# Appendix F – Sound Study

XCEL ENERGY

# SOUND STUDY

## BLUE LAKE BESS

PROJECT NO. 182179

JUNE 13, 2025

# CONTENTS

# TABLES

# List of Abbreviations

| Abbreviation | Term/Phrase/Name |
|---|---|
| ANSI | American National Standards Institute |
| BESS | Battery energy storage system |
| CadnaA | Computer Aided Noise Abatement |
| dB | decibel |
| dBA | A-weighted decibel |
| dBC | C-weighted decibel |
| Hz | hertz |
| ISO | International Organization for Standardization |
| $L_{eq}$ | equivalent-continuous sound level |
| $L_{10}$ | 10-percentile exceedance sound level |
| $L_{50}$ | 50-percentile exceedance sound level |
| $L_{90}$ | 90-percentile exceedance sound level |
| MPCA | Minnesota Pollution Control Agency |
| MVA | megavolt-amperes |
| NSA | noise sensitive area |
| Project | Xcel Energy Blue Lake Battery Energy Storage System |
| PWL | sound power level |
| SPL | sound pressure level |

# Executive Summary

Burns & McDonnell conducted a sound study for the proposed Xcel Energy (Xcel) Blue Lake Battery Energy Storage System (BESS) Project (Project), located in Scott County, Minnesota. The Project's initial design is expected to include the Sungrow Power Titan 2.0 4H-HX BESS containers (128), medium voltage transformers (32), associated auxiliary transformers (2), and a substation transformer (1). If future augmentation is required, it may include additional electrical components, and the augmented Project design should be reviewed for sound level impacts at that time.

The objectives of the sound study were to identify the applicable noise regulations and to develop a noise model to evaluate potential future sound level impacts from the Project.

The State of Minnesota regulates noise emissions at the state level. The Minnesota Pollution Control Agency (MPCA) has adopted the State's noise rules that are outlined in the document "A Guide to Noise Control in Minnesota." The guide provides that the Project is limited to 50 dBA at the nearest noise-sensitive areas (i.e., residences), as the Project is expected to operate during both daytime and nighttime hours.

Based on the current Project design, using expected base-package equipment sound levels, Project sound levels have been modeled. Predicted sound levels are shown in this report and are compared to the Minnesota noise limits. The Project, as modeled, is predicted to meet the MPCA nighttime limits at the nearest residential receptors.

# 1.0 Acoustic Terminology

The term "sound level" is often used to describe two different sound characteristics: sound power and sound pressure. Every source that produces sound has a sound power level (PWL). The PWL is the acoustic energy emitted by a sound source and is an absolute number that is not affected by the surrounding environment. The acoustic energy produced by a source propagates through media as pressure fluctuations. These pressure fluctuations, also called sound pressure levels (SPL), are what human ears hear and microphones measure.

Sound is physically characterized by amplitude and frequency. The amplitude of sound is measured in decibels (dB) as the logarithmic ratio of a sound pressure to a reference sound pressure (20 micropascals). The reference sound pressure corresponds to the typical threshold of human hearing. To the average listener, a 3-dB change in a continuous broadband sound is generally considered "just barely perceptible"; a 5-dB change is generally considered "clearly noticeable"; and a 10-dB change is generally considered a doubling (or halving, if the sound is decreasing) of the apparent loudness.

Sound waves can occur at many different wavelengths, also known as the frequency. Frequency is measured in hertz (Hz) and is the number of wave cycles per second that occur. The typical human ear can hear frequencies ranging from approximately 20 to 20,000 Hz. Normally, the human ear is most sensitive to sounds in the middle frequencies (1,000 to 8,000 Hz) and is less sensitive to sounds in the lower and higher frequencies. As such, the A-weighting scale was developed to simulate the frequency response of the human ear to sounds at typical environmental levels. The A-weighting scale emphasizes sounds in the middle frequencies and de-emphasizes sounds in the low and high frequencies. Any sound level to which the A-weighting scale has been applied is expressed in A-weighted decibels, or dBA. For reference, the A-weighted sound pressure level and subjective loudness associated with some common sound sources are listed in Table 1-1. The C-weighting scale has more of an emphasis on low frequency content than the A-weighting scale and is generally used to describe the low frequency characteristics of sound levels (e.g., "rattling" or "rumbling" associated with sound levels).

Sound in the environment is constantly fluctuating, as when a car drives by, a dog barks, or a plane passes overhead. Therefore, sound metrics have been developed to quantify fluctuating environmental sound levels. These metrics include the exceedance sound level. The exceedance sound level is the sound level exceeded during "x" percent of the sampling period and is also referred to as a statistical sound level. Common exceedance sound level values are the 10-, 50-,90-percentile exceedance sound levels, denoted by $L_{10}$, $L_{50}$, and $L_{90}$. The equivalent continuous sound level ($L_{eq}$) is the arithmetic average of the varying sound over a given time period and is the most common metric used to describe sound.

