American Pharaoh Battery Energy Storage
Noise Assessment

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Abbreviations

AC	Alternating current
Black Mountain	Black Mountain Energy Storage II LLC
BESS	Battery energy storage system
dB	Decibel
dB(A) or dBA	Decibel (A-weighted)
dB(C) or dBC	Decibel (C-weighted)
DC	Direct current
GA	Ground absorption
Hz	Hertz
L_{eq}	Equivalent continuous sound level
L_{10}	Sound level exceeded for 10% of the time
L_{50}	Sound level exceeded for 50% of the time
L_{90}	Sound level exceeded for 90% of the time
L_{max}	Maximum sound level
L_{min}	Minimum sound level
MVA	Megavolt-ampere
MW	Megawatt
Project	American Pharaoh Battery Energy Storage Facility
PV	Photovoltaic
PWL	Sound power level
SLM	Sound level meter
SPL	Sound pressure level

Executive Summary

Black Mountain Energy Storage II LLC (Black Mountain) is proposing to construct the American Pharaoh Battery Energy Storage Facility (Project). The Project is located in the City of Milwaukee, Wisconsin and will consist of a 300-megawatt (MW) battery energy storage system (BESS) facility. Black Mountain retained the services of Stantec Consulting Services Inc. (Stantec) to conduct a noise assessment for the Project.

This noise assessment was completed to assess Project operational compliance with the City of Milwaukee noise regulations. The noise study included ambient noise monitoring to establish existing nighttime ambient noise levels at residences near the facility and operational noise modeling to estimate noise levels generated by the Project equipment. Operational noise levels were predicted using the CadnaA acoustical modeling software, configured to implement ISO 9613-2 environmental sound propagation algorithms. The modeling accounted for noise from the proposed BESS battery containers, inverters, and substation transformers based on manufacturer-provided data.

The maximum Project-generated noise level at the nearest residences was estimated to be an equivalent continuous sound level (Leq) of 54 A-weighted decibels (dBA) during daytime and nighttime periods. The noise assessment results demonstrate that the Project can be operated in compliance with the City of Milwaukee noise limits with the implementation of the noise mitigation described in this report.

The equipment types, quantities, and locations used for this noise assessment are based on preliminary Project layout and equipment selection details provided by Black Mountain. Final equipment selection will determine the amount of noise mitigation needed to meet the City of Milwaukee noise limits. It is recommended that equipment noise emission levels be confirmed, and noise mitigation requirements be reassessed during the final design and equipment selection process.

1.0 Project Description

Black Mountain Energy Storage II LLC (Black Mountain) is proposing development of the American Pharaoh battery energy storage facility (Project) in Milwaukee, Wisconsin. The Project is a proposed 300-megawatt (MW) battery energy storage system (BESS) facility. The Project equipment will include battery containers, inverters, and a substation with power transformers.

The facility will be constructed on a parcel bounded by W Bender Avenue to the north, the Granville Substation to the east, a railroad corridor to the south, and N 84th Street to the west. Land use surrounding the Site is residential to the north and west and industrial to the south and east. **Figure 1** displays the Project components and surrounding area.

The operational sound sources from the Project include BESS facility battery containers, inverters, and substation transformers. The Project BESS facility is anticipated to include 416 battery containers and 104 inverters that will operate at full capacity during some daytime and nighttime hours. The Project will include two power transformers located within the substation footprint. The substation transformers are also expected to operate at full capacity during some daytime and nighttime hours. Equipment is not expected to operate at full capacity continuously during daytime or nighttime periods. The BESS facility operations will vary depending on the needs for electrical grid balancing.

2.0 Sound Terminology

Sound is caused by vibrations that generate waves of minute pressure fluctuations in the surrounding air. Sound levels are measured using a logarithmic decibel (dB) scale. Human hearing varies in sensitivity for different sound frequencies, and the frequency sensitivity changes based on the overall sound level. The ear is most sensitive to sound at frequencies between 800 and 8,000 hertz (Hz) and is least sensitive to sound at frequencies below 400 Hz or above 12,500 Hz. Consequently, several different frequency weighting schemes have been used to approximate the way the human ear responds to various frequencies at different sound levels. The A-weighted decibel, or dBA, scale is the most widely used for regulatory requirements, as it discriminates against low frequency noise similar to the response of the human ear at the low to moderate sound levels typical of environmental sources. Sound levels without a frequency weighting applied, referred to as unweighted or linear, are generally reported as dB or dBZ. Noise is typically defined as unwanted sound and the terms “noise” and “sound” are used interchangeably in this report.

The sound power level (PWL) of a noise source is the strength or intensity of noise that the source emits regardless of the environment in which it is placed. Sound power is a property of the source, and therefore is independent of distance. The radiating sound power then produces a sound pressure level (SPL) at a distance where human beings can perceive it as audible sound. The sound pressure level is dependent on the acoustical environment (e.g., indoor, outdoor, absorption, reflections) and the distance from the noise source. Unless otherwise stated, sound levels in this report are sound pressure levels.

