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RE: 81 & 93 Lake Street Sound Study

This report describes a sound propagation modeling analysis for the proposed Manchester Solar project (Project). The Project site is 81 & 93 Lake Street, Manchester, CT (Hartford County). The analysis determined that expected sound from the project are compliant with the applicable Town of Manchester and State of Connecticut and/or noise regulations.

1.0 Noise Statues

1.1 Town of Manchester

The Town of Manchester zoning regulations provide no quantitative noise limits (decibel levels, etc.). The Town ordinance cites allowable noise limits in § 223-6 Noise levels, Subsection B. Noise levels standards: "No person shall emit noise exceeding the levels stated herein". The limits for a residential receptor are shown in **Table 1-1**. The Project is not expected to emit significant sound during nighttime hours. The nighttime limits are shown for informational purposes only.

Table 1-1: Manchester Ordinance Noise Limits, dBA

	Receptor Located in Residential Zone	
	Daytime	**Nighttime**
Emitter Located in Industrial Zone	61 dBA	51 dBA
Emitter Located in Business or Residential Zone	55 dBA	45 dBA

This report assumes that the Project is either in a Business or Residential Zone.

The ordinance language also states § 223-6 Noise levels, Subsection C: Background noise and impulse noise:

> In those individual cases where the background noise levels caused by sources not subject to this chapter exceed the standards contained herein, a source shall be considered to cause excessive noise if the noise emitted by such source exceeds the background noise levels by five dBA, provided that no source subject to this chapter shall emit noise in excess of 80 dBA at any time, and provided that this section shall not be interpreted as decreasing the noise level standards of Subsection B of this section.

1.2 State of Connecticut

The Connecticut noise regulations define Noise Zones, described as follows:

> **Class A noise zone**: Lands designated Class A shall generally be residential areas where human beings sleep or areas where serenity and tranquility are essential to the intended use of the land.

> The land uses in this category shall include, but not be limited to, single and multiple family homes, hotels, prisons, hospitals, religious facilities, cultural activities, forest preserves, and land intended for residential or special uses requiring such protection.
>
> **Class B noise zone:** Lands designated Class B shall generally be commercial in nature, areas where human beings converse and such conversation is essential to the intended use of the land (Retail Trade, Parks, etc.).
>
> **Class C noise zone:** Lands designated Class C shall generally be industrial where protection against damage to hearing is essential, and the necessity for conversation is limited.

The Project site would be considered to be a Class C zone (Transportation, Communications and Utilities). Parcels upon which there are or could be residential dwellings are "Class A" noise zones, per the Connecticut noise regulation.

The Connecticut regulations for the Control of Noise contain the following noise standard (Sec. 22a-69-3.5. Noise zone standards):

(a) No person in a (Class C, B, or A) Noise Zone shall emit noise exceeding the levels stated herein and applicable to adjacent Noise Zones: (see Table 2)

Table 1-2: Connecticut Noise Zone Standards, dBA

	Class C	Class B	Class A (Day)	Class A (Night)
Class C Emitter to:	70 dBA	66 dBA	61 dBA	51 dBA
Class B Emitter to:	62 dBA	62 dBA	55 dBA	45 dBA
Class A Emitter to:	62 dBA	55 dBA	55 dBA	45 dBA

Per the regulation, "Levels emitted in excess of the values listed above shall be considered excessive noise."

The regulations also prohibit "Prominent Discreet Tones" (Sec. 22a-69-3.3. Prominent discrete tones):

> Continuous noise measured beyond the boundary of the Noise Zone of the noise emitter in any other Noise Zone which possesses one or more audible discrete tones shall be considered excessive noise when a level of 5 dBA below the levels specified in Section 3 (Allowable Noise Levels) of these Regulations is exceeded.

For example, a tonal sound source resulting in a sound level of 51 dBA would be considered to be 46 dBA with the 5-dBA tonal penalty applied (51 dBA – 5 dBA). The only potentially tonal sounds expected at the facility will be the inverters.

The Connecticut noise regulations further state:

> In measuring compliance with Noise Zone Standards, the following short-term noise level excursions over the noise level standards established by these Regulations shall be allowed, and measurements within these ranges of established standards shall constitute compliance therewith (see **Table 1-3:**):

Table 1-3: CT Standards Short-Term Noise Level Excursions

Allowable levels above standards (dBA)	Time period of such levels (minutes/hour)
3	15
6	7.5
8	5

There are no known federal sound level ordinances applicable to the project.

2.0 Site Description

The closest residences are summarized in **Table 2-1**. **Figure 1** (attached) shows the locations on an aerial image background. Locations A and B are within the Project limits and are shown for informational purposes only.

Table 2-1: Closest Residential Receptors

Receptor	Approx. Distance from Nearest Equipment Pad, Feet	Direction	Street Address
R1	230	East	11 Lake Street
R2	360	South-Southeast	90 Lake Street
R3	450	South-Southwest	61 Lake Street (closer to dwelling)
R4	220	West	61 Lake Street (rear of parcel)
Loc. A	85	South- Southwest	93 Lake Street (Dwelling)
Loc. B	300	Northeast	109 Lake Street (Dwelling)

3.0 Sound Propagation Modeling

A three-dimensional computer sound propagation model (“noise model”) was developed to analyze the noise contributions expected at the closest residences. The model was developed using CadnaA, version 2025 (build: 209.5501), a commercial noise modeling package developed by DataKustik GmbH. SLR was provided with a site plan of the Project, which was imported into the model space.

