TETRA TECH

TO: Infinity Wind Power

FROM: Tetra Tech, Inc.

DATE: November 10, 2014

PROJECT: Sunflower Wind Energy Project

RE: Updated Acoustic Screening-Level Analysis

Sunflower Wind Project, LLC (Sunflower) is proposing to construct and operate the Sunflower Wind Energy Project (Project) in accordance with the North Dakota Energy Conversion Facility Siting Criteria (North Dakota 2013). The Project will also consider noise-related best management practices (BMPs) stipulated in the Draft Upper Great Plains (UGP) Wind Energy Programmatic Environmental Impact Statement (PEIS) (Western Area Power Administration and U.S. Fish and wildlife Service 2013). The Project is located approximately 3 miles south of Hebron, North Dakota with portions of the Project area in both Morton County, North Dakota and Stark County, North Dakota. In February 2014 Tetra Tech completed a screening-level acoustic assessment to determine the feasibility of the Project to operate within applicable noise criteria. The results of the February 2014 acoustic analysis demonstrated that the Project would comply with regulatory limits and/or guidelines at all noise sensitive receptors (NSRs). In October 2014, Sunflower submitted a request to the North Dakota Public Services Commission (PSC) to add a third turbine type, the Vestas V-100-2.0 wind turbine generator (WTG). Applicable regulations, construction sound levels, and the operational acoustic modeling methodology for the Project are unchanged since the February 2014 memo, as are the results for the two turbine types considered in that study, and are therefore not included in this memo. The operational sound source levels for the new WTG and the predicted received operational sound levels at NSRs have changed since the February 2014 memo and are discussed in detail in the sections that follow.

Facility Operational Sound Levels

Sound power level data are used in acoustic models to predict received sound pressure levels at observer locations. The proposed Project has a nameplate (gross) generating capacity of 110 megawatts (MW) and the layouts under consideration include alternate WTG locations to achieve this capacity. Table 1 includes the WTG type, the Vestas V100-2.0 MW (V100-2.0), and the number of WTGs under consideration to achieve the nameplate capacity as well as the broadband sound power level associated with the WTG. The candidate WTG type was implemented at all locations in the layout; however, the actual number of WTGs used for the final Project design would be less than that indicated in Table 1.

Table 1. WTG Candidate Specifications

WTG Model	Quantity	MW per WTG	Hub Height (m)	Rotor Diameter (m)	Sound Power Level (dBA)*
V100-2.0	67	2.0	80	100	105

*A k-factor (or uncertainty factor) of 2 dBA was applied to the overall A-weighted sound power level.

WTG sound power levels are determined in accordance with IEC 61400-11, Wind Turbine Generator Systems—Part 11: "Wind turbine generator systems – Acoustic Noise Measurement Techniques". This methodology has been developed to allow for comparison between WTG manufacturers using consistent reporting and measurement techniques. The IEC test is an accepted standard providing a uniform methodology for measuring the noise emissions of a WTG from cut-in through full rotational wind speeds. The IEC testing standard defines deviation values σ_T, σ_R and σ_P for measured apparent sound power levels as described by IEC/TS 61400-14, where σ_T is the total standard deviation, σ_R is the standard deviation for test reproducibility, and σ_P is the standard deviation for product variation. To account for this inherent deviation associated with the IEC testing methodology, a confidence interval of k = 2 A-weighted decibels (dBA) was applied to the broadband A-weighted WTG sound power level values. The combination of the modeling parameters used and the inclusion of the 2 dBA term are expected to result in a reasonable and conservative assessment of Project sound levels.

Sound power specifications and octave band frequency data were obtained by Sunflower from the manufacturers of the WTG model under consideration. It is assumed that the WTGs for the Project would have similar sound power profiles as those used in the acoustic modeling analysis; however, it is possible that the final manufacturer warranty values may vary slightly. Table 2 provides a summary of the sound power data correlated by wind speed for each WTG model at reference rotor hub height assuming a roughness length[1] coefficient of 0.05 meters. As shown in Table 2, generally wind speeds lower than those corresponding to full rated power also result in lower sound levels.