Broadband (overall) sound levels which are expressed as a single number in decibels, account for acoustical energy across the frequency spectrum, including energy at low, middle, and high frequencies. To assess how much acoustical energy is present in different ranges of the frequency spectrum, noise can be separated into spectral (frequency) components using octave band filters. For environmental noise assessments, octave band noise levels are often expressed in unweighted decibels (dB) at octave band center frequencies from 31.5 to 8,000 Hz.

Numerous metrics and indices have been developed to quantify the temporal characteristics (changes over time) of community noise. The equivalent continuous sound level, L_{eq}, metric is the level of a hypothetical steady sound that would have the same energy as the fluctuating sound level over a defined period of time. The L_{eq} represents the time average of the fluctuating sound pressure level. The maximum and minimum sound levels, or L_{max} and L_{min}, are the loudest and quietest instantaneous sound levels occurring during a period of time. The L_{max} is particularly useful for evaluating loud, impulsive noise events.

Other statistical metrics useful to understanding environmental sound levels include the n-percent exceedance sound percentile levels, or L_n. This report includes the L_{10}, L_{50}, and L_{90} metrics. The L_{10} metric is the noise level that is exceeded 10% of the time and is often used to assess impact from transportation or construction noise sources. The L_{50} metric is the noise level that is exceeded 50% of the time and represents the statistical mid-point of fluctuating noise levels. The L_{90} metric is the noise level that is exceeded 90% of the time and is generally considered to be representative of the steady background or ambient noise environment.

A change in sound levels of 3 decibels is generally considered to be the threshold of perception, whereas a change of 5 decibels is clearly perceptible, and a change of 10 decibels is perceived as a doubling or halving of loudness. Each time the number of noise sources is doubled or halved, logarithmic addition (or subtraction) of decibels results in a 3 decibel change in sound levels.

3.0 Regulatory Environment

State, county, and local regulations were reviewed. State of Wisconsin and Milwaukee County noise regulations that would be applicable to the Project were not identified.

The City of Milwaukee (City) Code of Ordinances, Volume 1, Chapter 80, Subchapter 2: Noise Control (City Noise Ordinance) includes noise regulations that would apply to the Project. Section 80-64.1 of the City Noise Ordinance establishes daytime (7 a.m. – 9 p.m.) and nighttime (9 p.m. – 7 a.m.) noise limits depending on the zoning district (i.e., land use) of the property where the noise is received. The noise limits apply at the lot line of the receiving property and are established as noise rating (NR) numbers, as shown in **Figure 2**.

Figure 2. City of Milwaukee Noise Limits[1]

DISTRICT	NOISE RATING NUMBER DAY	NIGHT
Residential Districts	55	45
Neighborhood Shopping	55	45
Other Commercial Districts	60	50
Downtown Districts	60	60
Industrial Districts	65	55
Parks	55	45
Institutional	55	45
Planned Development adjacent to an IH or IM district	65	55
Other Planned Development	55	45

The noise rating numbers are not expressed in decibels. ISO Recommendation ISO/R 1996-1971[2] details noise rating curves that correspond to noise rating numbers. These curves show octave band noise levels in unweighted decibels (dB) between the 31.5 and 8,000 Hz octave bands for each noise rating number. Using these curves, the noise rating numbers in the City Noise Ordinance can be correlated to dB noise limits for each octave band. If the Project-generated noise level is below the noise limit in each octave band, then the noise rating number of the Project-generated noise will comply with the City of Milwaukee noise limits.

The zoning districts surrounding the Project are residential and industrial. As the Project equipment is expected to operate at night, the nighttime noise limits for the residential district are the most restrictive noise limits that apply to the Project and will be used as the basis for the compliance assessment.

The octave band noise levels that correspond to the nighttime NR 45 noise rating are shown in **Table 3.1.** The corresponding broadband A-weighted noise level is also shown in **Table 3.1**; however, the applicable noise limits are the octave band noise levels.

Table 3.1. City of Milwaukee Nighttime Noise Limits at Residential Lot Lines

Period	Noise Rating	Noise Limit (dB) at Octave Band Center Frequency (Hz)									Broadband Noise Level (dBA)
		31.5	63	125	250	500	1000	2000	4000	8000	
Nighttime	45	86	71	61	54	49	45	42	40	38	54

[1] City of Milwaukee Code of Ordinances, Volume 1, Chapter 80, Subchapter 2, Section 80-64.1.

[2] The reference for the noise rating curves cited in the City Noise Ordinance is “ISO/TC 43, Secretariat – 139, August 1961, Table I”. This reference was not able to be obtained; however, the ISO noise rating curves are standard curves for rating interior noise levels (most community used in the U.K.) and the noise rating curve values used for this assessment were found to be consistent with those of several other sources.

