (5 feet). All modeled locations are shown in Figures A-1 and A-2 (in Appendix A). The geographic coordinates, ground elevation, and NAC of each modeled receptor location are listed in Appendix C.

Wind Turbine Locations and Sound Power Levels

Noise levels were predicted assuming the full operation of all 41 Project turbines located in Minnesota and the 47 northernmost Project turbines located in Iowa (those within 10,000 feet of any receptor in Minnesota). More distant Iowa turbines will not contribute any significant noise to receptors in Minnesota. The ground elevation for each turbine location was determined using DEM data from the USGS National Elevation Dataset. The modeled turbines are mapped in Figures A-1 and A-2 (Appendix A), and Appendix B lists the specific coordinates and ground elevations for each modeled turbine.

In the SoundPLAN model, each turbine was represented as an acoustical point source located at its hub height, which is 80 meters (262 feet) above the ground. No directivity was applied to the noise sources, thus assuming maximum acoustic output in all directions. All turbines were assumed to be operating at full acoustic output (wind speed of 10 meters per second measured at hub height) in normal operating mode. All turbines were modeled as Vestas V120-2.0 units, with the exception of ten that were modeled as Vestas V110-2.0 units. The V110-2.0 turbines are all located in Minnesota (T-4, T-18, T-22, T-23, T-24, T-29, T-33, T-34, T-41, and T-42). Sixty-three of the turbines were modeled with standard blades and twenty-five with low-noise serrated trailing edge (STE) blades (see below for explanation of low-noise blades). Four of the STE sites are V110-2.0 units and 21 are V120-2.0 units.

The turbine sound power levels used in the analysis are listed in Table 4-1, and were provided by Vestas (*V110-2.0 MW Third octave noise emission* – document DMS 0059-4340_03 and *V120 2.0&2.2 MW Third octave noise emission* – document DMS 0072-1755_01).

Table 4-1. Source Sound Power Levels

Noise Source	Octave Band Sound Power Level (dB)									Overall Sound Power Level (dBA)
	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz	8,000 Hz	
Vestas V120-2.0	114.2	113.4	112.6	111.2	108.8	105.5	101.1	95.1	87.7	110.6
Vestas V120-2.0 w/ STE	113.9	112.4	111.0	109.2	106.7	103.4	99.2	93.6	86.7	108.6
Vestas V110-2.0	113.2	110.5	107.7	104.6	103.7	103.4	100.4	94.5	83.2	107.6
Vestas V110-2.0 w/ STE	115.5	113.1	109.5	104.8	102.0	100.8	98.8	94.7	81.8	106.0
120 MVA transformer	95.1	101.1	103.1	98.1	98.1	92.1	87.1	82.1	75.1	98.5

Note that the IEC 61400-11 standard requires the measurement of noise levels using a one to 10-minute average noise level, which in acoustics is called the equivalent level (L_{eq}). Thus, in effect, the noise levels predicted using this input data are also in L_{eq} terms. However, the Minnesota noise standards are in terms of statistical levels (L_{50} and L_{10}). In theory, for a continuously operating wind turbine, the L_{eq} and L_{50} are identical over the time period of interest (one to 10 minutes in the case of the IEC 61400-11 measurements, and one hour in the case of the Minnesota regulation). Thus, one-hour L_{eq} and L_{50} wind turbine noise levels are considered equivalent for the purposes of this analysis.

The State of Minnesota also regulates noise on the basis of the one-hour L_{10}. The L_{10} is the level exceeded 10 percent of the time over a stated time interval. The nighttime L_{10} limit applicable to this Project is 55 dBA. Based on measurements conducted on previous wind farm projects, turbine-only L_{10} noise levels are, at most, 2 dBA higher than the corresponding L_{eq} or L_{50} levels. Thus, meeting an L_{50} limit of 47 dBA ensures meeting the L_{10} limit of 55 dBA.

Low-Noise Blades

There are two primary sources of noise from the operation of wind turbines: (1) mechanical noise emanating from the drive train, gears, and motors located inside the nacelle, and (2) aeroacoustic noise generated by the blades cutting through the air. Mechanical noise has been minimized in modern turbines, leaving aeroacoustic noise as the dominant source at typical distances to residences. Aeroacoustic noise is generated through two primary means: turbulent boundary layer trailing edge noise and blade tip vortex noise. That is, noise is generated by turbulence that is created off the trailing edge of the blade and off of the tips of the blade. Noise from trailing edge turbulence has been shown to be the most significant source of noise from modern wind turbines. Mathematical modeling, wind tunnel testing, and acoustical measurement of operating turbines has demonstrated that the addition of serrations to the outer portion of the trailing edges of the blades (see Figure 4-2) decreases noise emissions by approximately 2 to 3 dBA.

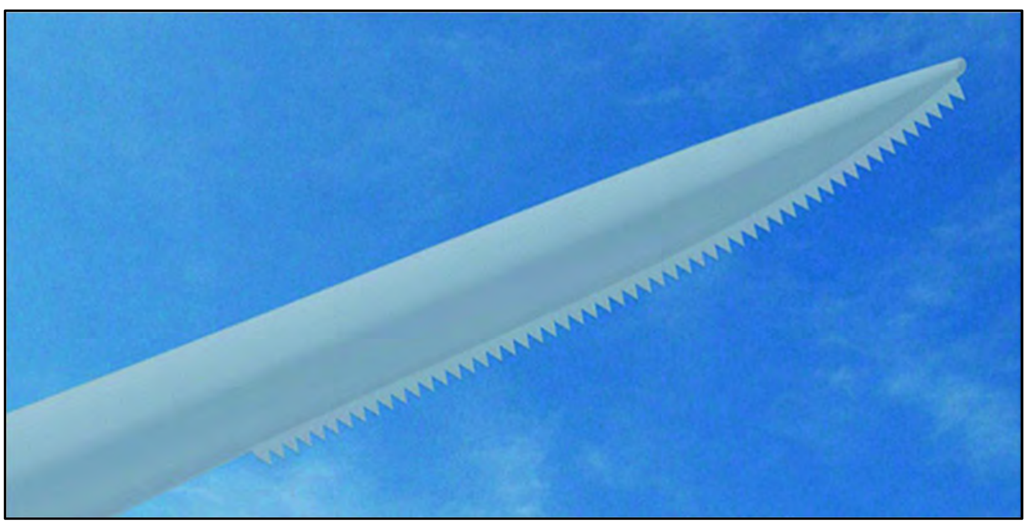

Figure 4-2. View of Serrated Trailing Edge Blade

Collector Substation

The Project's collector substation will contain step-up transformers, switch gear, metering, electrical control and communication systems, and other equipment required to transform wind turbine-generated power from 34.5 kV to 161 kV. The only significant noise-producing equipment are the two 120 mega-volt-ampere (MVA) step-up transformers. The analysis assumed the simultaneous operation of both 120 MVA step-up transformers at the substation. The substation location is shown in Figure A-2 (Appendix A), and transformer coordinates are listed in Appendix B. Ground elevations for the transformers were determined using the USGS National Elevation Dataset. The transformers were modeled as point sources located 3 meters (10 feet) above the ground, with no barriers or directivity reductions. Noise emissions from the step-up transformers were estimated using the method documented in the Edison Electric Institute report *Electric Power Plant Environmental Noise Guide* (1984). The method requires the MVA rating of the transformer (120) and its physical size (estimated as having a total surface area of approximately 65 square meters). The resulting octave band sound power levels are listed in Table 4-1.

