SOUND LEVEL ANALYSIS REPORT

Norwich Road Battery Storage Project
Waterford, Connecticut

Prepared for:

Qcells North America
300 Frank W Burr Blvd. #52
Teaneck, New Jersey 07666

Prepared by:

Epsilon Associates, Inc.
3 Mill & Main Place, Suite 250
Maynard, MA 01754

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1.0 EXECUTIVE SUMMARY

The Norwich Road Battery Storage Project (the Project) is a proposed battery energy storage system (BESS) with a capacity of approximately 4 megawatts (MW) in Waterford, Connecticut. The Project is being developed by Qcells North America (Qcells). Epsilon Associates Inc. (Epsilon) has been retained by Qcells to conduct a sound level analysis for this Project.

The sound level analysis consisted of sound level modeling of operational sound from the proposed facility. The Project will include 4 Tesla Megapack 2 XL energy storage containers and a 4MVA transformer. Computer modeling was used to predict worst-case future L_{eq} sound levels from the Project.

A sound barrier was included in the model as a mitigation option to reduce sound due to the Project in surrounding areas. The highest predicted exterior Project only L_{eq} sound level at a property line modeling location is 55 dBA without the proposed barrier and 47 dBA with the barrier. Modeling indicates that with the sound mitigation discussed in this report, the Project will meet the sound level limits set forth by the State of Connecticut.

2.0 INTRODUCTION

The proposed Project will consist of 4 Tesla Megapack 2 XL energy storage containers and a 4 MVA transformer. The Project has a capacity of approximately 4 MW and will be located in Waterford, Connecticut. This report presents the findings of a sound level modeling analysis to predict sound levels from the Project and comparison to the relevant sections of the Connecticut Department of Energy & Environmental Protection Control of Noise regulations. The Project components were modeled in CadnaA using sound data provided by Qcells. The Project layout and surrounding area are shown in Figure 2-1.

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Norwich Road Battery Storage Project **Waterford, Connecticut**

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Figure 2-1
Aerial Locus

3.0 SOUND TERMINOLOGY

There are several ways in which sound levels are measured and quantified. All of them use the logarithmic decibel (dB) scale. The following information defines the sound level terminology used in this analysis.

The decibel scale is logarithmic to accommodate the wide range of sound intensities found in the environment. A property of the decibel scale is that the sound pressure levels of two or more separate sounds are not directly additive. For example, if a sound of 50 dB is added to another sound of 50 dB, the total is only a 3-decibel increase (53 dB), which is equal to doubling in sound energy, but not equal to a doubling in decibel quantity (100 dB). Thus, every 3-dB change in sound level represents a doubling or halving of sound energy. The human ear does not perceive changes in the sound pressure level as equal changes in loudness. Scientific research demonstrates that the following general relationships hold between sound level and human perception for two sound levels with the same or very similar frequency characteristics[1]:

- 3 dB increase or decrease results in a change in sound that is just perceptible to the average person,
- 5 dB increase or decrease is described as a clearly noticeable change in sound level, and
- 10 dB increase or decrease is described as twice or half as loud.

Another mathematical property of decibels is that if one source of sound is at least 10 dB louder than another source, then the total sound level is simply the sound level of the higher-level source. For example, a sound source at 60 dB plus another sound source at 47 dB is equal to 60 dB.

A sound level meter (SLM) that is used to measure sound is a standardized instrument.[2] It contains "weighting networks" (e.g., A-, C-, Z-weightings) to adjust the frequency response of the instrument. Frequencies, reported in Hertz (Hz), are detailed characterizations of sounds, often addressed in musical terms as "pitch" or "tone". The most commonly used weighting network is the A-weighting because it most closely approximates how the human ear responds to sound at various frequencies. The A-weighting network is the accepted scale used for community sound level measurements; therefore, sounds are frequently reported as detected with a sound level meter using this weighting. A-weighted sound levels emphasize middle frequency sounds (i.e., middle pitched – around 1,000 Hz) and de-emphasize low and high frequency sounds. These sound levels are reported in decibels designated as "dBA". The C-weighting network has a nearly flat response for frequencies between 63 Hz and 4,000 Hz and is noted as dBC. Z-

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1 Bies, David, and Colin Hansen. 2009. *Engineering Noise Control: Theory and Practice*, 4th Edition. New York: Taylor and Francis.