## Table 1-1: Typical Sound Pressure Levels Associated with Common Sound Sources

| Sound Pressure Level (dBA) | Subjective Evaluation | Environment |
|---|---|---|
| 140 | Deafening | Jet aircraft at 75 feet |
| 130 | Threshold of pain | Jet aircraft during takeoff at a distance of 300 feet |
| 120 | Threshold of feeling | Elevated train |
| 110 | Very loud | Jet flyover at 1,000 feet |
| 100 |  | Motorcycle at 25 feet |
| 90 | Moderately loud | Propeller plane flyover at 1,000 feet |
| 80 |  | Diesel truck (40 mph) at 50 feet |
| 70 | Loud | B-757 cabin during flight |
| 60 | Moderate | Air-conditioner condenser at 15 feet |
| 50 | Quiet | Private Office |
| 40 |  | Farm field with light breeze, birdcalls |
| 30 | Very quiet | Quiet residential neighborhood |
| 20 |  | Rustling leaves |
| 10 | Just audible | -- |
| 0 | Threshold of hearing | -- |

Sources:
(1) Adapted from *Architectural Acoustics*, *M. David Egan, 1988*
(2) *Architectural Graphic Standards*, Ramsey and Sleeper, 1994

# 2.0 Applicable Regulations & Criteria

State and local noise regulations were reviewed to determine the applicable Project limits. The Project is located in Scott County, Minnesota, in the City of Shakopee. The MPCA has adopted the States noise rules that are outlined in the document "A Guide to Noise Control in Minnesota"[1]. The MPCA's limits are based on statistical calculations over a one-hour period. As presented in the Guide:

> The statutory limits for a residential location are $L_{10}$ = 65 dBA and $L_{50}$ = 60 dBA during the daytime (7:00 a.m. – 10:00 p.m.) and $L_{10}$ = 55 dBA and $L_{50}$ = 50 dBA during the nighttime (10:00 p.m. – 7:00 a.m.) (Minn. R. 7030.0040). This means that during the one-hour period of monitoring, daytime noise levels cannot exceed 65 dBA for more than 10 percent of the time or 60 dBA more than 50 percent of the time.

The sound level limits for all noise area classifications (NAC) are presented in Table 2-1 below. Based on the MPCA's rules, the Project is limited to 50 dBA $L_{50}$ at the nearest residential properties (NAC 1), 65 dBA $L_{50}$ at the nearest commercial properties (NAC 2), and 75 dBA $L_{50}$ at the nearest manufacturing or agricultural properties (NAC 3), as the Project could operate at any hour of the day or night.

### Table 2-1: MPCA Sound Level Limits

| Noise Area Classification | Classification Summary | Daytime (dBA) | | Nighttime (dBA) | |
|---|---|---|---|---|---|
| | | $L_{10}$ | $L_{50}$ | $L_{10}$ | $L_{50}$ |
| 1 | Noise Sensitive Areas | 65 | 60 | 55 | 50 |
| 2 | Commercial | 70 | 65 | 70 | 65 |
| 3 | Manufacturing/Agriculture | 80 | 75 | 80 | 75 |

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[1] https://www.pca.state.mn.us/sites/default/files/p-gen6-01.pdf

# 3.0 Ambient Sound Level Measurements

Ambient measurements were collected near the nearest residential properties to the south of the Project in 2022 as part of a different project in the area. The sound level measurements were collected to establish the existing ambient sound levels in the area of the residential properties. Sound level measurements were made using sound level meters that met the American National Standards Institute (ANSI) S1.4 requirements for a Type 1 Precision Sound Level Meter. One-half inch random-incidence microphones were used on the meters. Microphone windscreens were used for all measurements. The sound level meters were calibrated before and after each set of measurements using a sound level calibrator.

Ambient sound level measurements were collected at two measurement points (MP) as identified in Figure A-1 of Appendix A. MPs were selected to be near the closest residential properties. The microphones were located at a height of 5 feet (1.5 meters) above the ground, mounted on tripods. Each MP was free from excess reflections due to walls, columns, etc., and from significant shadowing effects. The sound levels varied at each MP due to the extraneous sounds that occurred during the measurement. Highway traffic noise was the dominant sound source during the measurement period.

Sound measurements were completed when weather conditions were favorable for conducting noise measurements. There was no precipitation during the times when measurements were being collected. The average $L_{50}$ and $L_{10}$ sound levels measured at each MP are provided below in Table 3-1. Highway traffic noise dominated the sound levels at both measurement locations.

