MEMORANDUM

Date: January 19, 2021

To: Crowned Ridge Wind, LLC

From: Mr. Richard Lampeter, Epsilon Associates Inc.

Subject: Crowned Ridge Wind – Sound Level Compliance Evaluation – LNTE 2021 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 conducted in 2021 (LNTE 2021). This summary has been provided in advance of a full report in order to remain consistent with the approach 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 (the Project). 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 have Low Noise Trailing Edge (LNTE) blades.

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. A second measurement program was conducted following the installation of LNTE blades on all wind turbines to fulfill the requirements with respect to the temporary waiver. A sound level compliance evaluation report[2] dated January 15, 2021 concluded that the Project demonstrated compliance at all locations.

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

2 Epsilon Associates, Inc. Sound Level Compliance Evaluation Report. January 15, 2021. Maynard, MA.

The third-party sound study review[3] by Hessler Associates, Inc. dated February 8, 2021 (Hessler Report) concluded that CRW was essentially compliant with the sound level limits set forth in the permit conditions based on the SD PUC-approved study protocols. The review also indicated that the Project exceeded the sound level limits at 3 of the 6 measurement locations during brief periods (<5% of the total measurements).

In response to these findings, CRW generated a Mitigation Plan within the Motion for Approval of Mitigation Plan dated March 18, 2021 that was approved by the SD PUC on April 9, 2021. Within that Mitigation Plan was the commitment to conduct a follow-up sound study. The Order Granting Petition for Reconsideration and Order Granting Motion to Amend Sound Study Mitigation Plan in Part on Reconsideration dated September 20, 2021 modified the components of the follow-up study. This latest measurement program was designed to fulfill the requirements of those Orders.

Regulatory Requirements

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.

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[3] Hessler Associates, Inc. Crowned Ridge Wind Final Operational Sound Test Data Review and Assessment. February 8, 2021. St. George, UT.

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.

Order Approving Mitigation Plan

In accordance with the Mitigation Plan, Crowned Ridge shall:

1) work to obtain waivers of Condition No. 26 from the affected landowners;
2) utilize Winter Ice Operations Mode on the wind turbines at all times;
3) conduct an additional sound study during the Fall of 2021 during similar weather patterns as to those experienced during the Fall of 2020 sound study; and
4) include the Lindgren residence in the additional sound study to be completed in Fall of 2021.

The additional sound study, per the Mitigation Plan found within the Motion for Approval of Mitigation Plan dated March 18, 2021, is to use the protocols approved by the Commission on October 2, 2020, with the following changes:

1) Perform the study at three locations;
2) Require that the study and report focus on time periods near wind turbine shutdowns;
3) Modify the wind turbine shutdown procedure to perform four shutdowns daily at 1:00 a.m., 7:00 a.m., 1:00 p.m., and 7:00 p.m. for wind turbines within 1.75 miles of a measurement location;
4) Perform the study in the Fall of 2021 during similar weather patterns and wind turbine output ranges that were present in October of 2020; and
5) Require that an acoustical consultant from Epsilon remain in Watertown, SD for the duration of the sound level measurement to allow for frequent personal observations during the performance of the sound study.

Per the Order, the number of measurement locations increased to four (4) with the addition of the Lindgren residence.

Order Granting Petition for Reconsideration and Order Granting Motion to Amend Sound Study Mitigation Plan in Part on Reconsideration

This Order added a fifth location, Ms. Christenson's residence to the study along with the requirement to include any applicable Crowned Ridge Wind II wind turbines in the shutdowns.

Sound Level Measurement Program

The LNTE 2021 measurement program was designed per the conditions described in the Mitigation Plan and as modified in the April 9, 2021 and September 20, 2021 Orders.

Broadband A-weighted (dBA) and one-third octave-band (dB) sound levels were measured at five (5) locations in the vicinity of the Project to collect post-construction sound level data. Three of the five locations were selected as representative of the locations showing sound level exceedances in the Hessler Report. The additional two locations were as ordered by the SD PUC. The five locations are summarized below and shown in Figure 1.

- **Location 3A:** Non-Participating – Modeling Receptor CR1-C44-NP
  - Modeled Project-Only Sound Level = 43 dBA
  - This location was selected to be representative of the Project area for Location 3 that was utilized in the prior sound level studies and showed a sound level exceedance in the Hessler Report.

- **Location 6:** Non-Participating – Modeling Receptor CR1-C29-NP
  - Modeled Project-Only Sound Level = 36 dBA
  - Christenson residence per the Order Granting Petition for Reconsideration and Order Granting Motion to Amend Sound Study Mitigation Plan in Part on Reconsideration
  - Measurements were performed at this property during the prior sound level studies. In contrast to the previous measurement programs, sound levels were measured within 25 feet of the home as opposed to at the property line.

