MEMORANDUM

Date: December 18, 2020

To: Crowned Ridge Wind, LLC

From: Mr. Richard Lampeter, Epsilon Associates Inc.

Subject: Crowned Ridge Wind – Sound Level Compliance Evaluation – LNTE 2020 Initial Findings

Epsilon Associates, Inc. (Epsilon) is pleased to provide this memo summarizing the initial findings of the Crowned Ridge Wind (CRW) sound level compliance evaluation per the requirements identified in the "2020 Sound Level Measurement Program Protocol" dated September 16, 2020 (2020 Protocol).

CRW is a 200-megawatt (MW) wind power generation facility composed of 87 General Electric (GE) wind turbines. All of the 87 wind turbines within the site are GE 2.3-116 units with a rotor diameter of 116 meters. Nine (9) GE 2.3-116 wind turbines have a hub height of 80 meters and 78 have a hub height of 90 meters. All wind turbines now have Low Noise Trailing Edge (LNTE) blades installed. Prior to the installation of LNTE blades on all wind turbines in the Project, a temporary curtailment program was designed, through predictive sound level modeling by EAPC, to mitigate sound levels produced by the Project such that compliance was demonstrated until all wind turbines were equipped with LNTE blades. In order to address the requirements within a temporary waiver granted by the South Dakota Public Utilities Commission (SD PUC) on January 9, 2020, a sound level measurement program was conducted by Epsilon in the late winter of 2020 to evaluate compliance with the sound level limits within CRW's permit condition. A sound level compliance evaluation report[1] dated May 13, 2020 concluded that the Project demonstrated compliance at all locations.

The latest measurement program was designed to fulfill the requirements with respect to the temporary waiver granted on January 9, 2020 and Condition 26 of the Final Decision.

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[1] Epsilon Associates, Inc. Sound Level Compliance Evaluation Report. May 13, 2020. Maynard, MA.

Epsilon ASSOCIATES INC.

Regulatory Requirements

Order Granting Temporary Waiver

In the matter of the application by Crowned Ridge Wind, LLC for a permit of a wind energy facility in Grant and Codington Counties (EL 19-003) a temporary waiver was granted on January 9, 2020. This order included four (4) conditions as specified below:

1) The temporary waiver expires September 15, 2020;
2) Applicant shall file with the Commission beginning April 1, 2020, monthly progress reports explaining the status of the LNTE installation;
3) Applicant shall curtail 16 turbines at wind speeds above 6 meters per second in accordance with the sound model using a 0.3 ground attenuation factor; and
4) Applicant shall conduct post-construction sound compliance testing in accordance with Condition 26 of the Final Order during the Temporary Waiver period and again after the LNTEs are installed on all turbines.

Final Decision and Order Granting Permit to Construct Facility; Notice of Entry

CRW is subject to permit conditions per the "Final Decision and Order Granting Permit to Construct Facility; Notice of Entry" (Final Decision). Condition 26 pertains to sound level limits and monitoring methodologies. The language in Condition 26 defining sound level limits is the following:

> *The Project, exclusive of all unrelated background noise, shall not generate a sound pressure level (10-minute equivalent continuous sound level, Leq) of more than 45 dBA as measured within 25 feet of any non-participating residence unless the owner of the residence has signed a waiver, or more than 50 dBA (10-minute equivalent continuous sound level, Leq) within 25 feet of any participating residence unless the owner of the residence has signed a waiver. The Project Owner shall, upon Commission formal request, conduct field surveys and provide monitoring data verifying compliance with specified noise level limits. If the measured wind turbine noise level exceeds a limit set forth above, then the Project Owner shall take whatever steps are necessary in accordance with prudent operating standards to rectify the situation.*

Sound level monitoring methodologies utilized in this program have been designed to abide by the procedures outlined in subparts a) through f) of Condition 26 in the Final Decision.