Table 2. WTG Broadband Sound Power Levels (dBA) Correlated with Wind Speed

	WTG Sound Power Level at Reference Wind Speed										
WTG	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s
V100-2.0	93.8	96.0	100.1	103.9	105.0	105.0	105.0	105.0	105.0	105.0	105.0

Source: Vestas 2010

The Project collector substation was not included in the acoustic analysis because setback distances to the nearest NSR are relatively large at ¾-mile and it is assumed that received sound levels would attenuate to low levels at the nearest NSR. The Project substation and interconnection yard would be located immediately adjacent to Western's existing 230 kV transmission line, and no Project transmission line would be required.

Acoustic Modeling Results

Acoustic modeling was completed for Project operation for two cases: (1) highest specified operational sound level according to the WTG manufacturer's specifications under typical downwind propagation conditions; and (2) highest specified operational sound level according to the WTG manufacturer's specifications under anomalous meteorological conditions. As mentioned, the final Project layout design would consist of fewer WTGs than were analyzed, therefore this analysis is representative of a worst case

[1] The roughness length describes the change in wind speed at increased elevation and may vary based on site specific terrain conditions.

scenario. Noise was modeled at a distance of 100 feet from each residential structure in consideration of the North Dakota noise standard described in the February 2014 technical memo.

The acoustic modeling results were compared to the State's numerical limits of 50 dBA. Table 3 summarizes the number of NSRs within selected sound pressure level ranges (in dBA) under each of the modeled operational conditions. The tabulated results are independent of the existing acoustic environment (i.e. are representative of expected Project-generated sound levels only). Table A-1 (Attachment 1) presents the received sound levels at each of the 16 individual NSRs by receptor ID and UTM coordinates. The assessment included prediction and plotting of sound levels generated by the Project. Sound contour maps corresponding to operation of the highest specified operational sound level under typical downwind and anomalous meteorological conditions displayed as color-coded isopleths are presented in Figures 1 and 2 (Attachment 1). Isopleths are projected onto scaled aerial photographs at a height of 1.52 meters (5 feet) above grade i.e., at the approximate height of a person's ears while standing. In conclusion, modeling results, as shown in Tables 3 and A-1, indicate that the Project will comply with the applicable State 50 dBA noise limit for wind energy projects.

Table 3. Number of NSRs by Sound Level Range and Exceedance Condition

Sound Level Range (dBA)	V100-2.0	
	Typical Downwind	Anomalous Meteorological
Less than 35	8	7
35 - 40	3	4
40 - 45	3	3
45-50	2	2
50-55+	0	0
>50 (North Dakota Limit)	0	0

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ATTACHMENT 1

Tabulated Results and Sound Contour Figures

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Table A-1. Tabulated Acoustic Modeling Results

NSR ID	UTM Coordinates (m)		Sound Levels (dBA L_{eq}) V100-2.0	
	Easting	Northing	Typical Downwind	Anomalous Meteorological
1	718990	5188568	41	42
2	719013	5186610	31	33
3	724362	5191939	46	46
4	723663	5188543	42	43
5	726461	5191668	43	44
6	728996	5191251	46	46
7	729204	5187628	32	34
8	720993	5186693	36	38
9	722287	5186857	36	37
10	723940	5185782	27	29
11	728120	5187231	32	34
12	727748	5184755	21	24
13	729223	5184162	17	20
14	722267	5186683	35	37
15	716294	5190086	29	32
16	724981	5194263	34	36

