MONITORING LOCATION(S)	Ron Weverka Residence – 2948 160th Avenue W, Hendricks, MN 58136
NOISE SOURCE(S)	Blazing Star 1 wind turbine generator #90 ("WTG-90");
SURVEYOR(S)	Mark Gerlach, Xcel Energy Environmental Analyst Lucas Knowlton, Xcel Energy Environmental Analyst
SURVEY DATES/TIME	March 11, 2020, March 31 – April 4, 2020 and May 18 - 19, 2020
WEATHER CONDITIONS	See Appendix A
REPORT AUTHOR(S)	Mark Gerlach, Xcel Energy Environmental Analyst Lucas Knowlton, Xcel Energy Environmental Analyst
REPORT DATE	July 9, 2020

SUMMARY

On March 9, 2020, BS1 operations staff received a complaint from Mr. Ron Weverka regarding noise levels at his rural residence located near wind turbine #90. The Weverka's noted that they were being kept awake by a loud, low-frequency noise resonating throughout their house every few seconds. They also indicated that the noise has been loudest when the wind is from the north and when there was fog with freezing temperatures. Xcel Energy's Environmental Services and Blazing Star staff coordinated with Mr. Weverka to conduct monitoring at the property to characterize noise levels present during turbine operation.

Overall, measured hourly noise levels were compliant with MPCA daytime noise standards, although additional outdoor monitoring is recommended based on the limited hours of valid noise monitoring data and the limited weather conditions they represented. Further investigation of the noise inside the Weverka residence is also recommended.

The remainder of this report contains the details of the event and Xcel's response including the data collected, data analysis, and any additional actions, if needed.

SITE OVERVIEW

The Blazing Star 1 Wind Farm ("BS1") is a 200 MW Large Wind Energy Conversion System ("LWECS") located in Lincoln County, Minnesota. The project is comprised of 90 Vestas model V120 (2.0 MW) and 10 model V110 (2.0 MW) wind turbines spanning 58-square miles. The project completed construction in April 2020 and is currently operational.

NOISE & HOW IT RELATES TO WIND TURBINES

Sound level or pressure is commonly expressed in units called decibels (dB). Noise typically includes a mixture of noise frequencies (pitch), and the human ear has differing sensitivity to different frequencies. In order to better approximate human hearing, sound pressure readings are typically adjusted using an A-weighted filter. Regulatory noise limits typically use A-weighted readings, which are noted as dBA.

Wind turbine noise is generated by mechanical equipment and the flow of air across turbine blades. Turbine noise experienced by a receptor is primarily aerodynamic and fluctuates with wind intensity, direction and consistency. Wind speed at the turbine blades and nacelle is greater than wind speed at the ground level. Ambient or background noise levels in rural agricultural settings are commonly low and made up of natural sound (e.g., wind, insects, rustling vegetation, etc.), but may be increased by human-generated sound (e.g., vehicles, farm equipment, recreational vehicles, etc.). Noise levels at a receptor are a combination of these sources, and monitoring equipment and protocols are designed to properly evaluate noise from a specific source.

To evaluate compliance with state noise regulations, monitoring is performed with a certified sound level meter in accordance with several regulatory guidance documents and standards, including the Minnesota Pollution Control Agency's (MPCA) "A Guide to Noise Control In Minnesota (2015)," the Minnesota Department of Commerce's "Guidance for Large Wind Energy Conversion System Noise Study Protocol and Report," and national/ international acoustic monitoring standards. These documents specify the data to collect, where to locate monitors, and how to process monitoring data to remove invalid data. Processing guidance requires removal of data from periods of precipitation or where ground level wind speeds are above11-miles/hour, to ensure microphone noise and background noise aren't the primary source measured. The guidance also allows removal of data during short-term loud noise events (e.g., vehicles, airplanes, equipment, birds, barking dogs and insects). Excluded data must be documented and described in compliance monitoring reports.

COMPLAINT OVERVIEW

On March 9, 2020 approximately 4:00 am, BS1 project staff received a wind turbine noise complaint from Mr. Ron Weverka regarding high noise levels at his rural residence. Mr. Grant Wilson, Blazing Star Construction Site Manager, went to the site to review the noise and to meet with Mr. and Mrs. Weverka. Weverka's noted that they were kept awake by a loud, low-frequency noise resonating throughout their house every few seconds. They also indicated that the noise has been loudest when the wind is from the north and when there was fog with freezing temperatures. At the time of the complaint fog and freezing temperatures were present and were causing frost/ice accumulation on turbine blades.