Codington County Ordinance

A section of CRW is within Codington County, SD and is subject to the following sound level requirements in Section 5.22.03(12) of Ordinance #65 Zoning Ordinance of Codington County, Noise subsection of General Provisions for Wind Energy Systems (WES):

> *Noise level generated by the wind energy system shall not exceed 50 dBA, average A-weighted Sound pressure level effects at the property line of existing non participating residences, businesses, and buildings owned and/or maintained by a governmental entity.*
>
> *Noise level measurements shall be made with a sound level meter using the A-weighting scale, in accordance with standards promulgated by the American National Standards Institute. An L90 measurement shall be used and have a measurement period no less than ten minutes unless otherwise specified by the Board of Adjustment.*

A complaint has been issued by a residence in the vicinity of the Project to Codington County. As part of this study, an evaluation of sound level compliance was made at the intervenor property line per the ordinance.

Sound Level Measurement Program

Broadband A-weighted (dBA) and one-third octave-band (dB) sound levels were measured at six (6) locations in the vicinity of the Project to collect post-construction sound level data. These locations are consistent with five of the six primary locations identified in the 2020 Protocol. The six locations are summarized below and shown in Figure 1.

- **Location 1:** Participating – Modeling Receptor CR1-C30-P
  - Modeled Project-Only Sound Level = 47 dBA
  - Highest modeled receptor
  - Measurements were performed at this location during the curtailment measurement program

- **Location 2:** Non-Participating – Modeling Receptor CR1-G68-NP
  - Modeled Project-Only Sound Level = 42 dBA
  - Measurements were performed at this location during the curtailment measurement program

- **Location 3:** Non-Participating – Modeling Receptor CR1-C41-NP
  - Modeled Project-Only Sound Level = 43 dBA
  - Measurements were performed at this location during the curtailment measurement program
  - This location was an alternate location (3A) in the 2020 Protocol

- **Location 4:** Non-Participating – Modeling Receptor CR1-C46-NP
  - Modeled Project-Only Sound Level = 43 dBA

- **Location 5:** Non-Participating – Modeling Receptor CR1-C14-NP
  - Modeled Project-Only Sound Level = 43 dBA
  - Measurements were performed at this location during the curtailment measurement program

- **Location 6:** Non-Participating – Modeling Receptor CR1-C29-NP
  - Intervenor (Christianson)
  - Measurements were performed at this location during the curtailment measurement program

The equipment for the sound level measurement program was setup starting on Tuesday, October 20, 2020 and equipment retrieval was completed on Tuesday, November 10, 2020.

Sound Level Evaluation

Methodology

The 'total' L_{eq} sound level (wind turbines + background) measured during each of at least 10 periods meeting the conditions specified in the Final Decision is compared to the wind energy facility limits. This is conservative since it includes both wind turbines plus background.

Background sound levels, either continuous or from sporadic loud events, can impact the total sound level. A review of the data and/or audio recordings is performed to remove extraneous events when necessary for the analysis of evaluation periods. If necessary, a representative background sound level is subtracted (on an energy basis) from the operational sound level to obtain the "wind turbine only" L_{eq} sound pressure level. This subtraction procedure is supported by ANSI S12.18. The "wind turbine only" sound pressure level is then compared to the wind energy facility limits.

In order to compare the measured sound data to the applicable sound pressure level limits, Epsilon evaluated the sound level data meeting the following criteria as specified in the 2020 Protocol:

1. There is no precipitation during the measurement period.[2]

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[2] According to ANSI S12.18-1994 (R2019), "No measurements shall be made during measurable precipitation or freezing rain." This condition is also required per the Final Decision.

2. The average ground level wind speed is 5 m/s (11.2 mph) or less.[3]
3. According to ANSI S12.18 the sound level measurements are to be during a wind direction under which the measurement location is ± 45 degrees within the downwind direction of the sound source.[4] Evaluating only downwind periods is not a specific requirement identified in the conditions of the Final Decision. In addition, according to a 2016 Massachusetts Clean Energy Center report[5] on wind turbine acoustics, wind direction only affects sound levels by "generally less than 1 dB". Therefore, it is reasonable to include additional wind directions in the analysis when downwind periods meeting the other criteria are not present and potentially uncommon.
4. Operational condition - Closest five wind turbines are operating. Closest wind turbine operating at maximum sound power (within 1.0 dBA). As the sound power determination cannot be made based on a comparison to wind turbine electrical output due to insufficient data on the EPCO operations, maximum electrical output, i.e. 2,300 kW, is necessary at the closest wind turbine.
5. The L_{10} and L_{90} sound levels were reasonably close together (≤ 4.0 dBA) indicating a steady sound, possibly from the wind turbines.[6]
6. Ground-level wind speed gusts were approximately 7 m/s or less.[7]