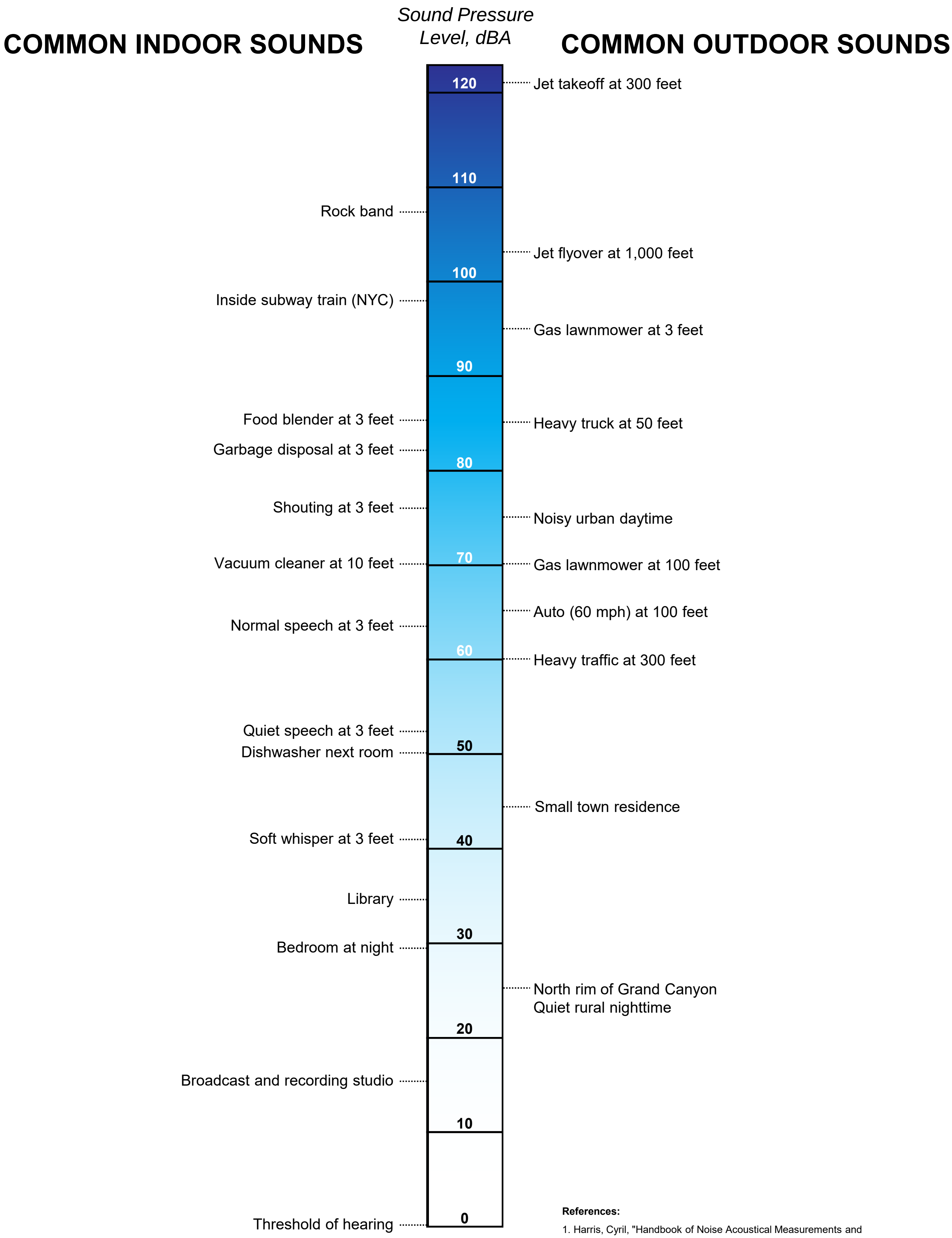
2 *American National Standard Electroacoustics – Sound Level Meters – Part 1: Specifications,* ANSI S1.4-2014 (R2019), published by the Standards Secretariat of the Acoustical Society of America, Melville, NY.

weighted sound levels are measured sound levels without any weighting curve and are otherwise referred to as "unweighted". Sound pressure levels for some common indoor and outdoor environments are shown in Figure 3-1.