In response, Xcel Energy's Environmental Services and Blazing Star staff coordinated with Weverka's to conduct noise monitoring at the property to characterize noise levels present during turbine operation. Additionally, on March 9, 2020 turbine #90 was placed on daily curtailment (shut-down) between 7:00 pm to 07:00 am and has remained on this schedule.

NOISE REGULATIONS/STANDARDS

Minnesota noise standards are set forth in Minnesota Administrative Rules Chapter 7030 and residential limits are shown in Tables 1 and 2. The standards are based on noise levels reported as L_{50}, and L_{10}, where L_{50} is the median sound level over a 1-hour period (i.e., 50% of the measured sound is louder than the L_{50} and 50% is quieter). L_{10} is the sound level that is exceeded only 10% of the time during the 1-hour period. Noise limits are based on A-weighted readings and may also be written as LA_{50} or LA_{10}. The limits are also split into daytime (7 am – 10 pm) and lower nighttime (10 pm to 7 am) values.

NOISE SURVEY EQUIPMENT

Larson-Davis 831 sound level meter (Meter LD831 SN 0001454, Preamp PRM831 SN 10124, Microphone 377B02 SN 106009). The sound meter meets IEC 61672 Class 1 specifications and the MPCA Guide.

B & K Type 4230 sound level calibrator (S/N 1700955), factory calibrated August 21, 2019.

NOISE MONITORING

Initial daytime monitoring occurred on the morning of March 11th, 2020 and was comprised of 1-minute averages. In order to collect additional noise data during a variety of weather conditions a noise monitor was deployed at the site from March 31 – April 4, 2020, and again on May 18-19, 2020. The monitor location during the extended collection periods was placed 30 feet south of the residence as shown in Figure 1. The Weverka residence is located approximately 1,150 feet south of turbine #90 and turbines #78 (4,300 feet) and #79 (4,900 feet) are the only other turbines within 1-mile of the property (Figure 2). Based on their relative distances #78 and #79 are expected to have a negligible effect on noise levels measured at the Weverka residence.

Extended continuous duration monitoring parameters during March 31 – April 4, 2020 included 10-second average LA_{EQ} and 1/3 octave frequencies. May 2020 monitoring parameters included 1-second averages of the same parameters.

Hourly weather observations at Myers Field Airport weather station in Canby, MN were used to identify wind speed and direction and periods of precipitation. Wind farm operations data was used to identify turbine #90 off or on status.

RESULTS/DISCUSSION

Initial monitoring results from March 11, 2020 are shown in Table 1. While these 1-minute average values cannot be used to confirm compliance, they do provide a useful indication of noise levels especially for the consistent noise of an operating wind turbine. The results were all below the state daytime and nighttime noise limits. Since weather conditions were significantly different than at the time of the complaint, continuous extended monitoring was pursued.

TABLE 1 – MARCH 11, 2020 1-MINUTE SNAPSHOT 9:30 AM

Location	L50 (dBA)	L10 (dBA)
Directly in front residence; ~10' from dining room window	46.9	49.9
10' N of driveway where gravel turns to the S	49.4	51.9
Inside house – at dining room table, facing window (toward T-90)	22.3	24.3
~1,000' NE of T-90 (directly in turbine wash/trailing wind direction)	49.4	51.6
MN daytime noise limit	60	65
MN nighttime noise limit	50	55

Wind SSW 10 mph with occasional gusts

Specific sound level metrics reported for the extended monitoring periods are hourly averaged LA_{50} and LA_{10}. A summary of these results is provided in Table 2, and the hourly noise, weather, and turbine operation data are provided in Appendix A. Due to the daily 7 pm to 7 am turbine curtailment and other maintenance/ operational shutdowns only 4-hours of monitoring during turbine operation were collected during March 31 – April 4, 2020 monitor deployment.

As noted in Table 2 these values were below state regulatory limits and could have been excluded from the this report as surface winds were NNW at 13 – 18 mph, which exceeds the 11-mph state guidance for valid data. May 18 – 19 monitoring captured 10-hours of noise during turbine operation, all of which were below state limits. During this period surface winds were 9 – 14 mph from the SSE (Appendix A).