Initial Findings

The focus of this initial analysis was to analyze periods meeting the criteria presented above which contained total sound levels that exceeded the regulatory limits. The details of this analysis will be presented in the full report to be submitted in mid-January. These initial findings will be supplemented with the full analysis which will evaluate additional periods (periods meeting the evaluation criteria with sound levels at or below the regulatory limit). This additional analysis may result in Project-Only sound levels lower than those present in this initial summary.

The initial findings of the sound level evaluation show compliance at all six measurement locations. This evaluation has been conducted approximately 25 feet from the residences with the exception of Location

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3 According to ANSI S12.18-1994 (R2019), "No sound level measurement shall be made when the average wind velocity exceeds 5 m/s when measured at a height of 2± 0.2 m above the ground." This condition is also required per the Final Decision.

4 Orientation between the source and receiver required for Method #1 in the ANSI standard. One exception is during an inversion with low ground level winds.

5 RSG et al, "Massachusetts Study on Wind Turbine Acoustics," Massachusetts Clean Energy Center and Massachusetts Department of Environmental Protection, 2016.

6 Based on professional experience; Epsilon has found this relationship exists during periods of steady sound from sources such as wind turbines.

7 Based on professional experience; Momentary gusts can have a significant effect on the sound levels with impacts depending on the variation and speed of the wind and the sound level metric.

6 where sound levels were measured at the property line per the Codington County ordinance. Because compliance is demonstrated at Location 6 (the property line), compliance is also demonstrated at the home. In addition, the evaluation at Location 6 is further conservative because L_{eq} sound levels were evaluated as opposed to L_{90} sound levels, which are always lower.

A summary of the initial results is provided in Table 1. The table quantifies the number of valid 10-minute measurement periods, i.e., periods when all critical data were available and complete, the number of those valid periods that met all of the evaluation criteria, and the wind turbine only sound levels determined in the initial evaluation. 'Total' sound levels include contribution from ambient sound sources other than the Project. At this stage in the analysis, wind turbine only sound levels are generally based on 'total' sound levels; therefore, sound levels from the Project are anticipated to be these levels or lower at the respective locations. For periods when total sound levels exceeded the limit, an ambient sound level analysis was incorporated into the evaluation.

Table 1 Initial Results Summary

Loc.	Participation Status	# of Valid Periods	# of Evaluation Periods	Preliminary Wind Turbine Only L_{eq} Sound Level (dBA)
1	Participating	~1,350/2,475[1]	39/117[1]	≤50
2	Non-Participating	2,660	102	≤45
3	Non-Participating	2,699	65	≤45
4	Non-Participating	2,698	142	≤45
5	Non-Participating	2,626	131	≤45
6	Non-Participating (PL)	2,756	235	≤45