Atmospheric Conditions

The air temperature, relative humidity, and atmospheric pressure were set to standard day conditions of 10°C, 70%, and 1 atmosphere, respectively. Per ISO 9613-2:1996, these values result in the least amount of atmospheric sound absorption and, therefore, higher levels of predicted noise.

Terrain and Ground Effects

Terrain in the Project area was modeled by importing ground elevations contained in National Elevation Dataset digital elevation model files. However, all long-distance terrain barrier effects, which could potentially inhibit sound propagation, were removed to keep the analysis conservative and predict the loudest potential noise levels. The acoustical effect of the ground material was modeled using the ISO 9613-2:1996 General Method. This method requires the selection of ground factors for the ground near the source, near the receiver, and in between. A ground factor of 0.0 represents a completely reflective surface such as pavement, which would result in a higher level of sound reaching a receiver. A ground factor of 1.0 represents absorptive ground such as thick grass or fresh snow, resulting in a lower level of sound reaching the receiver. For this Project, a ground factor of 0.5 was used as specified in the Site Permit.

Validation of Noise Prediction Method

The noise level prediction method employed on this project has been validated by Hankard Environmental by comparing predicted noise levels to those measured at operating wind farms. Hankard Environmental analyzed the long-term noise data it collected at eight operating wind farms consisting of 28 individual measurement locations. We assembled the very highest turbine-only noise levels measured at each location. These maximum levels only occurred for a few hours at each site over the course of many weeks, and in some cases months, of data collection. These maximum turbine-only noise levels were compared to the levels predicted at each location using the same prediction procedures employed on this Project (ISO 9613-2:1996 method with a 0.5 ground factor). The results show that the model exactly predicted the average of the maximum noise levels measured at all 28 locations. At a few locations, measured maximum turbine-only noise levels exceeded predicted levels by 1 dBA. At many locations the measured levels were many dBA less than the predicted levels. Overall, the method is considered very accurate based on these results.

Furthermore, the above-described analysis focused on the very highest turbine-only noise levels that were measured. A vast majority of the time, turbine-only noise levels will be less than those predicted by the ISO 9613-2:1996 method. This occurs when the turbines are not producing full acoustic output due to low winds, and/or atmospheric conditions are not conducive to sound propagation (unstable atmosphere, receptors upwind of nearest turbines).

5. Predicted Noise Levels

Noise levels from the operation of the Project were predicted at each of the NAC-1 and NAC-2 receptors located in the Project study area. Table 5-1 lists 25 receptors with the loudest predicted noise levels. Appendix C lists the predicted turbine-only noise levels for all 263 Minnesota receptors located in the study area. The results of the predictions are also shown graphically in the form of turbine-only noise level contours in Figures 5-1 and 5-2. Figure 5-1 shows the 47 dBA contour, which is the noise limit on this Project. All of the area between the contours and turbines has a predicted level in excess of 47 dBA, and the area outside the contours has a predicted level of less than 47 dBA. All of the receptors are located outside of the 47 dBA contour. Figure 5-2 provides additional information in that it shows the 50, 45, and 40 dBA contours. All loudest-hour turbine-only noise levels at all receptors in the area are predicted to be less than the state's 50 dBA nighttime standard and less than the 47 dBA standard specified in the Order.

As can be seen from Table 5-1, the loudest predicted turbine-only noise levels on this Project are approximately 45 dBA. Therefore, even given the possibility of measured turbine-only noise levels being occasionally 1 dBA higher than predicted turbine-only levels, measured noise levels are not expected to ever exceed the 47 dBA standard required by the Order. In fact, much of the time actual wind turbine noise levels will be less than the predicted levels described herein. This will occur when turbines are operating at less than full acoustic emissions, during the daytime when propagation conditions are less favorable, during those nights where there is no temperature inversion or wind gradient, and during those times when residences are upwind of the nearest turbines.

Table 5-2 summarizes total predicted noise levels after inclusion of background noise levels of 35 dBA determined during the ambient noise level survey taken in 2017.

The predicted noise levels described herein are valid for the turbine layout analyzed (L079), the receptor locations provided, the turbine sound power levels provided, the specific placement of the Project's 10 V110-2.0 turbines, and the specific placement of STE-bladed turbines. The turbine sites selected for Vestas V110-2.0 models (with and without STE blades) and Vestas V120-2.0 models (with STE blades) are shown in Table 5-2. All other turbines are Vestas V120-2.0 with standard blades. If there are any significant changes to the layout or turbine type, and/or if different turbine operating modes or blades are proposed, this noise analysis should be updated accordingly and compliance should again be demonstrated.

Table 5-1. Receptors with Highest Predicted Turbine-Only Noise Levels

Receptor ID	Participation Status	Level (dBA)
R96	Participating	45.0
R190	Non-Participating	45.0
R227	Participating	44.9
R302	Participating	44.9
R320	Non-Participating	44.9
R323	Participating	44.9
R338	Participating	44.9
R317	Non-Participating	44.8
R399	Participating	44.8
R402	Participating	44.8
R78	Non-Participating	44.7
R319	Participating	44.7
R539	Non-Participating	44.7
R129	Non-Participating	44.6
R184	Non-Participating	44.6
R280	Participating	44.6
R282	Non-Participating	44.6
R326	Non-Participating	44.6
R131	Participating	44.5
R188	Participating	44.5
R387	Participating	44.5
R298	Non-Participating	44.4
R316	Non-Participating	44.4
R300	Participating	44.0
R315	Non-Participating	44.0

Table 5-2. Total Predicted Noise Levels

Residence Classification	Total Noise (Background of 35 dBA[1] + Maximum Turbine-Only Noise Level)		
	Average L_{50} Modeled	Max L_{50} Modeled	Min L_{50} Modeled
dBA at All Residences	39.3	45.4	35.6
dBA at Participating Residences	40.8	45.4	36.6
dBA at Non-Participating Residences	38.8	45.4	35.6

[1]The average Project nighttime background sound level was 35 dBA (L_{50}); see Table 4-2 in the June 5, 2017 Pre-Construction Noise Analysis Report Appendix B in the Application.