Section 80-64.2 of the City Noise Ordinance states that "Pure tone and impulsive noises are factors. Five noise rating numbers shall be subtracted from the table in sub. 1 if the subject noise consists primarily of a pure tone or if it is impulsive in character." Based on the results of the noise modeling discussed in Sections 6 and 7, the primary Project noise source is expected to be the BESS battery container equipment. The noise from this equipment is typically generated by fans in the battery container ventilation system. Ventilation fan noise is broadband in character, rather than tonal. Project noise sources are also not impulsive.

Section 80-64.3 of the City Noise Ordinance further states that "Ambient noise is a factor. The subject noise must exceed the ambient noise by 5 dB or more, in any octave band, to be declared excessive." This clause is interpreted as stating that the Project-generated noise level in any octave band is not considered to be in violation of the octave band noise limits established by the noise rating curves if it is 4 dB or less above the ambient noise level in that same octave band. Ambient noise measurements were conducted for the Project to document nighttime ambient noise levels and establish a Project-generated noise design goal to demonstrate compliance with the City Noise Ordinance. The ambient measurements and their use to further define the assessment criteria are discussed in Section 4 and presented in **Table 4.3**.

4.0 Pre-Construction Ambient Noise Measurements

Pre-construction ambient noise measurements were completed at two measurement locations on August 30th, August 31st, and September 1st, 2023. The goal of the measurements was to establish nighttime ambient noise levels in the vicinity of the facility for assessment of compliance with the City Noise Ordinance.

City Noise Ordinance Section 80-65.2 was considered in selection of measurement locations. Measurements were taken in locations representative of ambient noise levels at residential lot lines adjacent to the facility, at a height of approximately 5 feet above ground, and in open areas without nearby acoustically reflective surfaces (e.g.: walls, barriers.) **Table 4.1** describes the noise measurement locations, which are also shown on **Figure 1**.

Table 4.1 Noise Measurement Locations

Measurement Site	Lat	Long	Site Description and Observations
M-1	43.131650°	-88.012298°	Represents the residential neighborhood directly north of the BESS facility. Measurement site was located near the northern boundary of the Project parcel to the south of residences (near residential lot line). Audible noise sources included distant roadway traffic, occasional trains with horn soundings, and residents outdoors at the apartment buildings to the north.
M-2	43.130074°	-88.015155°	Represents the residential neighborhood directly west of the BESS facility. Measurement site was located near the western boundary of the Project parcel to the east of residences. The measurement location was setback slightly further from N 84th St. than the residences to the west. Audible noise sources included local roadway traffic on N 84th St. and occasional trains with horn soundings.

Continuous unattended noise measurements were completed during the nighttime period from 9 p.m. to 7 a.m. starting on August 30th at site M-1 and on August 31st at site M-2. A Larson Davis Model 831 sound level meter (SLM) was used to measure unweighted and A-weighted one-third octave band and broadband sound pressure levels in the L_{eq}, L_{10}, L_{50}, and L_{90} metrics. The SLM was calibrated using a Larson Davis CAL200 acoustical calibrator at the beginning of each measurement period and calibration was checked at the end of each measurement period. The SLM was mounted to a tripod with the microphone positioned approximately 5 feet above ground and covered with a standard windscreen. The SLM and acoustical calibrator meet ANSI Type I requirements[3] [4] and were calibrated by an acoustical laboratory within one year of use. The equipment also meets the requirements of City Noise Ordinance Section 80-65.1. Photos of noise measurement equipment are included in **Appendix B**.

Meteorological data during the measurement period was acquired from Weather Underground[5]. Temperatures ranged from 46-56°F and no precipitation was noted during the measurements. Wind speeds were 12 miles per hour or less at 30 feet above ground throughout the measurement period. Field staff also noted that while on site, wind conditions were calm with very low wind speeds.

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3 ANSI/ASA S1.4-2014/Part 1 / IEC 61672-1:2013. American National Standard for Electroacoustics – Sound Level Meters Part 1: Specifications (reaffirmed by ANSI August 13, 2019).

4 ANSI/ASA S1.40-2006 (R2020) American National Standard Specifications and Verification Procedures for Sound Calibrators (reaffirmed by ANSI, 8 May 2020)

5 [Milwaukee, WI Weather History | Weather Underground (wunderground.com)]

4.1 NOISE MEASUREMENT RESULTS

Measured 1-hour L_{eq}, or $L_{eq}(h)$, ambient noise levels are presented in **Figure 3** for the nighttime period at sites M-1 and M-2. The measurement results show that the hourly noise levels were very similar at both sites during most nighttime hours. **Table 4.2** presents the nighttime L_{eq} noise levels in broadband (dBA) and octave band (dBZ) formats.