Removal of sporadic human or other noise spikes (e.g., vehicles, airplanes, thunder, birds, animals and insects) is also allowed by state guidance but was not performed since audio recordings were not collected for verification. Daily turbine #90 curtailment shutdown (7 pm to 7 am), prevented nighttime noise monitoring data collection between 10 pm and 7 am. None of the noise monitoring occurred during weather conditions at the time of the original complaint: fog, freezing temperatures and turbine blade frosting/ icing.

TABLE 2: MEASURED VALUES SUMMARY AND COMPARISON TO REGULATORY LIMITS

PARAMETER	DAYTIME (07:00 – 22:00)		MONITOR HOURS	NIGHTTIME (22:00 - 0700)	
	L_{50}	L_{10}		L_{50}	L_{10}
April 2, 2020 Measured Values (dBA) Minimum – Maximum	49.9 - 53	54.6 – 56.1	4	NA	NA
May 18-19, 2020 Measured Values (dBA) Minimum – Maximum	40.5 – 47.4	46.8 - 59	10	NA	NA
Regulatory Limit (dBA)	60	65		50	55

COMPARISON TO PRE-CONSTRUCTION NOISE MODELING

As part of the site permit, the developer was required to model the noise contribution of operating turbines at occupied residences in proximity to wind turbines. Modeling results were documented in an October 18, 2018 RSG Noise Compliance Report, and results for the Weverka home are provided in Appendix B. Their residence was identified as #11 and the turbine only noise contribution was modeled at 49.1 dBA. The modeling report also estimated noise levels at the residence with various levels of background noise. Although the measured and modeled values are within similar ranges, no conclusions can be made regarding the modeling without an assessment of the actual background noise levels at the site.

CONCLUSION

Overall, measured hourly noise levels were compliant with MPCA daytime noise standards, although additional outdoor monitoring is recommended based on the limited hours of valid noise monitoring data and the limited weather conditions they represent. Further investigation of the noise inside the Weverka residence is also recommended.

FIGURE 1: NOISE MONITOR LOCATION AT PROPERTY

Source: Google Earth (2020)

FIGURE 2: WIND TURBINE GENERATOR LOCATIONS RELATIVE TO PROPERTY

Source: Google Earth (2020)

APPENDIX A
SUMMARY OF HOURLY NOISE MONITORING

Data excluded, turbines not in operation
Data eligible to be excluded, wind > 11 mph or precipitation

TABLE A 1-HOUR AVERAGE MONITORING RESULTS

DATE	TIME	TURBINE OPERATION STATUS*	SOUND LEVEL PRESSURE (dBA)		WEATHER DATA		
			LA_{50}	LA_{10}	WIND SPEED (MPH)	WIND DIRECTION** (°)	PRECIPITATION
3/31 – 4/2/2020		Off	NA	NA	NA	NA	NA
4/2/2020	1126-1539	Off	NA	NA	NA	NA	NA
4/2/2020	1540-1600	On, < 1 hr	53.0	56.1	14-18	285	No
4/2/2020	1600-1700	On	50.4	55.3	14-15	280	No
4/2/2020	1700-1800	On	49.9	54.6	14-16	280	No
4/2/2020	1800-1900	On	51.7	55.9	13-16	290	Yes
4/2 - 4/4/2020	1900-0948	Off	NA	NA	NA	NA	NA
5/18/2020	1836-1900	On, < 1 hr	43.6	48.3	11-14	135	No
5/18/2020	1900-2000	Off	44.0	48.5	7-10	120	No
5/18/2020	2000-2100	Off	38.7	44.7	0-3	110	No
5/18 - 5/19/2020	2100-0300	Off	NA	NA	NA	NA	NA
5/19/2020	0400-0500	Off	31.9	34.0	0-3	320	No
5/19/2020	0500-0600	Off	48.3	56.7	0	0	No
5/19/2020	0600-0700	Off	38.4	45.8	0	0	No
5/19/2020	0700-0800	On	42.0	54.7	0-13	125	No
5/19/2020	0800-0900	On	45.6	59.0	9-11	110	No
5/19/2020	0900-1000	On	47.4	55.0	10-13	110	No
5/19/2020	1000-1100	On	42.1	58.3	9-10	120	No
5/19/2020	1100-1200	On	40.5	49.6	9-10	120	No
5/19/2020	1200-1300	On	41.6	47.6	8-10	130	No
5/19/2020	1300-1400	On	41.7	47.0	11-14	130	No
5/19/2020	1400-1500	On	44.6	50.8	11-14	120	No
5/19/2020	1500-1538	On, < 1 hr	41.2	46.8	13	100	No