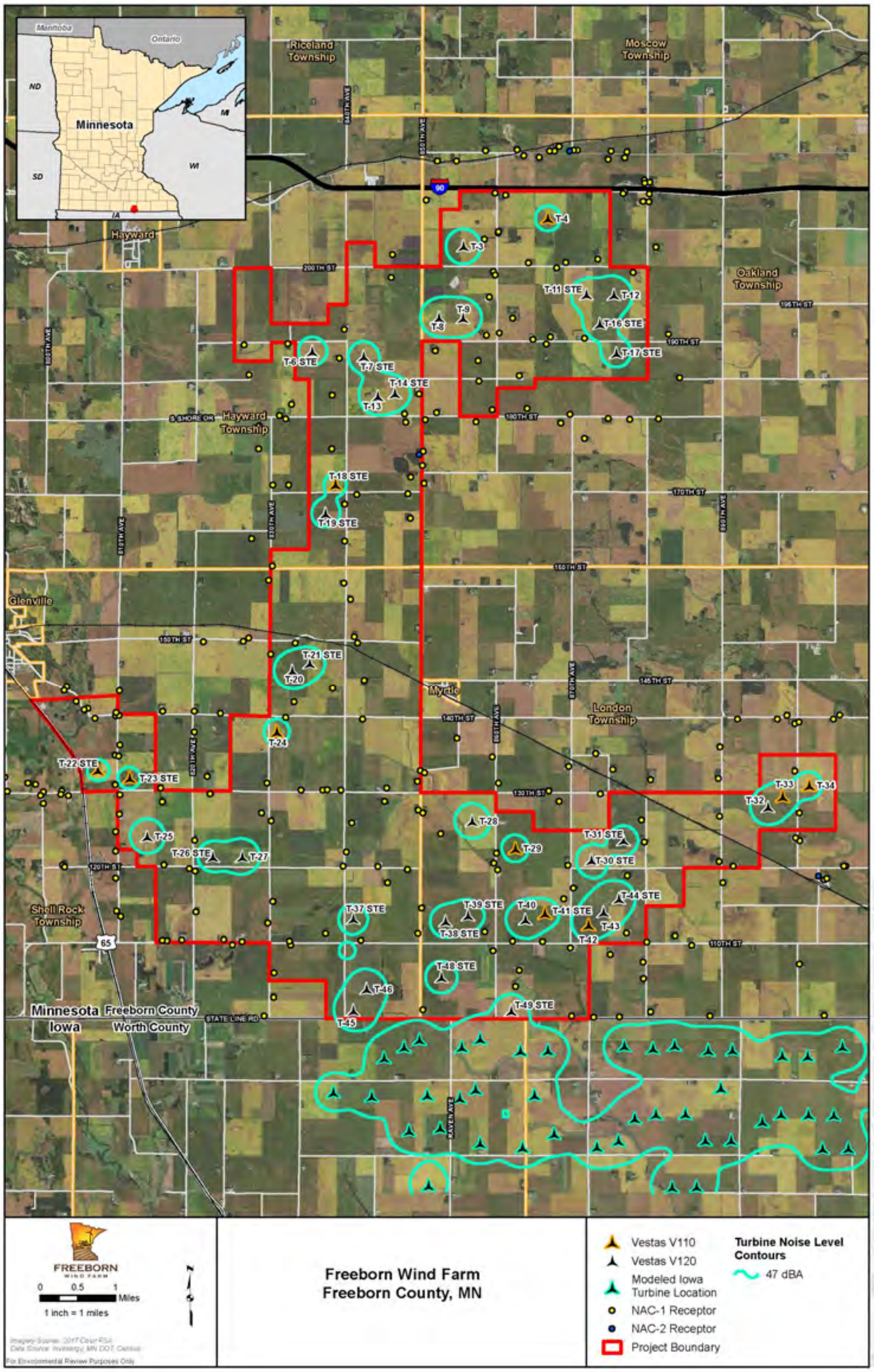

Figure 5-1. Predicted Turbine-Only Noise Level Contour (47 dBA)