Because the sounds in our environment vary with time, they cannot simply be described with a single number. Two methods are used for describing variable sounds. These are exceedance levels and the equivalent level, both of which are derived from some number of moment-to-moment sound level measurements. Exceedance levels are values from the cumulative amplitude distribution of all of the sound levels observed during a measurement period. Exceedance levels are designated L_n, where n can have a value between 0 and 100 in terms of percentage. Two sound level metrics that are commonly reported in community sound studies are described below.

- L_{90} is the sound level exceeded 90 percent of the time during the measurement period. The L_{90} is close to the lowest sound level observed. It is essentially the same as the residual sound level, which is the sound level observed when there are no obvious nearby intermittent sound sources.

- L_{eq}, the equivalent level, is the level of a hypothetical steady sound that would have the same energy (*i.e.,* the same time-averaged mean square sound pressure) as the actual fluctuating sound observed. The equivalent level is designated L_{eq} and is typically A-weighted. The equivalent level represents the time average of the fluctuating sound pressure, but because sound is represented on a logarithmic scale and the averaging is done with linear mean square sound pressure values, the L_{eq} is mostly determined by loud sounds if there are fluctuating sound levels.



References:

1. Harris, Cyril, "Handbook of Noise Acoustical Measurements and Noise Control", p 1-10., 1998
2. "Controlling Noise", USAF, AFMC, AFDTC, Elgin AFB, Fact Sheet, August 1996
3. California Dept. of Trans., "Technical Noise Supplement", Oct, 1998

Figure 3-1

Common Indoor and Outdoor Sound Levels

4.0 NOISE REGULATIONS

4.1 Federal Regulations

There are no federal noise regulations applicable to this Project.

4.2 State Regulations

The Project is located on commercial zoned land within the Town of Waterford, Connecticut and is required to comply with the State of Connecticut noise control regulation issued by the Connecticut Department of Energy & Environmental Protection.

4.2.1 Noise Zone Standards (§22a-69-3.5)

The sound level limits in the regulation vary by land classification that is based on land use. There are three land use classes that generally fall into the categories of industrial, commercial, and residential and the land classification of both the emitter and the receptor must be considered. The sound level limits of each class are shown in Table 4-1.

Table 4-1 Connecticut Noise Limits by Land Classification

	Maximum Sound Level (dBA) by Emitter's Zone		
Receptor's Zone	**Class C (Industrial)**	**Class B (Commercial)**	**Class A (Residential)**
Class C (Industrial)	70	62	62
Class B (Commercial)	66	62	55
Class A (Residential) / Day	61	55	55
Class A (Residential) / Night	51	45	45

Although the Project site is currently zoned C-G commercial, the proposed land use will be for utility purposes which falls under emitter Class C. However, to be conservative, the emitter Class B limits which correspond to the current land use and zoning will be applied. Since the project may be operational during the night, the most restrictive residential nighttime limit of 45 dBA was applied for evaluating Project sound levels at the adjacent residential property lines. The residential daytime or commercial limits were applied at the non-residential property lines based on the receptor land use. This is discussed further in Section 5.3.

4.2.2 Prominent Discreet Tones (§22a-69-3.3)

The Connecticut regulation also limits sources from emitting prominent discrete tones (PDTs). PDTs are defined in the regulation using one-third octave band sound levels (§22a-69-1.2(r)). If continuous sound levels measured at a receptor contains a PDT, the sound levels in Table 4-1 are to be reduced by 5 dBA. Sound pressure levels due to the project equipment will therefore be evaluated for PDTs in addition to the broadband limits shown in Table 4-1.

4.3 Local Regulations

The Town of Waterford has a noise control ordinance that contains the same quantitative limits as the State Regulations (Waterford, Connecticut Code of Ordinances §9.06.050). Therefore, demonstrating compliance with the state regulations will also show compliance with the local ordinance.

5.0 MODELED SOUND LEVELS

5.1 Sound Sources and Noise Controls

The primary sources of sound from the Project will be 4 Tesla Megapack 2 XL battery storage containers operating at 40% fan duty cycle and a 4 MVA transformer. Sound pressure and sound power level data for the Megapacks were provided by Qcells, and the transformer sound power level was calculated by Epsilon based on the power rating. The equipment is summarized in Table 5-1. The Megapack sound data are confidential and are therefore not reported here. The Project layout is shown in Figure 5-1.