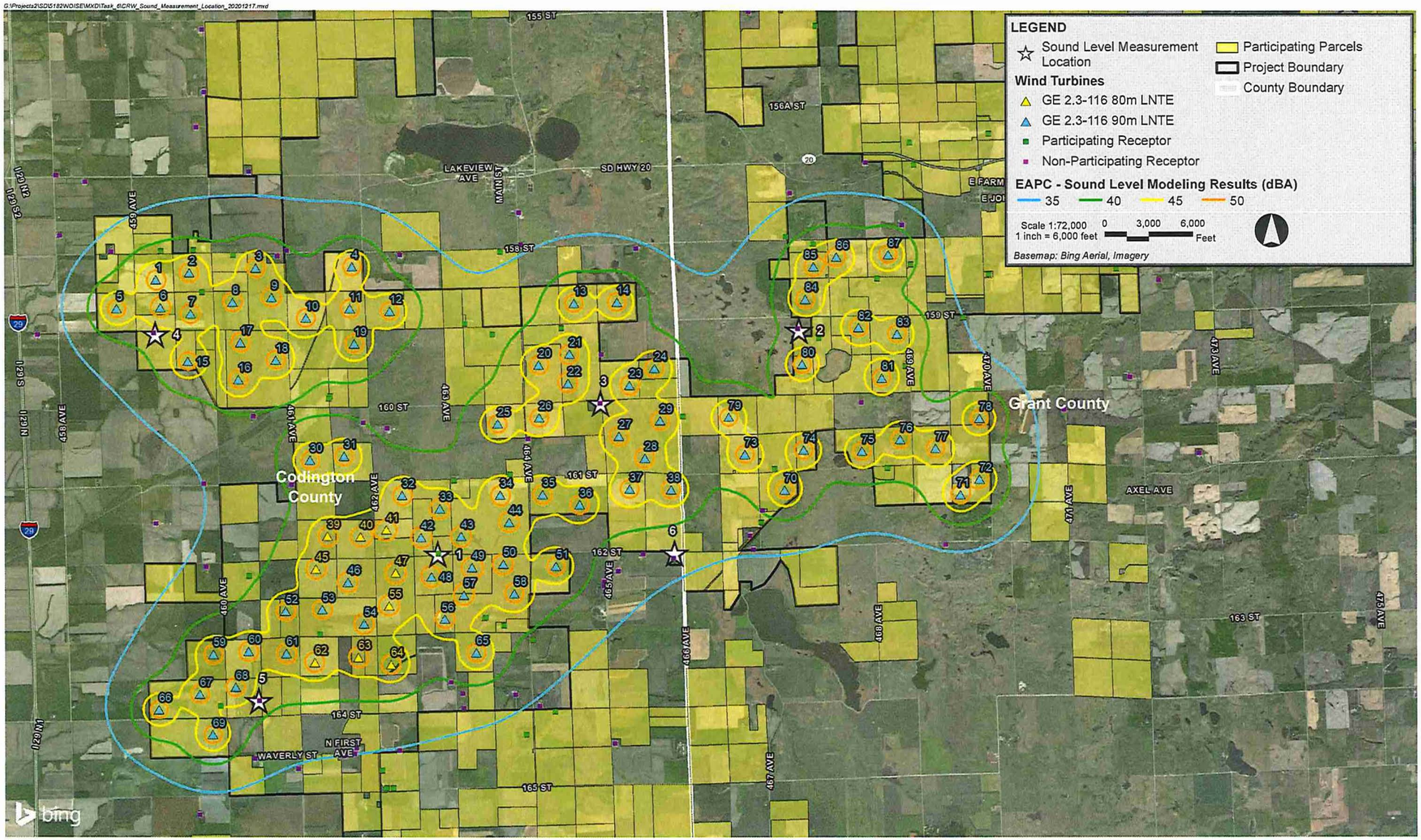
Notes:

1. The tripod holding the microphone at this location blew over from strong winds between the mid-program check on 10/28/2020 and pickup on 11/9/2020. There are two periods during which Epsilon suspects this to have occurred based on a review of the data: the night of 10/30/2020 or the evening of 11/7/2020. The two values presented in the table are representative of both cases.

Conclusions

Based on the initial results of the analysis of data collected during the sound level measurement program, the sound levels at all six locations meet the sound level limits (County property line, non-participating residence, and participating residence limits). These results are only preliminary at this point. Additional periods remain to be evaluated, i.e. periods of lower total sound levels, which will potentially result in lower wind turbine only sound levels being assigned to each location as compared to those presented in

Table 1. Therefore, this additional analysis is not anticipated to change the conclusions of this memo with respect to compliance. Further QA/QC will be conducted as well. The full analysis will be presented in a report to be submitted in mid-January.



Crowned Ridge Wind Energy Center **Grant and Codington Counties, South Dakota**

Epsilon Associates Inc.

Figure 1

Sound Level Measurement Locations