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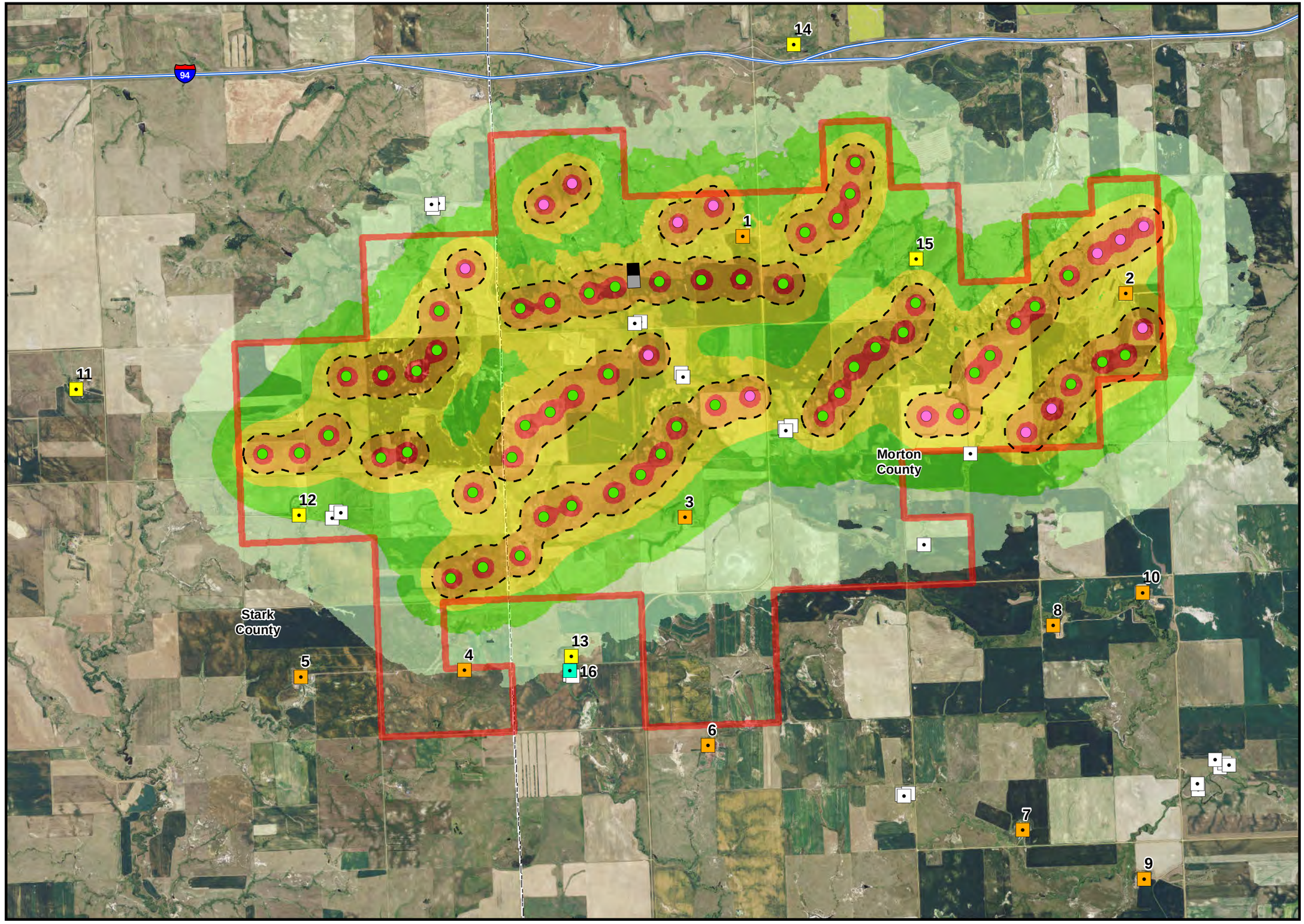
Sunflower Wind Project

Application for North Dakota Certificate of Site Compatibility

Figure 1
Operational Leq Sound Levels under Typical Downwind Conditions
Vestas V100-2.0

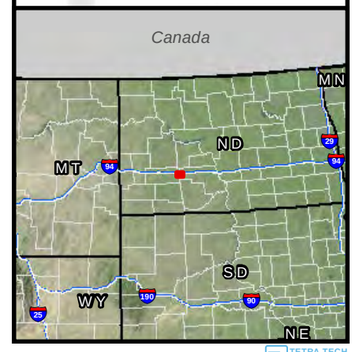
Morton and Stark Counties, ND
November 2014



- Project Area
- Turbine Location
- Alternate Turbine Location
- Occupied Residence
- Unoccupied Residence
- Residential Structure (Occupation Unknown)
- Other Nonresidential Structure
- Proposed Interconnection
- Proposed Substation
- County Boundary
- Interstate Highway
- North Dakota Limit 50 dBA

Sound Isopleths (dBA)

- 35-40
- 40-45
- 45-50
- 50-55
- 55-60
- 60 or greater



1:45,000 WGS84 UTM Zone 13N

0 2 4 Miles

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Sunflower Wind Project

Application for North Dakota Certificate of Site Compatibility

Figure 2

Operational Leq Sound Levels under Anomalous Downwind Conditions

Vestas V100-2.0

Morton and Stark Counties, ND

November 2014

- Project Area
- Turbine Location
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Canada

MN ND MT SD WY NE

1:45,000 WGS84 UTM Zone 13N

0 2 4 Miles

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