Table 5-1 Modeled Sound Levels per Sound Source

Sound Source	Number of Units Modeled	Sound Power Level, dBA L_{eq}
Tesla Megapack 2 XL, 40% Fan Duty Cycle, 2025	4	CONFIDENTIAL
4 MVA Transformer	1	78

5.1.1 Sound Mitigation

A sound barrier has been proposed to reduce sound impacts from the Project at nearby receptors. The barrier will be 12-feet-tall and will surround the Project equipment on all sides as shown in Figure 5-1. The barrier should contain no substantial cracks or gaps and any gates in the barrier should be closed during normal operation.

This is one of many potential barrier designs that could effectively mitigate sound due to the Project. The barrier was modeled to be protective of the nearest sensitive receptors which are located west, north, and east of the Project. For modeling purposes, it was assumed that the barrier is sufficiently robust such that sound transmission through it is negligible. However, there are many commercially available products that can provide an acceptable amount of mitigation including the AcoustiFence sound reducing fence, which has an overall sound transmission class (STC) rating of 28 and a noise reduction coefficient (NRC) of 0.78.

5.2 Modeling Methodology

The sound levels associated with the proposed energy storage system were predicted using the CadnaA sound level calculation software developed by DataKustik GmbH. This software uses the ISO 9613-2 international standard for sound propagation.[3] The software accounts for topography, ground attenuation, multiple building reflections (if applicable), drop-off with distance, and atmospheric

[3] *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation,* International Standard ISO 9613-2:1996 (International Organization for Standardization, Geneva, Switzerland, 1996).

absorption. The CadnaA software allows for octave band calculation of sound from multiple sources as well as computation of diffraction.

Inputs and significant parameters employed in the model are described below.

- *Project Layout:* The analysis is for the Project layout dated July 18, 2024. The proposed Project layout is shown in Figure 5-1.

- *Terrain Elevation:* Elevation contours for the modeling domain were imported into CadnaA which allowed for consideration of terrain shielding where appropriate. The terrain height contour elevations for the modeling domain were generated from elevation information derived from the National Elevation Dataset (NED) developed by the U.S. Geological Survey.

- *Source Sound Levels:* Sound levels used in the modeling are discussed in Section 5.1.

- *Ground Attenuation:* The model allows inputs between 0 (hard ground) and 1 (porous ground). Spectral ground absorption was calculated using a G-factor of 0.5 for the modeling domain which is representative of mixed ground cover. Nearby paved areas are set to 0.

- *Modeling Grid:* A modeling grid with 5-meter spacing was calculated for the entire region surrounding the Project. The grid was modeled at a height of 1.5 meters above ground level to be consistent with the modeling locations. The resulting sound level isopleths are shown in Figure 5-2 (unmitigated) and Figure 5-3 (mitigated).

Several modeling assumptions inherent in the ISO 9613-2 calculation methodology, or selected as conditional inputs by Epsilon, were implemented in the CadnaA model to ensure conservative results (i.e., higher sound levels), and are described below:

- All modeled sources were assumed to be operating simultaneously and the Megapacks were modeled operating at 40% fan duty cycle corresponding to the greatest expected operational sound level impacts.
- Per ISO 9613-2, the model assumed favorable conditions for sound propagation, corresponding to a moderate, well-developed ground-based temperature inversion, as might occur on a calm, clear night or equivalently downwind propagation.
- Meteorological conditions assumed in the model (T=10°C/RH=70%) were selected to minimize atmospheric attenuation in the 500 Hz and 1 kHz octave bands where the human ear is most sensitive.
- No additional attenuation due to tree shielding, air turbulence, or wind shadow effects was considered in the model.

5.3 Sound Modeling Locations

The Project site and the parcels to the north, east, and south are in a general commercial zoning district (designated C-G). There is a low-density residential district to the west (designated R-40). While the parcels to the north and east are zoned commercial, the parcel to the north is a daytime only health care facility and the parcel to the east contains a cemetery. Therefore, the daytime residential limits have been applied at these locations because the land use requires greater protection under §22.-69-2.3 of the Connecticut regulations.