Figure 3. Measured L_{eq}(h) Ambient Noise Levels

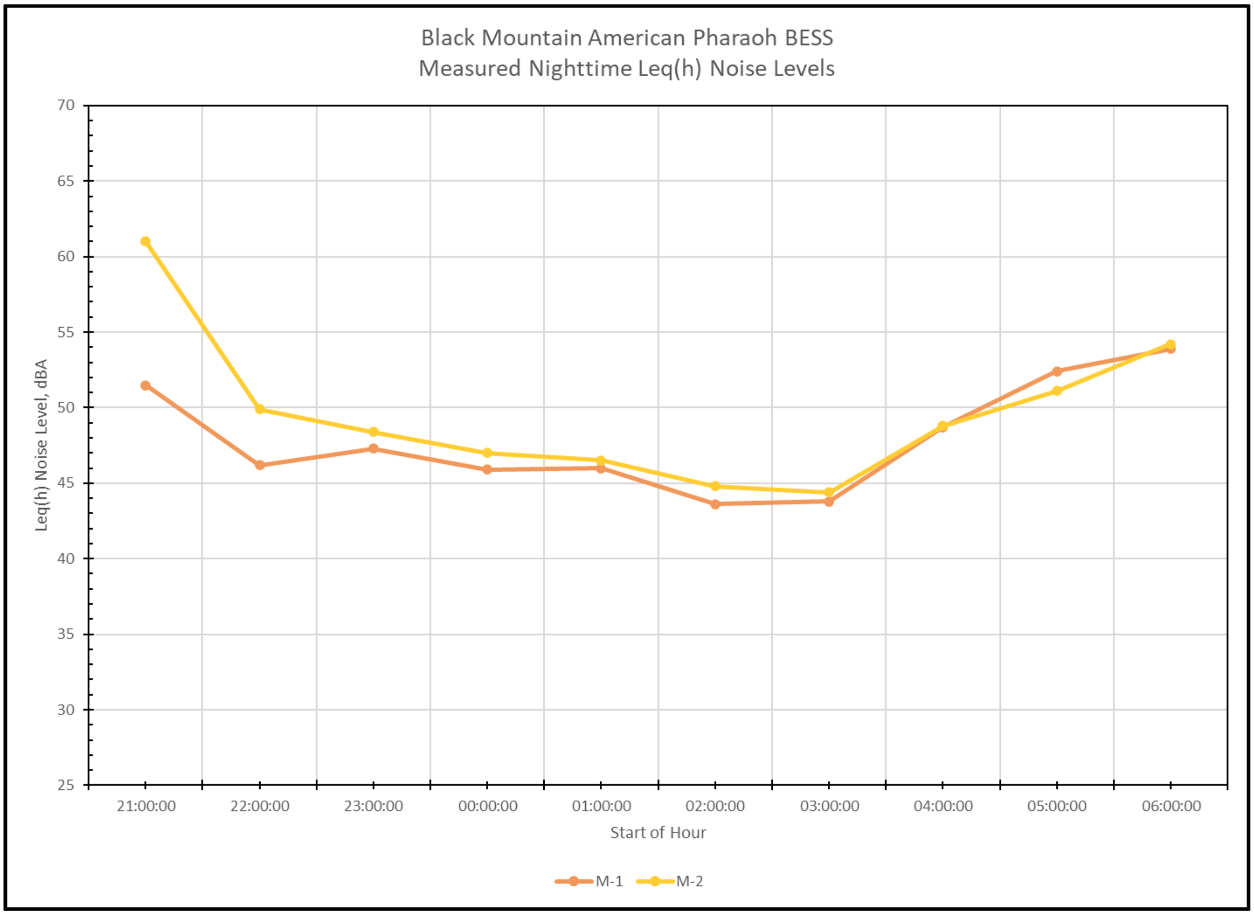


Table 4.2. Measured Nighttime Ambient L_{eq} Noise Level Summary

Site	Noise Level (dB) at Octave Band Center Frequency (Hz)									Broadband Noise Level (dBA)
	31.5	63	125	250	500	1000	2000	4000	8000	
M-1	54	56	52	44	44	46	39	38	26	49
M-2	56	58	53	47	51	48	42	40	29	53
M-1 and M-2 Average	55	57	53	46	49	47	41	39	27	51

The average measured nighttime ambient noise levels from Sites M-1 and M-2 were then used to calculate the project-generated noise design goal based on the ambient noise consideration in the City Noise Ordinance (see Section 3). **Table 4.3** shows that the Project-generated noise design goal (row 3) was calculated by selecting the measured ambient noise level plus 4 dB (row 2) as the design goal for a given octave band, if it was higher than the City of Milwaukee nighttime noise limit (row 1).

Table 4.3. Calculation of Project-Generated Noise Design Goal

Description	Noise Level (dB) at Octave Band Center Frequency (Hz)								
	31.5	63	125	250	500	1000	2000	4000	8000
Milwaukee Nighttime Noise Limit	86	71	61	54	49	45	42	40	38
Measured Ambient + 4 dB	59	61	57	50	53	51	45	43	31
Project-Generated Noise Design Goal	86	71	61	54	53	51	45	43	38

The Project-generated noise design goal identified in **Table 4.3** are the octave band noise levels that would meet the requirements of the City Noise Ordinance and have been used to evaluate compliance in this assessment. The noise design goals are based on the City of Milwaukee nighttime residential noise rating curves with an adjustment applied to account for the measured nighttime ambient octave band noise levels, in accordance with the City Noise Ordinance.