Table 3-1: Measured Sound Levels

| Measurement Point | $L_{50}$ Ambient Daytime (dBA) | $L_{50}$ Ambient Nighttime (dBA) | $L_{10}$ Ambient Daytime (dBA) | $L_{10}$ Ambient Nighttime (dBA) |
|---|---|---|---|---|
| MP1 | 66 | 64 | 69 | 68 |
| MP2 | 74 | 70 | 77 | 74 |

# 4.0 Modeled Sound Levels

Operational sound levels for the proposed Project were performed using the Computer Aided Noise Abatement (CadnaA) modeling software. Equipment sound levels used for modeling were based on a combination of provided data for the battery storage packs and medium voltage transformers, and estimated data for the auxiliary transformers. This model was used for determining expected sound levels due to the Project at the neighboring residential receptors.

## 4.1 Sound Modeling Methodology and Input Parameters

Predictive noise modeling was performed using the industry-accepted sound modeling software CadnaA, version 2025. The software is a scaled, three-dimensional program, which considers air absorption, terrain, ground absorption, and reflections and shielding for each piece of noise-emitting equipment. It predicts sound pressure levels at discrete locations and over a gridded area based on input source sound levels. The model calculates sound propagation based on International Organization for Standardization (ISO) 9613-2:2024, General Method of Calculation. ISO 9613-2 assesses the sound level propagation based on the octave band center-frequency range from 31.5 to 8,000 Hz.

The ISO standard considers sound propagation and directivity. The sound-modeling software calculates omnidirectional, downwind sound propagation, in tandem with user-specified directivities and propagation properties. Empirical studies accepted within the industry have demonstrated that modeling may over-predict sound levels in certain directions, and as a result, modeling results generally are considered a conservative measure of the Project's actual sound level.

The modeled atmospheric conditions were assumed to be calm, and the temperature and relative humidity were left at the program's default values. Reflections and shielding were considered for sound waves encountering physical structures. Sound levels around the site can be influenced by the sound reflections from physical structures onsite. The area surrounding the Project has mild elevation changes, which scatter and absorb the sound waves. Thus, terrain was included to account for surface effects such as ground absorption. Average ground absorption for the Project site and surrounding bodies of water was set to a value of 0.0 to account for the hard pavements and reflective water. Average ground absorption for the surrounding land area was set to a value of 0.5 to account for the combination of generally soft vegetative ground and industrial areas surrounding the Project site. Foliage was not included in the model and instead was captured by the 0.5 average ground absorption, as to not overestimate attenuation during the fall/winter months when the trees aren't as dense with foliage. The modeling assumptions are outlined in Table 4-1. This model is exclusive of noise sources not associated with the Project (e.g., existing industry, traffic noise and local fauna). Only Project sound levels have been evaluated.

Table 4-1: Sound Modeling Parameters

| Model Input | Parameter Value |
|---|---|
| On-site & Lake Ground Absorption | 0.0 |
| Surrounding Land Ground Absorption | 0.5 |
| Number of Reflections | 2 |
| Receptor Height | 5 feet above grade |
| Terrain | USGS topographic land data |
| Temperature | 50 °F |
| Humidity | 70% |

## 4.2 Project Acoustical Design

The Project general arrangement is included as Figure A-2 of Appendix A. The Project is expected to include:

- 128 – Power Titan 2.0 4H-HX
- 32 – medium voltage transformers
- 2 – auxiliary transformers
- 1 – substation transformer

Sound levels for the Power Titan BESS containers and medium voltage transformers are based on supplier provided sound level data for the equipment packages. The auxiliary transformers' sound levels have been estimated based on in-house sound level calculations based on the unit's rated system voltage. The substation transformer's sound levels are based on industry-accepted internal sources. No additional mitigation options beyond base design have been included in the noise model. All modeled equipment sound levels are included in Appendix B.

## 4.3 Model Results

Project sound levels were modeled for normal operation, assuming a 35 degrees Celsius ambient temperature with maximum BESS cooling power of 100%. The acoustic model results are for the BESS Project operations and do not include any contributions from existing ambient sound sources. The predicted A-weighted sound level contours are shown in Figures A-3 of Appendix A. The Project sound levels predicted at the nearest residential receptors are provided in Table 4-2. The most significant noise contributor from the Project are the Power Titan BESS containers.

Table 4-2: Model Predicted Sound Levels (Base Design)

| Receiver Location | Receiver Description | Distance from Project to Receptor | Coordinates (UTM Zone 15) | | MPCA Sound Level Limit | Modeled Project Sound Level |
|---|---|---|---|---|---|---|
| | | | Easting (m) | Northing (m) | dBA | dBA |
| R1 | Residence | 2,000 feet | 466,466 | 4,958,827 | 50 | 50 |
| R2 | Residence | 2,100 feet | 465,982 | 4,958,905 | 50 | 50 |

Ambient sound levels measured near the residential receptors are detailed in Section 3. The average nighttime sound level at MP1, which is close to R1 and R2, was 64 dBA $L_{50}$. The sound due to highway traffic noise at the nearest residential locations is significantly louder than the modeled Project contributions of 50 dBA $L_{50}$. When an area has high ambient sound levels that are 10-15 dBA above Project contributions, most of the Project sound is generally masked at receptors. Mitigation in the form of low-noise equipment or sound walls could be implemented to reduce Project noise offsite. However, mitigating the Project would not lower the experienced sound levels at the residential receptors, as the highway traffic noise would still be dominant with or without the Project installed.