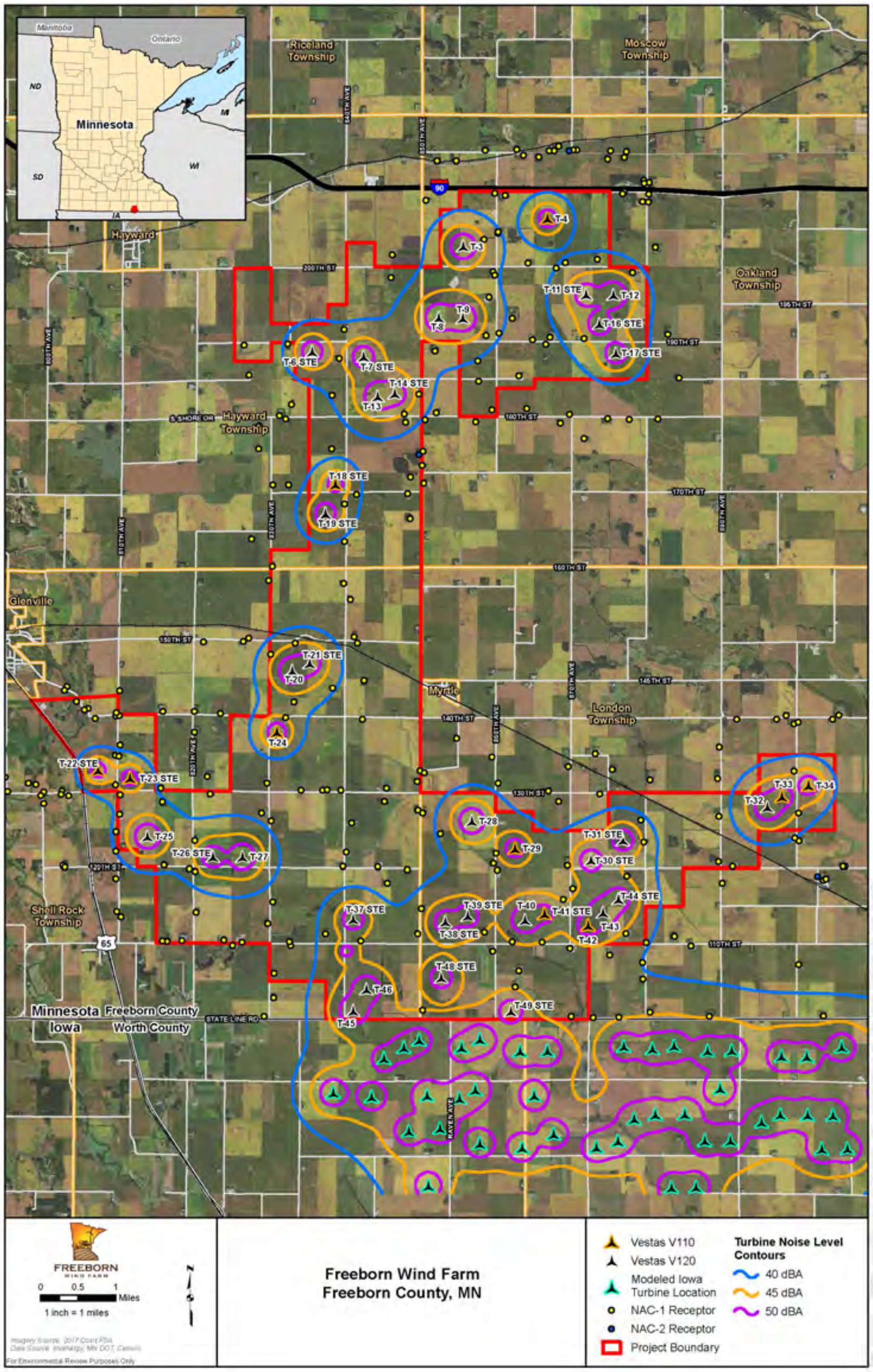

Figure 5-2. Predicted Turbine-Only Noise Level Contours (40, 45, 50 dBA)

Table 5-2. Locations of V110 and STE-Bladed Turbines

Turbine ID	Turbine Type	Blade Type
T-4	V110 2.0	standard
T-6	V120 2.0	STE
T-7	V120 2.0	STE
T-11	V120 2.0	STE
T-14	V120 2.0	STE
T-16	V120 2.0	STE
T-17	V120 2.0	STE
T-18	V110 2.0	STE
T-19	V120 2.0	STE
T-21	V120 2.0	STE
T-22	V110 2.0	STE
T-23	V110 2.0	STE
T-24	V110 2.0	standard
T-26	V120 2.0	STE
T-29	V110 2.0	standard
T-30	V120 2.0	STE
T-31	V120 2.0	STE
T-33	V110 2.0	standard
T-34	V110 2.0	standard
T-37	V120 2.0	STE
T-38	V120 2.0	STE
T-39	V120 2.0	STE
T-41	V110 2.0	STE
T-42	V110 2.0	standard
T-44	V120 2.0	STE
T-48	V120 2.0	STE
T-49	V120 2.0	STE
T-100	V120 2.0	STE
T-101	V120 2.0	STE
T-102	V120 2.0	STE
T-103	V120 2.0	STE

APPENDIX A

Project Site Plan

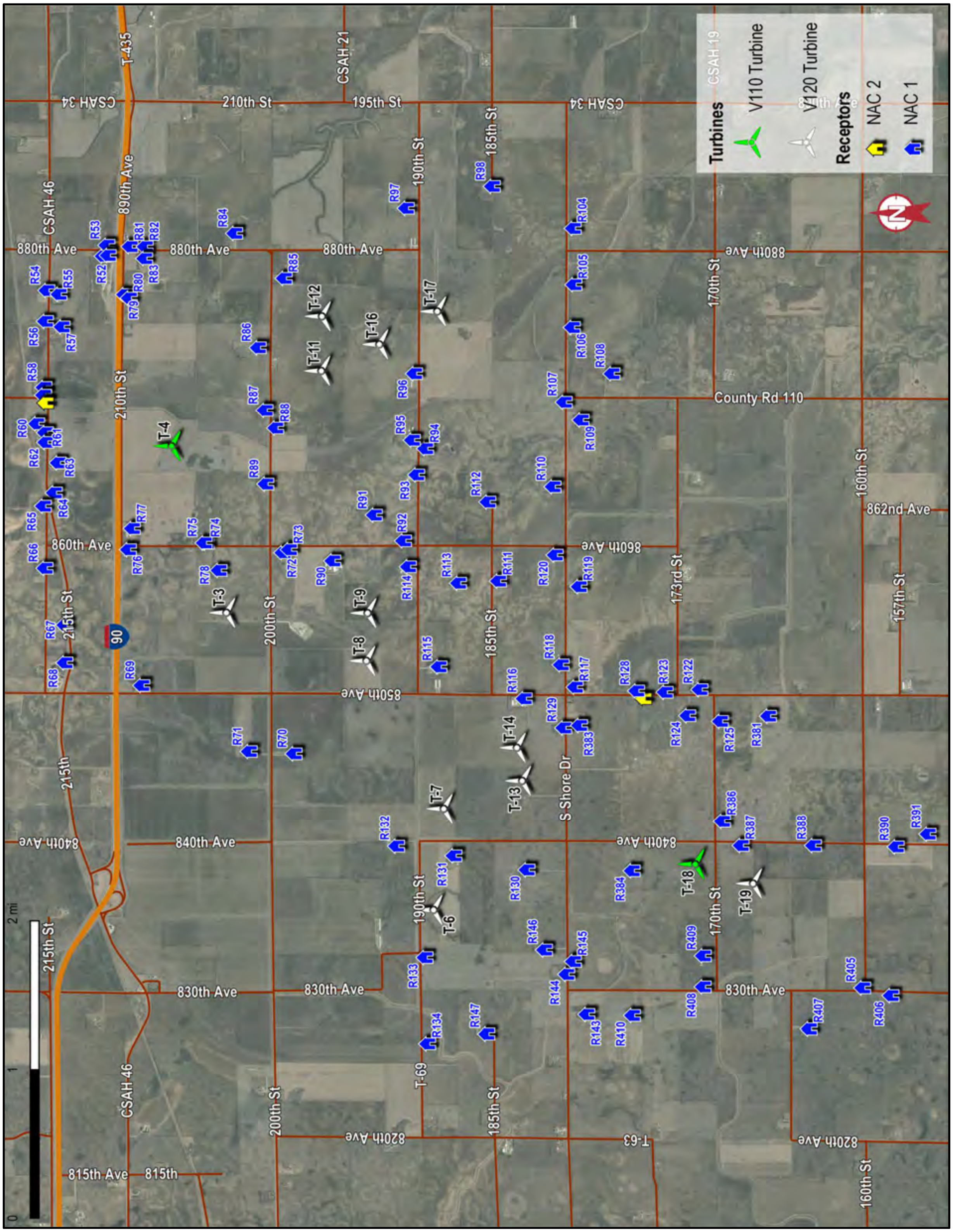

Figure A-1. Site Plan (North)