5.0 Noise Receptor Locations

Publicly available aerial imagery was utilized to establish noise receptors, or locations where noise levels are evaluated, at the Project property lines and at the nearest residential property lines on each side of the facility. Receptor locations are shown on **Figure 1** with coordinates provided in **Appendix A**.

Receptors R-1, R-5, and R-6 represent the western, eastern, and southern Project property lines. Receptors R-2, R-3, R-4, R-7, and R-8 represent the nearest residential property lines to the Project in each direction and are the locations where compliance with the City Noise Ordinance was assessed in this study.

6.0 Noise Modeling Methodology

The Project, as currently proposed, includes 416 battery containers, 104 inverters, and two substation transformers at the locations shown on **Figure 1**. These are the primary operational noise sources associated with the Project. The equipment types, quantities, and locations used for this noise assessment are based on preliminary Project layout and equipment selection details provided by Black Mountain. It is recommended that equipment noise emission levels and octave band spectra be confirmed, and the noise analysis updated as part of the final design and equipment selection process.

The Project is expected to include 416 BYD MC Cube battery containers. Each battery container was modeled with an unmitigated sound power level of 96 dBA. The equipment sound power level was estimated based on available manufacturer information indicating that the sound pressure level at 1 meter from each unit is 75 dBA. Octave band noise level data for the BESS battery units was not available from the manufacturer. Octave band noise levels were estimated based on typical spectra from noise testing reports of BESS battery units from other manufacturers.

The Project is expected to include 104 SMA 4600 UP-US inverter stations. Each inverter station was modeled with an unmitigated sound power level of 93 dBA based on manufacturer noise testing data. The octave band equipment sound power level values provided in the manufacturer noise testing report were utilized for noise modeling.

The Project substation is expected to include two 165 megavolt-ampere (MVA) power transformers. The NEMA TR-1 standard[6] was used to estimate a transformer NEMA noise rating of 82 dBA for the forced-air cooling (ONAF) condition with fans operating. Methods from the Electric Power Plant Environmental Noise Guide[7] were then used to estimate an unmitigated overall sound power level of 102 dBA and the octave band spectra.

The unmitigated equipment sound power levels used for the noise assessment are presented in **Table 6.1**. Equipment noise mitigation measures that are anticipated to be needed to meet the applicable noise limits are discussed in Section 7.

[6] National Electrical Manufacturers Association (NEMA) Standards Publication TR 1-2013 (R2019). Transformers, Step Voltage Regulators and Reactors.

[7] Edison Electric Institute. Electric Power Plant Environmental Noise Guide. Volume 1 2nd Edition.

Table 6.1. Unmitigated Equipment Sound Power Levels

Equipment	Octave Band Sound Power Level (dB)									Broadband Sound Power Level (dBA)
	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	
BESS Battery Unit BYD MC Cube	96	90	95	95	94	90	88	85	79	96
BESS Inverter SMA 4600 UP-US	88	92	90	89	89	84	81	88	85	93
Substation Transformer 165 MVA	98	104	106	101	101	95	90	85	78	102

Sound attenuates between a source and receptor location due to a variety of factors, including but not limited to, distance between source and receptor, atmospheric absorption, ground type, topography, shielding from solid structures, vegetation, and meteorological conditions. Operational noise levels from the proposed Project equipment were estimated using the CadnaA model by Datakustik, which utilizes the ISO 9613-2 standard[8] algorithms for outdoor sound propagation.

A CadnaA Project base model was first developed by importing topographic data from the U.S. Geological Survey National Elevation Dataset and aerial imagery. The site grading was assumed to be flat and at a similar elevation to existing levels based on information provided by Black Mountain. Receptor points were added for the identified receptor locations at five feet above ground.

The substation transformers were modeled as point sources with a height of 9.8 feet (3 meters) above ground. The BESS battery container units and inverters were modeled as area sources within the CadnaA model based on the locations of each type of equipment in the preliminary Project layout. Modeling the battery containers and inverters as area sources is a conservative approach to estimate worst-case operational noise levels because it does not account for additional noise attenuation that is likely to occur from adjacent equipment physically blocking (or shielding) the noise pathway in some instances. The heights of battery container and inverter noise sources were modeled at the top of equipment based on equipment dimensions from the manufacturer data sheets.

Additional assumptions that were used to estimate worst-case operational noise levels included the following:

- A ground absorption value of 0.5 (on a scale of 0.0 representing hard ground or water bodies to 1.0 representing porous ground) was used.
- No sound attenuation from vegetation (foliage) to simulate a worst-case condition when leaves have fallen off trees.