# 5.0 Conclusion

Burns & McDonnell completed a sound study for the Xcel Energy Blue Lake BESS, located in Scott County, Minnesota. The study included a review of the applicable noise regulations for the Project and acoustical modeling to estimate Project sound levels at neighboring residential properties.

The Project is required to meet the applicable sound level limits set by the MPCA as outlined in their guidance document. Project sound levels have been modeled for BESS operations using conservative assumptions (i.e., full cooling power and downwind sound propagation). The model is based on vendor-provided sound level data for the Project equipment. The Project, as modeled, is predicted to meet the MPCA nighttime limits of 50 dBA $L_{50}$ at the nearest residential properties.

Review of previously measured ambient sound level data shows that the traffic noise generated by the highway at the nearest residential receptors south of the Project is significantly greater than the modeled noise impacts from the Project.

# APPENDIX A – FIGURES

**LEGEND**

| | |
|---|---|
| ● | Measurement Points |
| 🟦 | Project Structures |
| ⬜ | Project Area |

**REFERENCE**

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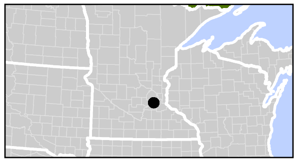
MILES

0 0.07 0.14
KILOMETERS

N



## Figure A-1
## Measurement Points

**LOCATION:** Scott County, MN
**PROJECT:** Excel Energy - Blue Lake BESS
**PROJ. NO.:** 182179
**CREATED:** 06/13/2025

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**LEGEND**

- 🟦 Project Structures
- ⬜ Project Area

**REFERENCE**

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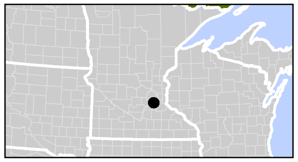
0 0.03 0.05
KILOMETERS

N



## Figure A-2
## Project General Arrangement

**LOCATION:** Scott County, MN
**PROJECT:** Excel Energy - Blue Lake BESS
**PROJ. NO.:** 182179
**CREATED:** 06/13/2025

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**LEGEND**

| | | | | | |
|---|---|---|---|---|---|
| ▇ | Project Structures | — | 40 dBA | — | 55 dBA |
| ▇ | Project Area | — | 45 dBA | — | 60 dBA |
| ● | NSA Receptors | — | 50 dBA | — | 65 dBA |

**REFERENCE**

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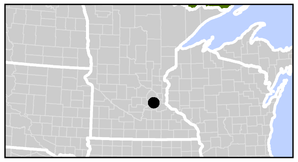
0 0.1 0.2
KILOMETERS

N



## Figure A-3
## Base Design Sound Level Contours (dBA)

**LOCATION:** Scott County, MN
**PROJECT:** Excel Energy - Blue Lake BESS
**PROJ. NO.:** 182179
**CREATED:** 06/13/2025

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# APPENDIX B – MODELED SOUND LEVELS

# Appendix B - BESS Modeled Sound Power Levels

**Xcel Energy**

Blue Lake BESS Project

| | | Sound Power Level (dB)[1] Octave Band Frequency (Hz) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Name** | **Number of Sources** | **31.5** | **63.0** | **125** | **250** | **500** | **1000** | **2000** | **4000** | **8000** | **Overall (dBA)** | **Notes[2]** |
| **BESS Equipment** | | | | | | | | | | | | |
| Power Titan 2.0 BESS Container | 128 | 93 | 88 | 87 | 99 | 103 | 98 | 95 | 88 | 80 | 102 | Vendor Study |
| MV Transformer | 32 | | 90 | 91 | 93 | 87 | 82 | 79 | 73 | 65 | 89 | Vendor Study |
| Auxillary Transformer | 2 | 72 | 78 | 80 | 75 | 75 | 69 | 64 | 59 | 52 | 75 | Calculated from Power Rating[2] |
| Substation Transformer | 1 | 103 | 109 | 111 | 106 | 106 | 100 | 95 | 90 | 83 | 107 | Industry-Accepted Source[3] |

Notes:

1. All sound levels are based on expected base design equipment (i.e., no additional mitigation beyond base design)

2. NEMA ratings used for estimated frequency spectral data

3. Referenced from B&H Noise Control

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