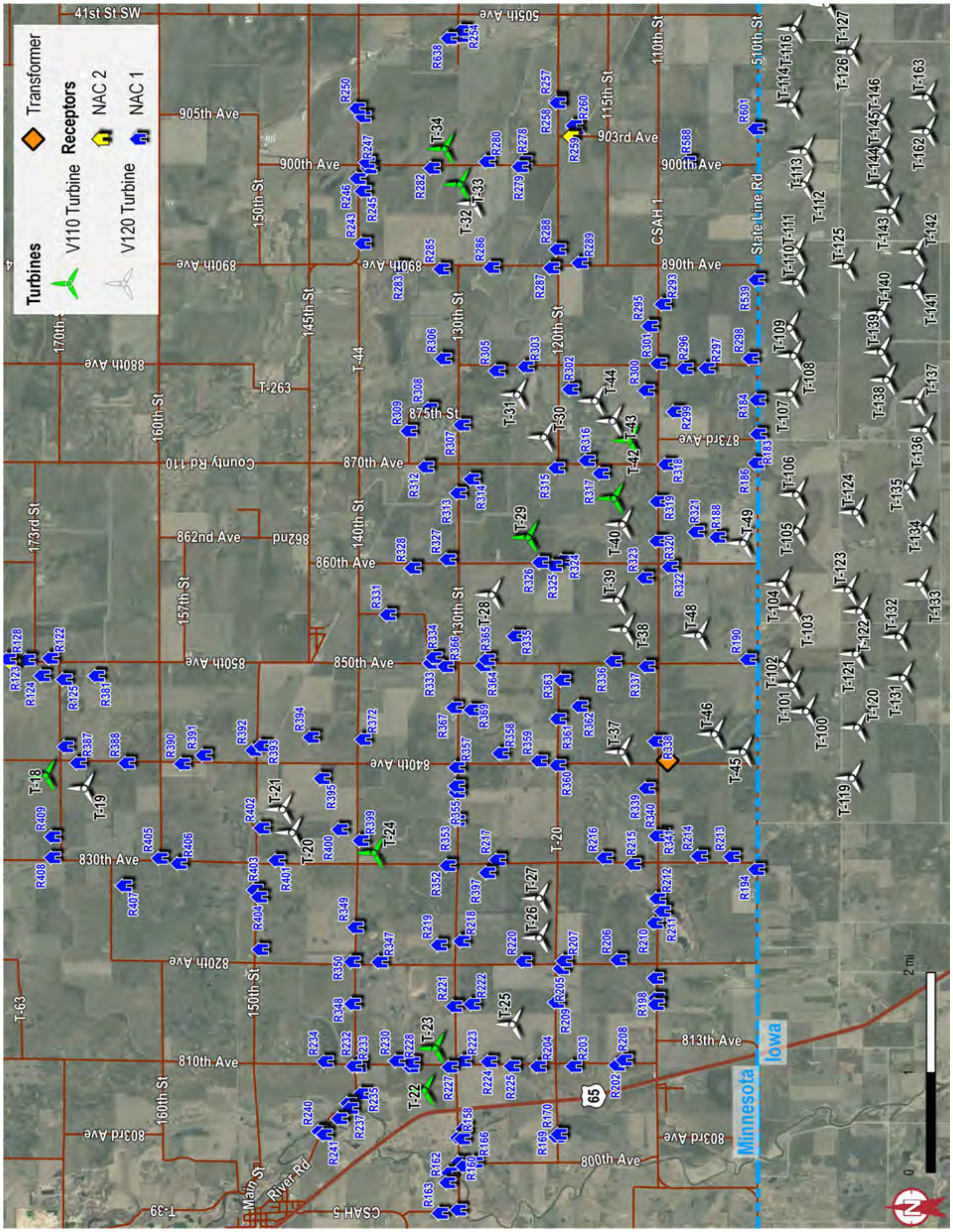

Figure A-2. Site Plan (South)

APPENDIX B

Turbine and Transformer Locations

Source ID	Source Type	UTM Zone 15		Ground Elevation (m ASL)*	Source Height (m AGL)**
		Easting (m)	Northing (m)		
T-3	V120 2.0.(Std)	487244	4832851	381	80
T-4	V110 2.0 (Std)	489056	4833446	384	80
T-6	V120 2.0.(STE)	484014	4830600	380	80
T-7	V120 2.0 (STE)	485113	4830489	381	80
T-8	V120 2.0 (Std)	486721	4831330	381	80
T-9	V120 2.0 (Std)	487241	4831317	384	80
T-11	V120 2.0 (STE)	489875	4831819	389	80
T-12	V120 2.0 (Std)	490469	4831813	386	80
T-13	V120 2.0 (Std)	485417	4829637	383	80
T-14	V120 2.0 (STE)	485777	4829695	384	80
T-16	V120 2.0 (STE)	490164	4831189	386	80
T-17	V120 2.0 (STE)	490522	4830560	383	80
T-18	V110 2.0 (STE)	484510	4827756	383	80
T-19	V120 2.0 (STE)	484300	4827128	384	80
T-20	V120 2.0 (Std)	483581	4823771	383	80
T-21	V120 2.0 (STE)	483960	4823928	384	80
T-22	V110 2.0 (STE)	479426	4821633	371	80
T-23	V110 2.0 (STE)	480106	4821463	381	80
T-24	V110 2.0 (Std)	483254	4822449	381	80
T-25	V120 2.0 (Std)	480485	4820214	388	80
T-26	V120 2.0 (STE)	481883	4819778	389	80
T-27	V120 2.0 (Std)	482520	4819780	393	80
T-28	V120 2.0 (Std)	487433	4820544	373	80
T-29	V110 2.0 (Std)	488362	4819958	371	80
T-30	V120 2.0 (STE)	489983	4819704	378	80
T-31	V120 2.0 (STE)	490675	4820134	374	80
T-32	V120 2.0 (Std)	493766	4820841	367	80
T-33	V110 2.0 (Std)	494074	4821063	363	80
T-34	V110 2.0 (Std)	494648	4821310	362	80
T-37	V120 2.0 (STE)	484890	4818449	382	80
T-38	V120 2.0 (STE)	486867	4818399	375	80
T-39	V120 2.0 (STE)	487344	4818521	375	80
T-40	V120 2.0 (Std)	488572	4818436	373	80
T-41	V110 2.0 (STE)	488991	4818572	373	80
T-42	V110 2.0 (Std)	489927	4818322	377	80
T-43	V120 2.0 (Std)	490247	4818593	378	80
T-44	V120 2.0 (STE)	490574	4818879	377	80
T-45	V120 2.0 (Std)	484890	4816488	376	80