[8] ISO 9613-2: 1996. Acoustics – Attenuation of sound during propagation outdoors. Part 2: General method of calculation.

- Sound attenuation from existing buildings is not accounted for in the model. Land uses with intervening buildings between the location and the facility will receive additional noise attenuation from buildings.
- Meteorological conditions are conducive to sound propagation with all receptors located downwind of all noise sources.

7.0 Estimated Operational Noise Results

An operational noise assessment was completed for the Project battery containers, inverters, and substation transformers. The estimated noise levels represent the “worst-case” condition with facility equipment operating at full capacity, which is expected during some daytime and nighttime hours, depending on the electric grid requirements.

The initial results of the operational noise modeling using unmitigated equipment noise emission levels indicated exceedances of the Project-generated nighttime noise limits shown in **Table 4.3**. Receptor R-2 is the residential property line location with the highest estimated noise levels. A 15 dB exceedance was predicted in the 2,000 Hz octave band at R-2. R-2 represents the property line for residences located directly north of the Project facility. Exceedances were also identified at the other residential property line receptors (R-3, R-4, R-7, and R-8) for the unmitigated condition. Estimated unmitigated noise levels are provided in tabular format in **Appendix A.**

Based on the initial modeling results, noise mitigation measures were assessed to identify the level of noise mitigation needed to meet the Project-generated noise design goal and comply with the City Noise Ordinance. A combination of two types of noise mitigation approaches were identified as likely to be needed: (1) selection of quieter equipment or equipment with additional noise mitigation measures applied so that less noise is generated at the source, and (2) placement of noise barriers adjacent to equipment to reduce the amount of noise that propagates to adjacent residences. **Table 7.1** lists the assumptions that were incorporated into the next version of the noise model to estimate mitigated noise levels.

Table 7.1. Equipment Noise Mitigation

Equipment	Noise Reduction (dB)	Broadband Equipment Sound Power Level with Noise Mitigation (dBA)
BESS Battery Unit BYD MC Cube	9	87
BESS Inverter SMA 4600 UP-US	5	88
Substation Transformer 165 MVA	10	92

Selection of BESS battery container and inverter equipment to meet the mitigated noise emission levels shown above can be achieved through evaluation of multiple vendors during equipment selection, procuring equipment with manufacturer noise control measures (also called sound attenuation kits) incorporated, and/or procuring third party on-equipment noise control measures (e.g.: acoustical silencer or enclosure.)

A 10 dB reduction in substation transformer noise emission levels can typically be achieved by specification of “low-loss” transformers with a NEMA – 10 noise rating.

The noise reduction values shown in **Table 7.1** were primarily determined based on the estimated 2,000 Hz octave band unmitigated noise level at receptor R-2, which required the most attenuation to meet the design goal. The same amount of noise reduction has been assumed for each octave band in this assessment and this is reflected in the mitigated broadband equipment sound power levels shown in **Table 7.1**. Equipment noise mitigation requirements should be reassessed on an octave band basis at the final design and equipment selection stage after confirming equipment noise emission levels and spectra. Tonality of noise sources should also be considered in equipment selection.

In the mitigated analysis three potential noise barriers, shown on **Figure 1**, were modeled adjacent to equipment to provide shielding of BESS battery container and inverter equipment noise at residences to the north and west of the facility. The noise barriers were assumed to be acoustically absorptive and 16 feet tall with a total length of 1,906 feet.

Estimated mitigated noise levels at each receptor location, with the noise mitigation measures described above incorporated into the CadnaA model, are provided in tabular format in **Appendix A**. Sound level contours, which illustrate areas of equal sound level, are displayed on **Figure 1**. The figure presents the expected broadband A-weighted noise levels due to the operation of the Project noise sources with mitigation applied. The sound level contours do not include the contribution of ambient sound levels.

The results show that noise levels generated by the Project are not expected to exceed 54 dBA L_{eq} at the property line of nearby residences (receptors R-2, R-3, R-4, R-7, and R-8). **Table 7.2** compares the estimated octave band noise levels to the Project-generated noise limits at the three residential property line receptors expected to be exposed to the highest noise levels (R-2, R-3, and R-4).

The noise assessment results in **Table 7.2** demonstrate that with noise mitigation measures incorporated, the expected noise levels at the property lines of the residential receptor locations can meet the noise design goal in all octave bands. The results table in **Appendix A** further demonstrates that estimated noise levels at each identified residential property line receptor are expected to comply with the noise design goal. The noise design goal was established to evaluate compliance with the City Noise Ordinance.

8.0 Conclusion

This noise assessment was completed to evaluate operational compliance of the American Pharaoh BESS project with City of Milwaukee noise regulations. An operational noise model was developed and utilized to estimate the noise levels generated by Project equipment, including noise from the proposed BESS battery containers, inverters, and substation transformers. The maximum Project-generated noise level was estimated to be 54 dBA L_{eq} during daytime and nighttime periods at the nearest residences. The noise assessment results demonstrate that the Project can be operated in compliance with the City of Milwaukee noise limits with the implementation of the noise mitigation described in this report.