TABLE 12: DISCRETE RECEIVER RESULTS – WITH AND WITHOUT BACKGROUND SOUND LEVELS

Receiver ID	Receiver Status	Modeled Sound Pressure Level (dBA)	Combined Background and Modeled Sound Pressure (L_{50} dBA)					Coordinates (UTM NAD83 Z14N)		
			35 dBA Background	40 dBA Background	45 dBA Background	50 dBA Background	55 dBA Background	X (m)	Y (m)	Relative Height of 4m + Elevation Z (m)
1	Part.	49.9	50.0	50.3	51.1	53.0	56.2	712112	4940724	513
2	Part.	49.9	50.0	50.3	51.1	53.0	56.2	712109	4940724	513
3	Part.	49.7	49.8	50.1	51.0	52.9	56.1	708087	4941227	520
4	Part.	49.8	49.9	50.2	51.0	52.9	56.1	704631	4935730	551
5	Part.	49.6	49.7	50.1	50.9	52.8	56.1	711816	4929676	544
6	Part.	49.4	49.6	49.9	50.7	52.7	56.1	706800	4938505	538
7	Part.	49.3	49.5	49.8	50.7	52.7	56.0	709431	4941062	522
8	Part.	49.3	49.5	49.8	50.7	52.7	56.0	710378	4940404	518
9	Part.	49.2	49.4	49.7	50.6	52.6	56.0	713004	4938818	521
10	Part.	49.1	49.3	49.6	50.5	52.6	56.0	709274	4934210	545
11	Part.	49.1	49.3	49.6	50.5	52.6	56.0	711809	4928697	536
12	Part.	49.0	49.2	49.5	50.5	52.5	56.0	708551	4937290	535
13	Part.	49.0	49.2	49.5	50.5	52.5	56.0	708544	4937292	535
14	Part.	48.8	49.0	49.3	50.3	52.5	55.9	706316	4934001	546
15	Part.	48.8	49.0	49.3	50.3	52.5	55.9	707283	4927671	546
16	Part.	48.7	48.9	49.2	50.2	52.4	55.9	710733	4931380	544
17	Part.	48.4	48.6	49.0	50.0	52.3	55.9	709204	4927886	551
18	Part.	48.3	48.5	48.9	50.0	52.2	55.8	707416	4928744	550
19	Part.	48.2	48.4	48.8	49.9	52.2	55.8	708048	4934831	526
20	Part.	48.0	48.2	48.6	49.8	52.1	55.8	709601	4926959	545
21	Part.	48.0	48.2	48.6	49.8	52.1	55.8	711642	4933694	528
22	Part.	47.9	48.1	48.6	49.7	52.1	55.8	707856	4941518	518
23	Part.	47.7	47.9	48.4	49.6	52.0	55.7	707707	4935296	537
24	Part.	47.7	47.9	48.4	49.6	52.0	55.7	708562	4927542	546
25	Part.	47.7	47.9	48.4	49.6	52.0	55.7	711826	4928643	536
26	Part.	47.7	47.9	48.4	49.6	52.0	55.7	711935	4929376	540
27	Part.	47.4	47.6	48.1	49.4	51.9	55.7	703149	4927091	557
28	Part.	47.4	47.6	48.1	49.4	51.9	55.7	707976	4933197	540
29	Part.	47.2	47.5	48.0	49.2	51.8	55.7	708248	4934117	535
30	Part.	47.1	47.4	47.9	49.2	51.8	55.7	709485	4936675	526
31	Part.	47.1	47.4	47.9	49.2	51.8	55.7	707838	4936270	536
32	Part.	46.9	47.2	47.7	49.1	51.7	55.6	712318	4942096	503
33	Part.	46.8	47.1	47.6	49.0	51.7	55.6	709954	4931141	554