Source ID	Source Type	UTM Zone 15		Ground Elevation (m ASL)*	Source Height (m AGL)**
		Easting (m)	Northing (m)		
T-46	V120 2.0 (Std)	485179	4816948	377	80
T-48	V120 2.0 (STE)	486775	4817202	376	80
T-49	V120 2.0 (STE)	488270	4816483	375	80
T-100	V120 2.0 (STE)	485548	4815465	377	80
T-101	V120 2.0 (STE)	485975	4815696	375	80
T-102	V120 2.0 (STE)	486303	4815858	377	80
T-103	V120 2.0 (STE)	487215	4815697	374	80
T-104	V120 2.0 (Std)	487607	4815875	372	80
T-105	V120 2.0 (Std)	488467	4815617	371	80
T-106	V120 2.0 (Std)	489053	4815623	369	80
T-107	V120 2.0 (Std)	490686	4815722	368	80
T-108	V120 2.0 (Std)	491304	4815669	369	80
T-109	V120 2.0 (Std)	491760	4815734	371	80
T-110	V120 2.0 (Std)	492488	4815623	370	80
T-111	V120 2.0 (Std)	493000	4815631	370	80
T-112	V120 2.0 (Std)	494070	4815512	367	80
T-113	V120 2.0 (Std)	494605	4815497	365	80
T-114	V120 2.0 (Std)	495357	4815708	365	80
T-116	V120 2.0 (Std)	496590	4815668	363	80
T-117	V120 2.0 (Std)	497301	4815584	363	80
T-119	V120 2.0 (Std)	484467	4814726	377	80
T-120	V120 2.0 (Std)	485285	4814642	375	80
T-121	V120 2.0 (Std)	486475	4814662	375	80
T-122	V120 2.0 (Std)	487165	4814602	372	80
T-123	V120 2.0 (Std)	487508	4814792	374	80
T-124	V120 2.0 (Std)	488768	4814665	369	80
T-125	V120 2.0 (Std)	492752	4814818	370	80
T-126	V120 2.0 (Std)	496218	4814754	363	80
T-127	V120 2.0 (Std)	496985	4815129	365	80
T-131	V120 2.0 (Std)	486085	4813901	375	80
T-132	V120 2.0 (Std)	486752	4813966	374	80
T-133	V120 2.0 (Std)	487605	4813634	372	80
T-134	V120 2.0 (Std)	488506	4813542	370	80
T-135	V120 2.0 (Std)	489183	4813841	368	80
T-136	V120 2.0 (Std)	490102	4813550	366	80
T-137	V120 2.0 (Std)	490561	4813686	367	80
T-138	V120 2.0 (Std)	490912	4814168	365	80
T-139	V120 2.0 (Std)	491363	4814258	365	80

Source ID	Source Type	UTM Zone 15		Ground Elevation (m ASL)*	Source Height (m AGL)**
		Easting (m)	Northing (m)		
T-140	V120 2.0 (Std)	491991	4814267	365	80
T-141	V120 2.0 (Std)	492418	4813700	367	80
T-142	V120 2.0 (Std)	492977	4813699	367	80
T-143	V120 2.0 (Std)	493642	4814098	367	80
T-144	V120 2.0 (Std)	494044	4814252	367	80
T-145	V120 2.0 (Std)	494622	4814247	370	80
T-146	V120 2.0 (Std)	495168	4814243	364	80
T-152	V120 2.0 (Std)	486502	4812732	373	80
T-158	V120 2.0 (Std)	491707	4812692	365	80
T-159	V120 2.0 (Std)	492231	4812702	367	80
T-162	V120 2.0 (Std)	494929	4813522	370	80
T-163	V120 2.0 (Std)	495481	4813524	366	80
Transformer 1a	120 MVA	484752	4817765	379	3
Transformer 1b	120 MVA	484759	4817765	379	3

* ASL = Above sea level
** AGL = Above ground level

APPENDIX C

Receptor Locations and Predicted Turbine-Only Noise Levels

Receptor ID	NAC	Participation Status *	UTM Zone 15 Easting (m)	UTM Zone 15 Northing (m)	Ground Elevation (m ASL)	Turbine-Only Levels (dBA)
R52	1	NP	491123	4834254	390	29.7
R53	1	NP	491242	4834213	389	29.5
R54	1	NP	490750	4834866	390	28.4
R55	1	NP	490708	4834734	390	28.9
R56	1	NP	490414	4834881	389	29.0
R57	1	NP	490354	4834701	389	30.1
R58	1	NP	489695	4834898	388	30.6
R59	1	NP	489611	4834902	387	30.8
R60	1	NP	489298	4834977	388	30.8
R61	1	NP	489201	4834881	386	31.4
R62	1	NP	489095	4834878	386	31.5
R63	1	NP	488873	4834743	387	32.4
R64	1	NP	488547	4834785	386	31.9
R65	1	NP	488403	4834903	386	31.2
R66	1	NP	487728	4834886	386	30.8
R67	1	NP	487111	4834670	388	31.6
R68	1	NP	486700	4834670	392	31.1
R69	1	NP	486454	4833835	386	35.3
R70	1	NP	485712	4832180	382	37.4
R71	1	NP	485737	4832667	383	36.0
R72	1	NP	487897	4832302	393	40.9
R73	1	NP	487930	4832232	393	40.6
R74	1	NP	487999	4833133	392	40.4
R75	1	NP	488003	4833156	391	40.3
R76	1	P	487930	4833980	391	36.0
R77	1	P	488159	4833938	391	36.4
R78	1	NP	487704	4832995	393	44.7
R79	1	NP	490706	4834022	393	31.8
R80	1	NP	490667	4833971	393	32.1
R81	1	NP	491227	4833962	393	30.5
R82	1	NP	491227	4833797	393	31.1
R83	1	NP	491097	4833803	393	31.5
R84	1	P	491371	4832825	386	35.2