Epsilon selected modeling locations based on local zoning maps and aerial imagery. The receptors were placed at the locations with the greatest impacts at each property line adjacent to the Project. Receptors were placed one foot within the receiving property as specified in the state and local regulations. Receptors were modeled as discrete points at a height of 4.9 ft (1.5 m) above ground level which is the approximate ear height of a typical standing adult. The modeling locations are shown in Figure 5-1.

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Figure 5-1

Sound Level Modeling Locations

5.4 Sound Level Modeling Results

The predicted sound levels at the modeling locations without mitigation range from 46 to 55 dBA. With a 12-foot-tall mitigating sound barrier, the levels range from 40 to 47 dBA. In addition to the discrete modeling points, sound level isopleths or contours generated from the modeling grid are shown in Figure 5-2 for the unmitigated case and Figure 5-3 for the mitigated case. The sound levels presented in this report do not include any contribution from existing sound sources in the area.

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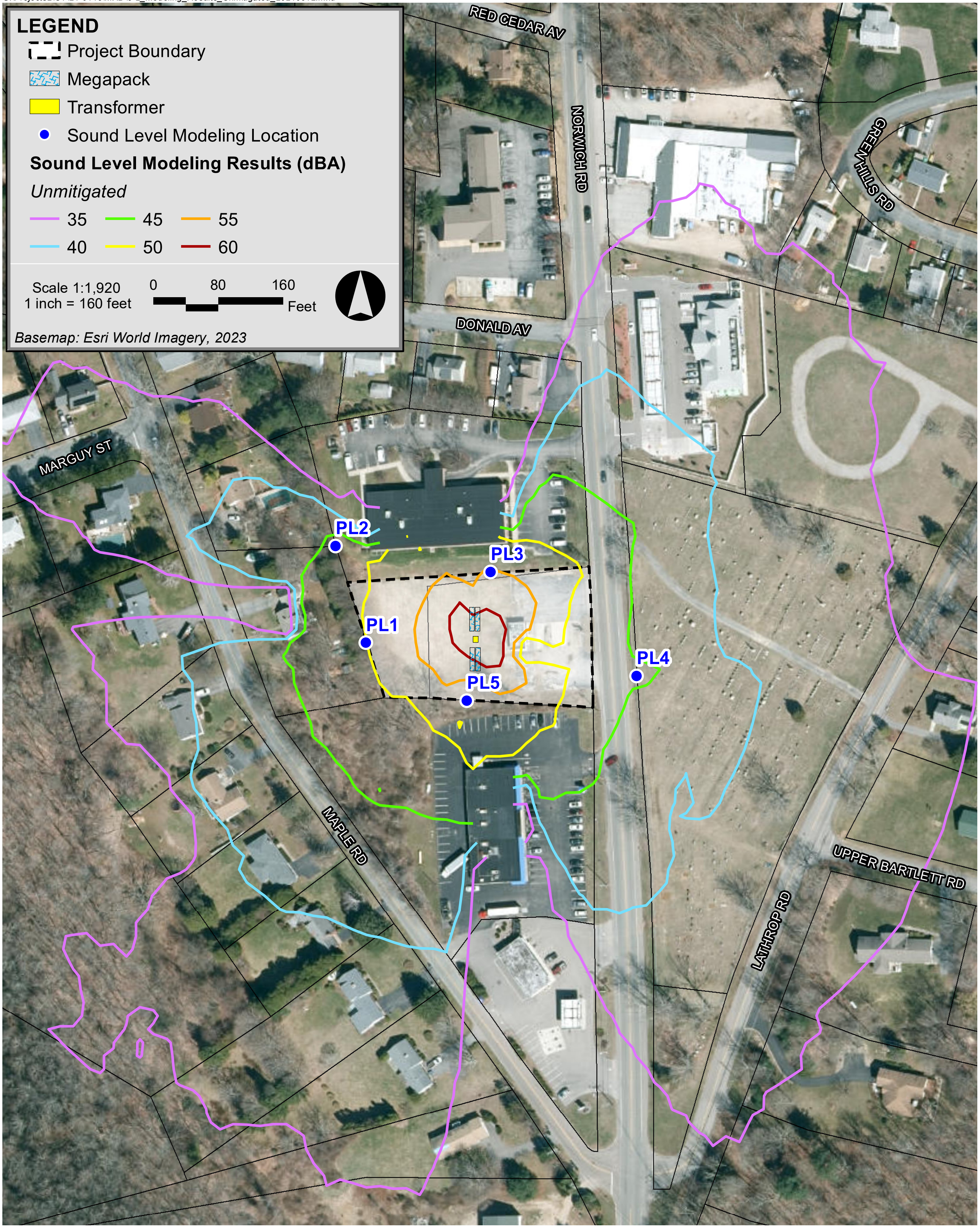