The equipment types, quantities, and locations used for this noise assessment are based on preliminary Project layout and equipment selection details provided by Black Mountain. Final equipment selection will determine the amount of noise mitigation needed to meet the City of Milwaukee noise limits. It is recommended that equipment noise emission levels be confirmed, and noise mitigation requirements be reassessed during the final design and equipment selection process.

Table 7.2. Compliance Assessment at Nearest Residential Property Line Receptors

Receptor			Description	Octave Band Noise Level (dB)									Broadband
ID	Land Use	Location		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz	8,000 Hz	dBA
R-2	Residential	Property Line	Estimated Nighttime Noise	57	54	54	53	51	49	45	40	20	54
			Nighttime Noise Design Goal	86	71	61	54	53	51	45	43	38	56*
			Nighttime Compliance?	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***N/A****
R-3	Residential	Property Line	Estimated Nighttime Noise	56	54	54	51	51	48	44	37	17	53
			Nighttime Noise Design Goal	86	71	61	54	53	51	45	43	38	56*
			Nighttime Compliance?	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***N/A****
R-4	Residential	Property Line	Estimated Nighttime Noise	55	52	51	50	48	44	38	31	9	49
			Nighttime Noise Design Goal	86	71	61	54	53	51	45	43	38	56*
			Nighttime Compliance?	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***N/A****

* Broadband noise level included for reference only. City of Milwaukee noise ordinance does not include broadband noise limits.