Receptor ID	NAC	Participation Status *	UTM Zone 15 Easting (m)	UTM Zone 15 Northing (m)	Ground Elevation (m ASL)	Turbine-Only Levels (dBA)
R85	1	P	490882	4832287	389	42.6
R86	1	P	490127	4832569	394	41.6
R87	1	P	489445	4832495	391	40.5
R88	1	P	489252	4832379	388	40.1
R89	1	NP	488643	4832487	392	38.5
R90	1	P	487808	4831759	390	42.3
R91	1	P	488306	4831307	392	39.1
R92	1	P	488025	4830991	392	40.4
R93	1	P	488742	4830847	398	37.5
R94	1	P	489027	4830751	393	38.0
R95	1	NP	489120	4830895	390	38.8
R96	1	P	489846	4830871	387	45.0
R97	1	NP	491645	4830961	385	36.8
R98	1	NP	491882	4830026	382	33.0
R104	1	NP	491425	4829147	383	31.1
R105	1	NP	490813	4829139	380	32.7
R106	1	NP	490348	4829157	383	33.4
R107	1	NP	489534	4829245	391	33.2
R108	1	NP	489844	4828725	391	31.0
R109	1	NP	489338	4829061	390	32.2
R110	1	NP	488614	4829367	390	33.1
R111	1	P	487588	4829960	393	37.0
R112	1	P	488447	4830074	396	35.4
R113	1	NP	487566	4830393	397	39.6
R114	1	P	487744	4830938	392	42.9
R115	1	NP	486657	4830606	386	42.9
R116	1	P	486310	4829680	388	43.4
R117	1	NP	486435	4829125	391	39.5
R118	1	NP	486678	4829278	389	38.5
R119	1	P	487527	4829083	391	34.1
R120	1	NP	487871	4829343	388	34.0
R122	1	NP	486409	4827770	389	32.9
R123	1	NP	486380	4828148	386	34.4
R124	1	NP	486125	4827903	390	34.1

			UTM Zone 15			
Receptor ID	NAC	Participation Status *	Easting (m)	Northing (m)	Ground Elevation (m ASL)	Turbine-Only Levels (dBA)
R125	1	NP	486064	4827547	394	33.4
R127	2	P	486310	4828380	389	35.7
R128	1	NP	486395	4828457	387	35.8
R129	1	NP	485993	4829250	389	44.6
R130	1	NP	484448	4829649	387	40.6
R131	1	P	484602	4830443	383	44.5
R132	1	P	484707	4831066	384	41.4
R133	1	NP	483498	4830757	383	41.5
R134	1	NP	482567	4830729	383	32.2
R143	1	NP	482882	4828999	383	31.8
R144	1	NP	483316	4829218	383	33.9
R145	1	NP	483455	4829145	385	34.3
R146	1	NP	483580	4829459	385	35.8
R147	1	NP	482672	4830086	385	32.7
R157	1	NP	478806	4821088	372	35.7
R158	1	P	478664	4821178	372	34.8
R159	1	NP	478647	4821113	372	34.4
R160	1	NP	478269	4821161	373	31.6
R161	1	NP	478098	4821320	372	30.5
R162	1	NP	477939	4821352	373	29.5
R163	1	NP	477447	4821472	379	26.6
R164	1	NP	477497	4821176	375	26.9
R165	1	NP	478205	4821085	373	31.0
R166	1	NP	478270	4820910	373	31.2
R169	1	NP	478678	4819588	373	30.7
R170	1	NP	478722	4819551	373	30.8
R183	1	NP	490037	4816332	370	42.8
R184	1	NP	490590	4816343	373	44.6
R186	1	NP	489569	4816363	369	42.9
R188	1	P	488366	4816990	376	44.5
R190	1	NP	486386	4816497	377	45.0
R194	1	NP	482989	4816362	385	35.1
R197	1	NP	481232	4817992	388	32.3
R198	1	P	480912	4817975	386	31.6

Receptor ID	NAC	Participation Status *	UTM Zone 15 Easting (m)	UTM Zone 15 Northing (m)	Ground Elevation (m ASL)	Turbine-Only Levels (dBA)
R199	1	NP	480809	4817982	385	31.5
R202	1	P	479836	4818614	381	31.9
R203	1	NP	479818	4819314	382	36.1
R204	1	NP	479817	4819888	383	40.1
R205	1	P	481388	4819516	391	42.5
R206	1	NP	481529	4818592	388	36.0
R207	1	P	481511	4819469	391	43.5
R208	1	NP	479920	4818497	379	31.6
R209	1	P	480844	4819596	394	41.4
R210	1	NP	482125	4817999	391	34.0
R211	1	NP	482314	4817879	390	33.8
R212	1	P	482518	4817958	389	34.3
R213	1	NP	483193	4816759	386	35.8
R214	1	P	483203	4817284	388	35.7
R215	1	NP	483073	4818358	391	35.9
R216	1	NP	483175	4818814	391	37.4
R217	1	P	483143	4820544	390	38.3
R218	1	NP	481832	4821123	392	36.7
R219	1	NP	481768	4821490	393	35.3
R220	1	P	481505	4820123	394	43.5
R221	1	NP	480778	4821246	394	39.4
R222	1	P	480814	4820953	398	40.5
R223	1	P	479902	4821099	379	42.9
R224	1	P	479892	4820682	379	41.1
R225	1	NP	479820	4820309	379	41.3
R227	1	P	479806	4821316	377	44.9
R228	1	NP	479810	4821948	378	41.7
R229	1	P	479880	4821932	381	41.7
R230	1	P	479904	4822171	382	38.5
R231	1	NP	479814	4822792	375	32.9
R232	1	NP	479888	4822797	376	32.8
R233	1	P	479821	4822863	375	32.4
R234	1	NP	479896	4823328	382	29.9
R235	1	NP	479376	4822737	376	33.0