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Figure 5-2

Sound Level Modeling Results – Unmitigated

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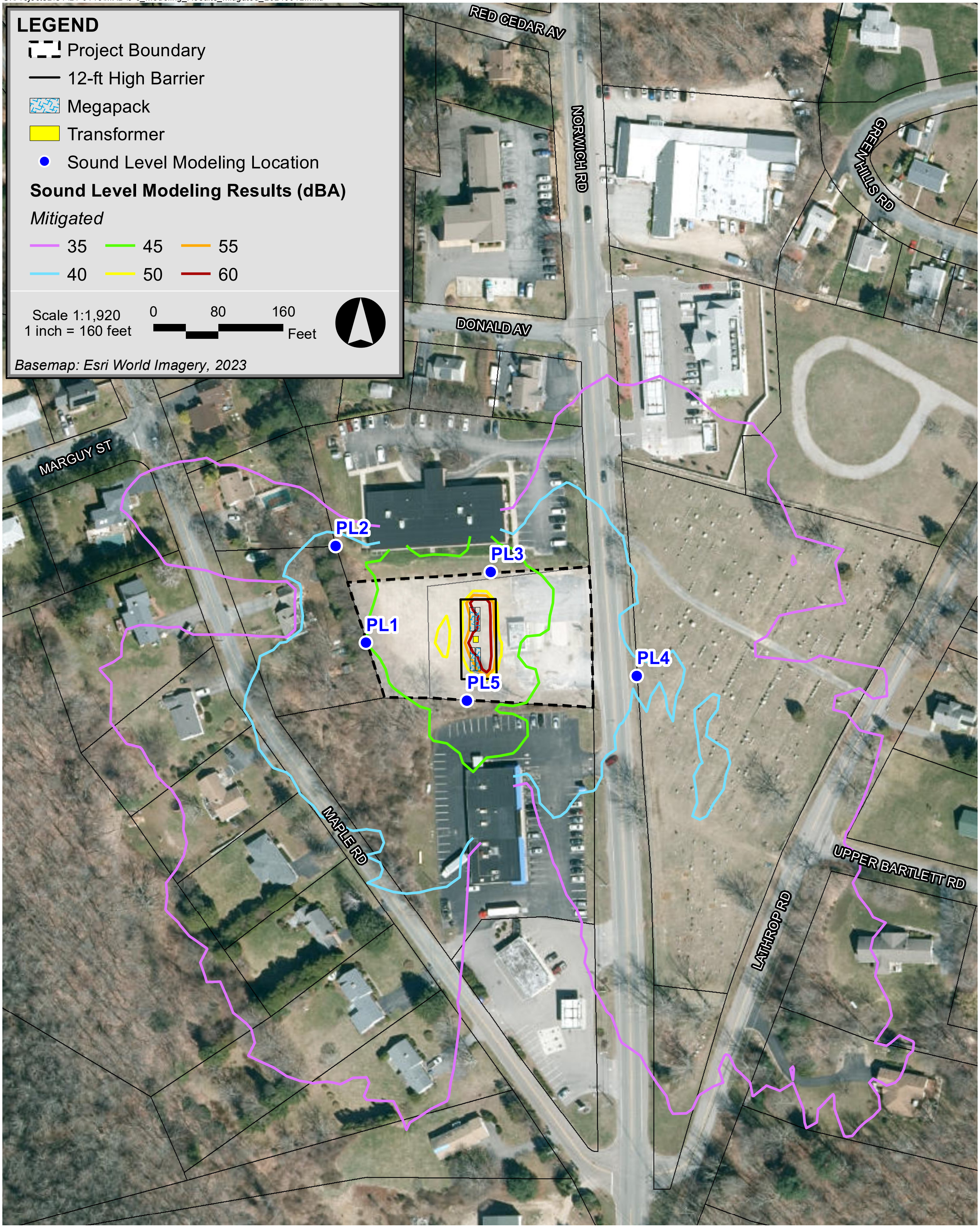