Figure 1

Noise Measurement Sites, Receptors, and Operational Noise Results

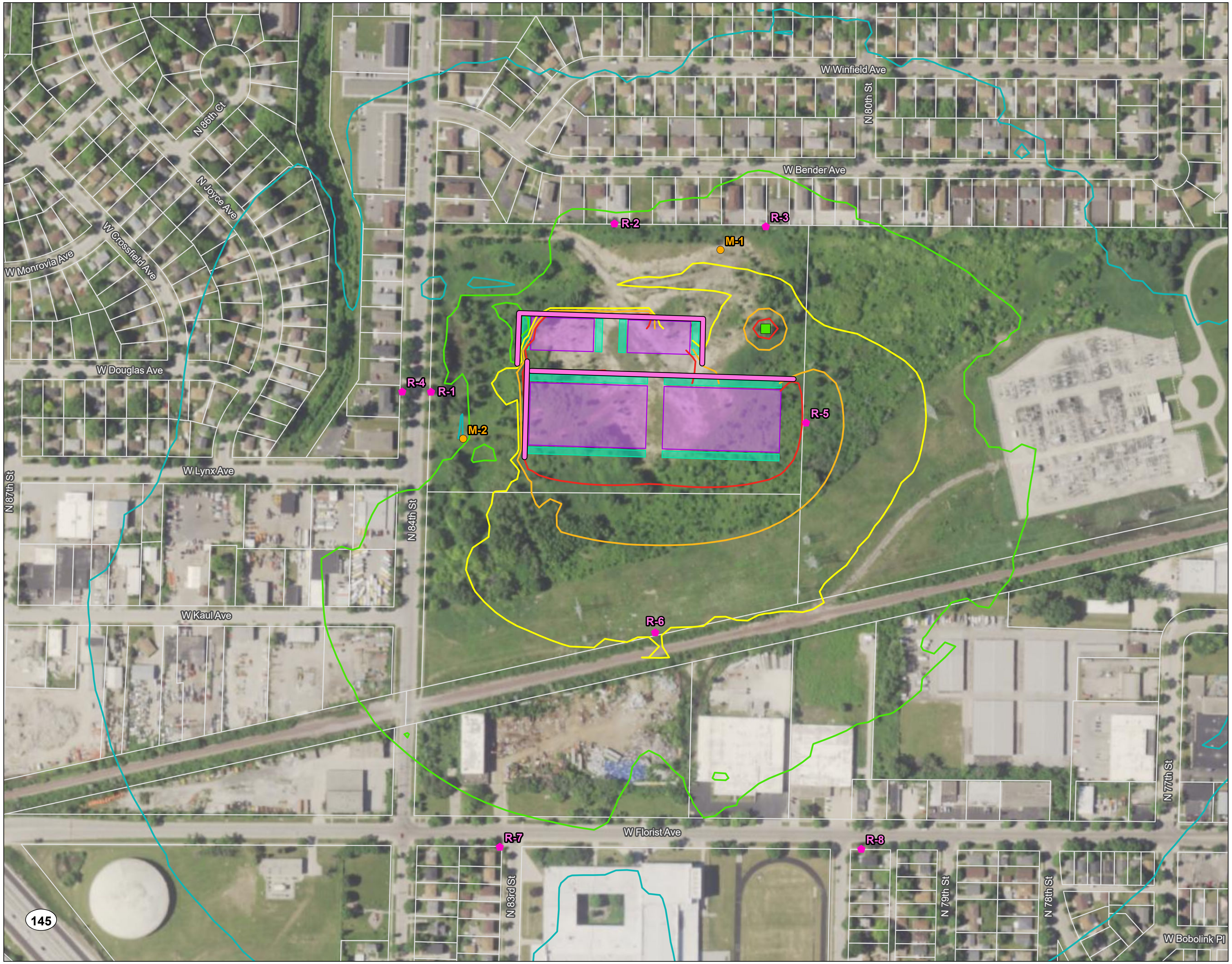


Figure No.
1

Title
Noise Measurement Sites, Receptors, & Operational Noise Results

Client/Project 227706250
Black Mountain Energy Storage II LLC
American Pharaoh BESS
Noise Report

Project Location
T8N, R21E, S28
C. of Milwaukee, Milwaukee Co., WI

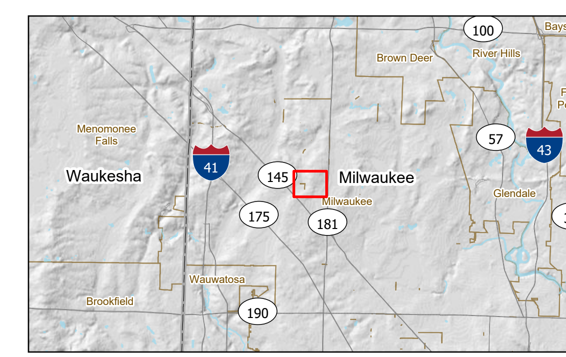
Prepared by JM on 2023-09-11
TR by RA on 2023-09-11
IR by JP on 2023-09-13

N

0 150 300 Feet
(At original document size of 11x17)
1:3,600

Legend
- BESS Inverter
- BESS Battery Container
- Parcel Boundary
- Substation Transformer
- Measurement Site
- Sensitive Receptor
- Potential Noise Barrier

Mitigated Noise Contour (dBA)
- 40
- 45
- 50
- 55
- 60
- 65



Notes
1. Coordinate System: NAD 1983 UTM Zone 16N
2. Data Sources: Stantec, Black Mountain Energy Storage II, WisDOT, WDNR, SCO
3. Background: 2022 NAIP

Stantec

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Appendix A

Receptor Locations and Operational Noise Results

Appendix A American Pharaoh BESS Project - Receptor Locations and Operational Noise Results

Table A.1. Unmitigated Project Noise Level

Receptor ID	Location	Project Leq Noise Level										X	Y	Z
		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz	8,000 Hz	Broadband	(UTM 16N)	(UTM 16N)	
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dBA	m	m	m
R-1	Facility property line	65	61	62	61	60	57	54	49	33	62	417,401	4,775,803	227
R-2	Residential property line	71	66	67	63	65	63	60	55	39	67	417,569	4,775,956	236
R-3	Residential property line	69	66	66	62	64	61	58	52	33	66	417,707	4,775,953	235
R-4	Residential property line	64	60	61	60	59	56	53	47	30	61	417,375	4,775,803	226
R-5	Facility property line	75	70	72	70	70	68	65	62	52	73	417,743	4,775,774	231
R-6	Facility property line	69	64	65	61	62	60	57	50	29	64	417,606	4,775,583	230
R-7	Residential property line	64	59	58	55	56	54	49	38	-1	58	417,464	4,775,388	232
R-8	Residential property line	61	57	56	53	54	51	47	35	-4	56	417,794	4,775,386	226

Table A.2. Mitigated Project Noise Level

Receptor ID	Location	Project Leq Noise Level										X	Y	Z
		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz	8,000 Hz	Broadband	(UTM 16N)	(UTM 16N)	
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dBA	m	m	m
R-1	Facility property line	56	53	52	51	48	44	38	32	13	49	417,401	4,775,803	227
R-2	Residential property line	57	54	54	53	51	49	45	40	20	54	417,569	4,775,956	236
R-3	Residential property line	56	54	54	51	51	48	44	37	17	53	417,707	4,775,953	235
R-4	Residential property line	55	52	51	50	48	44	38	31	9	49	417,375	4,775,803	226
R-5	Facility property line	66	62	63	61	62	59	57	54	45	64	417,743	4,775,774	231
R-6	Facility property line	59	56	55	52	53	52	48	43	23	56	417,606	4,775,583	230
R-7	Residential property line	54	51	49	46	47	45	41	31	-7	49	417,464	4,775,388	232
R-8	Residential property line	53	49	47	45	46	44	39	29	-10	48	417,794	4,775,386	226

Appendix B

Noise Measurement Photos

Photo B.1. Site M-1 looking south

Photo B.2. Site M-1 looking west

Photo B.3. Site M-2 looking northeast

Photo B.4. Site M-2 looking west