- **Location 7:** Participating – Modeling Receptor CR1-C35-P
  - Modeled Project-Only Sound Level = 43 dBA
  - This location was selected to be representative of the Project area for Location 1 that was utilized in the prior sound level studies and showed a sound level exceedance in the Hessler Report.

- **Location 8:** Non-Participating – Modeling Receptor CR1-G23-NP
  - Modeled Project-Only Sound Level = 42 dBA
  - This location was selected to be representative of the Project area for Location 2 that was utilized in the prior sound level studies and showed a sound level exceedance in the Hessler Report.

- **Location 9:** Non-Participating – Modeling Receptor CR1-C37-NP
  - Modeled Project-Only Sound Level = 44 dBA
  - Lindgren residence per the Order Approving Mitigation Plan

The equipment for the sound level measurement program was setup starting on Tuesday, November 2, 2021 and equipment retrieval was completed on Thursday, November 18, 2021. Wind turbine shutdowns began on November 3, 2021 following the conclusion of equipment deployment at all locations.

Sound Level Evaluation

Methodology

The 'total' L_{eq} sound level (wind turbines + background) measured during periods meeting the conditions specified in the Mitigation Plan is initially 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, audio recordings, and/or field personnel observations is performed to remove extraneous events when necessary for the analysis of evaluation periods. If necessary, a representative background sound level, measured during a wind turbine shutdown period, 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 certain instances, although elevated sound levels are present due to a non-wind turbine sound source, they cannot be removed from the data. In these instances, a wind turbine only sound level cannot be determined, and these periods are not evaluated with respect to the 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.[4]

[4] 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.[5]
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.[6] 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[7] 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.
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.[8]
6. Ground-level wind speed gusts were approximately 7 m/s or less.[9]

In contrast to the 2020 Protocol conditions, and as specified in the Mitigation Plan, the sound level study evaluation focused on periods near wind turbine shutdowns. Also in contrast, this study did not set a limitation on the wind turbine power output for evaluation periods.[10] Respectively, all periods meeting the above criteria that were also within approximately one (1) hour of the start or completion of a shutdown have been evaluated.

Initial Findings

The focus of this initial analysis was to analyze whether periods in relatively close proximity to wind turbine shutdowns met the regulatory sound level limits. The initial findings will be supplemented with a full analysis which will also include a review of periods where personal observations were made by an Epsilon consultant. This additional analysis may result in modified conclusions as compared to those

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5 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.

6 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.

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

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

9 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.

10 The prior evaluation required a power output of the maximum 2,300 kW at the closest wind turbine.

presented in this initial summary. The details of the complete analysis will be presented in the full report to be submitted in mid-February.

The initial findings of the sound level evaluation show compliance at all five measurement locations. A summary of the initial results is provided in Table 1. The table quantifies the total number of complete 10-minute measurement periods, i.e., full periods when all critical data were available, the number of the measurement periods that met all of the evaluation criteria and occurred within approximately one (1) hour from the start or completion of a wind turbine shutdown, 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. 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 Measurement Periods	# of Evaluation Periods[1,2]	Preliminary Wind Turbine Only L_{eq} Sound Level (dBA)
3A	Non-Participating	2,115	188	≤45
6	Non-Participating	2,016[2]	169[3]	≤40
7	Participating	2,042	257	≤50
8	Non-Participating	2,099	219	≤45
9	Non-Participating	2,052	156	≤45

Notes:
1. Within approximately 1 hour of the start or completion of a shutdown.
2. Total number of evaluation periods include periods during unscheduled curtailments at the site unrelated to the sound study.
3. Includes only periods after the relocation of the measurement equipment at Location 6.

Conclusions

Based on the initial results of the analysis of data collected during the sound level measurement program, the sound levels at all five locations meet the sound level limits (non-participating residence and participating residence limits). These results are only preliminary at this point in time. The initial findings will be supplemented with a full analysis which will also include a review of periods where personal observations were made by an Epsilon consultant. This additional analysis may result in modified conclusions as compared to those presented in this initial summary. Further QA/QC will be conducted as well. The full analysis will be presented in a report to be submitted in mid-February.

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LEGEND

- Sound Level Measurement Location
- **Wind Turbines**
  - GE 2.3-116 80m LNTE
  - GE 2.3-116 90m LNTE
  - Crowned Ridge Wind II Wind Turbine
- Participating Receptor
- Non-Participating Receptor
- Participating Parcels
- Project Boundary
- County Boundary

EAPC - Sound Level Modeling Results (dBA)

35 — 40 — 45 — 50

Scale 1:72,000
1 inch = 6,000 feet
0 3,000 6,000 Feet

Basemap: Bing Aerial, Imagery

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

Epsilon Associates Inc.

Figure 1
Sound Level Measurement Locations - 2021