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Figure 5-3

Sound Level Modeling Results – Mitigated

6.0 EVALUATION

6.1 Broadband Sound Level Limits

Sound level modeling results are shown in Table 6-1 for both the unmitigated (no barrier) and mitigated scenarios. All modeled sound levels are A-weighted equivalent sound levels (L_{eq}, dBA). The predicted sound levels at the modeling locations range from 46 to 55 dBA for the unmitigated scenario and from 40 to 47 for the mitigated (proposed) scenario. Although the emitter Class C limits may be applicable due to the project land use, the modeled sound levels for the mitigated scenario meet the more restrictive emitter Class B regulatory limits at all locations as shown in Table 6-1and Figure 5-3.

Table 6-1 Sound Level Modeling Results

Modeling Receptor	Description	Modeled Sound Pressure Level, L_{eq}, dBA[1]	§22a-69-3.5 Receptor Class[1]	§22a-69-3.5 Emitter Class B Sound Level Limit, dBA
Unmitigated Results (No Barrier)				
PL1	Residential	50	A (Night)	45
PL2	Residential	46		
PL3	Health Care Facility	55	A (Day)	55
PL4	Cemetery	46		
PL5	Commercial	52	B	62
Mitigated Results (12-Foot-Tall Barrier)				
PL1	Residential	45	A (Night)	45
PL2	Residential	42		
PL3	Health Care Facility	47	A (Day)	55
PL4	Cemetery	40		
PL5	Commercial	46	B	62

Notes:

1. Levels exceeding the relevant regulatory limit are shown in red.

6.2 Prominent Discrete Tone Evaluation

The Connecticut regulation considers PDTs as excessive noise under certain conditions. One third octave band sound pressure levels due to the Project equipment were modeled using data from the equipment manufacturer and calculated by Epsilon. According to the regulation, if a tone is present, the broadband regulatory limits shown in Table 4-1 must be reduced by 5 dB. Third-octave band sound pressure levels at all modeling receptors were evaluated for PDTs.

The PDT evaluation data are shown in Table 6-2. The regulation states that a tone is present if the sound pressure level in a one-third octave band exceeds the arithmetic average of the two adjacent one-third octave band by an amount greater than in Sec. 22a-69-1.2 of the regulation. For reference, these thresholds are shown in the last row of Table 6-2. As shown in the table, there are no PDTs present, therefore, the Project meets the Connecticut regulatory standards with respect to PDTs.

Table 6-2 Prominent Discrete Tone Evaluation

Rec.ID	L_{eq} Sound Pressure Levels (dB) by 1/3 Octave Band Center Frequency (Hz)																				
	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k
PL1	44	39	36	41	44	36	36	35	37	35	37	36	34	31	31	28	26	22	14	8	0
PL2	41	35	33	37	41	32	32	31	34	31	34	33	31	29	28	26	23	19	11	4	0
PL3	49	43	40	46	50	41	40	38	40	36	37	36	34	32	31	28	26	22	15	9	3
PL4	41	35	33	37	41	33	32	30	32	29	31	30	28	26	26	23	21	17	9	2	0
PL5	49	44	40	45	48	39	39	37	39	35	37	35	33	31	31	28	26	22	15	9	3
Connecticut DEP Prominent Discrete Tone Threshold (dB)																					
	16	14	12	11	9	8	7	6	6	5	4	4	4	3	3	3	3	4	4	5	6

7.0 CONCLUSION

A comprehensive sound level assessment was conducted for the proposed Norwich Road Battery Storage Project in Waterford, Connecticut. The Project consists of four Tesla Megapack 2 XL energy storage containers and a 4 MVA transformer and has a capacity of approximately 4 MW.

Sound level modeling was conducted for the proposed project layout both with and without a 12-foot-tall sound barrier. The sound levels at the modeling locations range from 40 to 47 dBA with the proposed mitigating barrier. Modeling indicates that with the sound mitigation discussed in this report, the Project will meet the sound level limits set forth in both the Connecticut state regulations and the Waterford Code of Ordinances.