Receptor ID	NAC	Participation Status *	UTM Zone 15 Easting (m)	UTM Zone 15 Northing (m)	Ground Elevation (m ASL)	Turbine-Only Levels (dBA)
R236	1	NP	479221	4822954	377	31.1
R237	1	NP	479141	4822922	371	31.1
R238	1	NP	478975	4823098	373	29.6
R240	1	NP	478769	4823420	373	27.3
R241	1	NP	478716	4823342	373	27.5
R243	1	NP	493119	4822721	374	31.1
R245	1	NP	493967	4822719	370	32.5
R246	1	NP	494171	4822801	370	31.9
R247	1	P	494343	4822622	370	33.2
R248	1	P	494431	4822654	370	33.0
R249	1	NP	495171	4822719	365	30.9
R250	1	NP	495303	4822811	365	29.9
R253	1	NP	496467	4821141	364	28.5
R254	1	NP	496563	4821119	366	28.0
R257	1	NP	495437	4819575	365	32.2
R258	1	NP	495394	4819573	365	32.4
R259	1	NP	494975	4819282	366	33.0
R260	1	NP	495027	4819307	365	32.9
R278	1	NP	494446	4820117	369	38.9
R279	1	NP	494361	4820178	369	39.9
R280	1	P	494443	4820713	366	44.6
R282	1	NP	494339	4821604	369	44.6
R283	1	NP	492744	4822126	371	33.2
R285	1	NP	492707	4821449	372	36.1
R286	1	NP	492732	4820638	373	37.5
R287	1	NP	492724	4819672	371	35.3
R288	1	P	493023	4819574	370	35.4
R289	1	NP	492805	4819214	372	34.7
R293	1	NP	492138	4817870	373	37.6
R295	1	NP	491785	4818081	374	38.1
R296	1	NP	491096	4817516	377	40.0
R297	1	NP	491103	4817161	375	40.4
R298	1	NP	491260	4816456	373	44.4
R299	1	P	490399	4817682	375	42.2

			UTM Zone 15			Turbine-Only
Receptor ID	**NAC**	**Participation Status ***	**Easting (m)**	**Northing (m)**	**Ground Elevation (m ASL)**	**Levels (dBA)**
R300	1	P	490744	4818140	376	44.0
R301	1	NP	491180	4817942	375	40.3
R302	1	P	490763	4819366	379	44.9
R303	1	P	491128	4820087	379	43.8
R305	1	NP	491061	4820555	379	41.6
R306	1	NP	491258	4821420	377	34.0
R307	1	NP	490184	4821121	381	36.7
R308	1	NP	490452	4821641	381	33.6
R309	1	NP	490086	4821980	384	32.1
R312	1	NP	489504	4821705	380	33.2
R313	1	NP	489080	4821180	378	35.7
R314	1	NP	489306	4820961	378	36.6
R315	1	NP	489484	4819591	377	44.0
R316	1	NP	489606	4819099	378	44.4
R317	1	NP	489399	4818873	378	44.8
R318	1	NP	489543	4817818	377	43.2
R319	1	P	488945	4817953	374	44.7
R320	1	NP	488304	4817959	375	44.9
R321	1	NP	488451	4817337	373	42.4
R322	1	NP	487888	4817759	374	42.7
R323	1	P	487708	4818164	375	44.9
R324	1	NP	487989	4819491	374	42.6
R325	1	NP	487904	4819630	375	42.8
R326	1	NP	487960	4819852	376	44.6
R327	1	NP	488005	4821349	377	38.0
R328	1	P	487868	4821914	381	34.3
R331	1	NP	487112	4822314	384	32.0
R333	1	NP	486329	4821619	375	33.8
R334	1	NP	486421	4821571	377	34.4
R335	1	NP	486766	4820262	378	41.1
R336	1	NP	486358	4818673	380	42.8
R337	1	NP	486275	4818132	381	42.7
R338	1	P	485063	4817983	383	44.9
R339	1	NP	484302	4818132	385	41.7

Receptor ID	NAC	Participation Status *	UTM Zone 15 Easting (m)	UTM Zone 15 Northing (m)	Ground Elevation (m ASL)	Turbine-Only Levels (dBA)
R340	1	P	483562	4817886	388	36.8
R341	1	NP	483529	4817963	388	36.7
R346	1	NP	481696	4824377	386	31.3
R347	1	P	481492	4822446	390	33.0
R348	1	NP	480817	4822886	381	31.8
R349	1	NP	482052	4822841	387	34.5
R350	1	P	481498	4822892	384	32.3
R352	1	NP	483051	4821348	387	36.0
R353	1	NP	483783	4821200	386	34.6
R355	1	P	484240	4821200	384	33.5
R356	1	NP	484342	4821205	384	33.3
R357	1	P	484639	4821203	384	32.9
R358	1	NP	484870	4820493	389	33.5
R359	1	NP	484746	4819872	391	35.2
R360	1	NP	484676	4819574	386	36.5
R361	1	NP	485427	4819567	387	36.8
R362	1	NP	485632	4819218	386	38.3
R363	1	NP	486055	4819498	383	37.7
R364	1	NP	486289	4820776	379	36.6
R365	1	NP	486385	4820714	379	37.4
R366	1	P	486274	4821385	377	34.5
R367	1	P	485609	4821243	386	32.9
R369	1	P	485573	4820957	388	33.2
R372	1	P	485095	4822717	379	33.5
R381	1	NP	486121	4827026	388	32.0
R383	1	NP	486019	4829077	387	42.3
R384	1	P	484439	4828507	386	38.4
R386	1	P	484977	4827525	388	41.3
R387	1	P	484713	4827322	391	44.5
R388	1	P	484712	4826537	393	38.9
R390	1	NP	484699	4825638	392	33.4
R391	1	NP	484836	4825292	392	33.2
R392	1	NP	484918	4824486	391	35.8
R393	1	P	484991	4824354	390	35.7

Receptor ID	NAC	Participation Status *	UTM Zone 15 Easting (m)	UTM Zone 15 Northing (m)	Ground Elevation (m ASL)	Turbine-Only Levels (dBA)
R394	1	P	485129	4823556	383	35.2
R395	1	P	484461	4823382	385	40.6
R397	1	NP	482937	4820708	388	38.2
R399	1	P	483455	4822751	384	44.8
R400	1	NP	483633	4823089	385	42.9
R401	1	NP	483135	4824114	389	43.6
R402	1	P	483658	4824353	390	44.8
R403	1	NP	482658	4824465	385	36.6
R404	1	NP	482544	4824393	387	36.1
R405	1	NP	483169	4826002	385	32.6
R406	1	NP	483086	4825694	387	32.5
R407	1	NP	482726	4826583	383	31.4
R408	1	NP	483180	4827735	383	34.3
R409	1	NP	483517	4827734	383	36.9
R410	1	P	482870	4828503	383	31.7
R418	2	NP	489526	4834877	386	31.0
R419	1	NP	491131	4834199	390	29.9
R422	2	NP	494848	4819357	366	33.5
R539	1	NP	492533	4816358	373	44.7
R588	1	NP	494437	4817472	371	37.1
R601	1	NP	494974	4816372	370	43.5
R638	1	NP	496437	4821329	367	28.7
R639	1	NP	497296	4816344	362	42.6
R640	1	NP	498538	4816406	360	35.4
R641	1	NP	499276	4816545	359	31.2
R642	1	NP	499183	4817034	355	30.2

* P = Participating, NP = Non-participating
* * ASL = Above Sea Level