The software considers spreading losses, ground and atmospheric effects, shielding from barriers and buildings, reflections from surfaces and other noise propagation properties. The software is based on published engineering standards. The ISO 9613-2 standard was used for air absorption and other noise propagation calculations. Standard ISO 9613-2 meteorological conditions were used, which assume a stable atmosphere consistent with early morning and evening twilight conditions along with a light, downwind condition from the noise source to the receiver. This typically yields conservative results.

To be conservative, foliage was not included in the noise model. The Project terrain was modeled based on the site layout grading. Terrain beyond the Project extents was modeled based on USGS

topographical data at a resolution of 10 by 10 meters. A temperature of 20 degrees Celsius and 70 percent relative humidity (Standard ISO conditions) were used for the atmospheric absorption calculations. The ground surrounding the study area was modeled as mixed, with a 0.5 ground absorption coefficient.

3.1 Data and Assumptions

Modeling assumptions include the following:

- Four (4) 1,500 VDC site inverters having a sound rating of 67 dBA at 10 feet (3 meters) - on the 93 Lake Street site equipment pad
- Three (3) 1,500 VDC inverters having a sound rating of 67 dBA at 10 feet (3 meters) - on the 81 Lake Street site equipment pad
- Inverters are situated 5 feet above grade elevation on a support structure
- 52 photovoltaic (PV) panel trackers, having a sound power level of 87 dBA per tracker (65 dBA at 1 meter)

The inverter sound levels are controlled primarily by the cooling fans on the units, making the sound output at 10 feet the same for the 125 kVA and 150 kVA models (output power).

Table 3-1 presents the sound power levels used in the model for the proposed equipment. The A-Weighted sound power levels (dBA) were calculated based on the manufacturer sound pressure level data. Sound power levels are presented for each octave band, which are indicative of previous inverter and transformer sound measurements performed by SLR. Actual octave band sound levels may be different from those shown in the table.

Table 3-1: Sound Power (L_w) for Proposed Equipment

Source	Linear L_w at Octave Center Frequency, Hz									
	31.5	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dBA**
1,500 VDC inverter, L_w [a]	78	79	80	80	86	81	79	70	66	87
PV Panel Trackers, L_w [b]	67	70	71	71	77	72	70	61	57	78

a. Corresponds to 67 dBA at 3 meters
b. Corresponds to 65 dBA at 1 meter

3.1.1 Steady Operation (Pad Equipment)

Table 3-2 summarizes the calculated sound pressure levels from the proposed pad equipment (inverters, transformers) at each receptor. A 5-dBA tonal penalty was applied to the model results.

Table 3-2: Model Results - Steady Operation (Pad Equipment)

Receptor	Approx. Distance from Nearest Equipment Pad, Feet	Calculated A-Weighted Sound Level (dBA)	Add 5-dBA Tonal Penalty	Most Stringent Limit [a]	Complies with Limit? (Y/N)
R1	230	42.3	47.3	55	Y
R2	360	39.1	37.9	55	Y
R3	450	32.9	44.1	55	Y
R4	220	44.6	49.6	55	Y
Loc. A	85	53.8	58.8	N/A	N/A
Loc. B	300	43.4	48.4	N/A	N/A

a. Town of Manchester, Emitter Located in Business or Residential Zone to Residential Zone, Daytime

Calculated levels including a theoretical 5-dBA tonal penalty are below the most stringent limit (Town of Manchester at all nearby offsite receptors. Sound levels at Location A exceed 55 dBA, but that condition could be mitigated with a local noise wall.

Figure 2 presents the A-Weighted sound propagation contours for the pad equipment. The contours do not include a 5-dBA tonal penalty.

3.1.2 Transient Sounds (PV Panel Trackers)

The photovoltaic panels will be equipped with trackers to optimize Project energy output. The trackers will periodically move the PV panels to follow the sun. Trackers (52) were placed within the 3D model space based on the current site layout drawing. The trackers could potentially operate simultaneously, but they will only operate for a few seconds at a time, approximately every five minutes. For this reason, sound from the trackers would be considered transient.

Table 3-3 summarizes the calculated sound levels from the trackers at each receptor. The levels shown also include the sound level contributions from the pad equipment shown in **Table 3-2**. A tonal penalty was not applied to the tracker sound contribution, given the very brief amount of time they will operate.

Table 3-3: Model Results – Transient Tracker Sound

Receptor	Pad Equipment Contribution with 5-dBA Penalty A-Weighted Sound Level (dBA)	Calculated Transient Tracker Contribution (dBA)	Total Transient Sound Level (dBA)	Most Stringent Limit [a]	Complies with Limit? (Y/N)
R1	47.3	42.7	48.6	55	Y
R2	37.9	38.4	41.2	55	Y
R3	44.1	40.9	45.8	55	Y
R4	49.6	43.8	50.6	55	Y
Loc. A	58.8	47.0	59.1	N/A	N/A
Loc. B	48.4	45.0	50.0	N/A	N/A

Calculated levels are below the most stringent limit (Town of Manchester at nearby residential receptors).

Figure 3 presents the A-Weighted sound propagation contours for the trackers only.

4.0 Conclusion

SLR has developed sound modeling for the 81 & 93 Lake Street solar project, per the latest revised site plan. Calculated Project sound levels comply with the most stringent Town of Manchester limits for sound emitted to a Residential land use.

Please contact us if you have any questions or comments.

Regards,

SLR International Corporation

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Figure 1: Closest Receptors

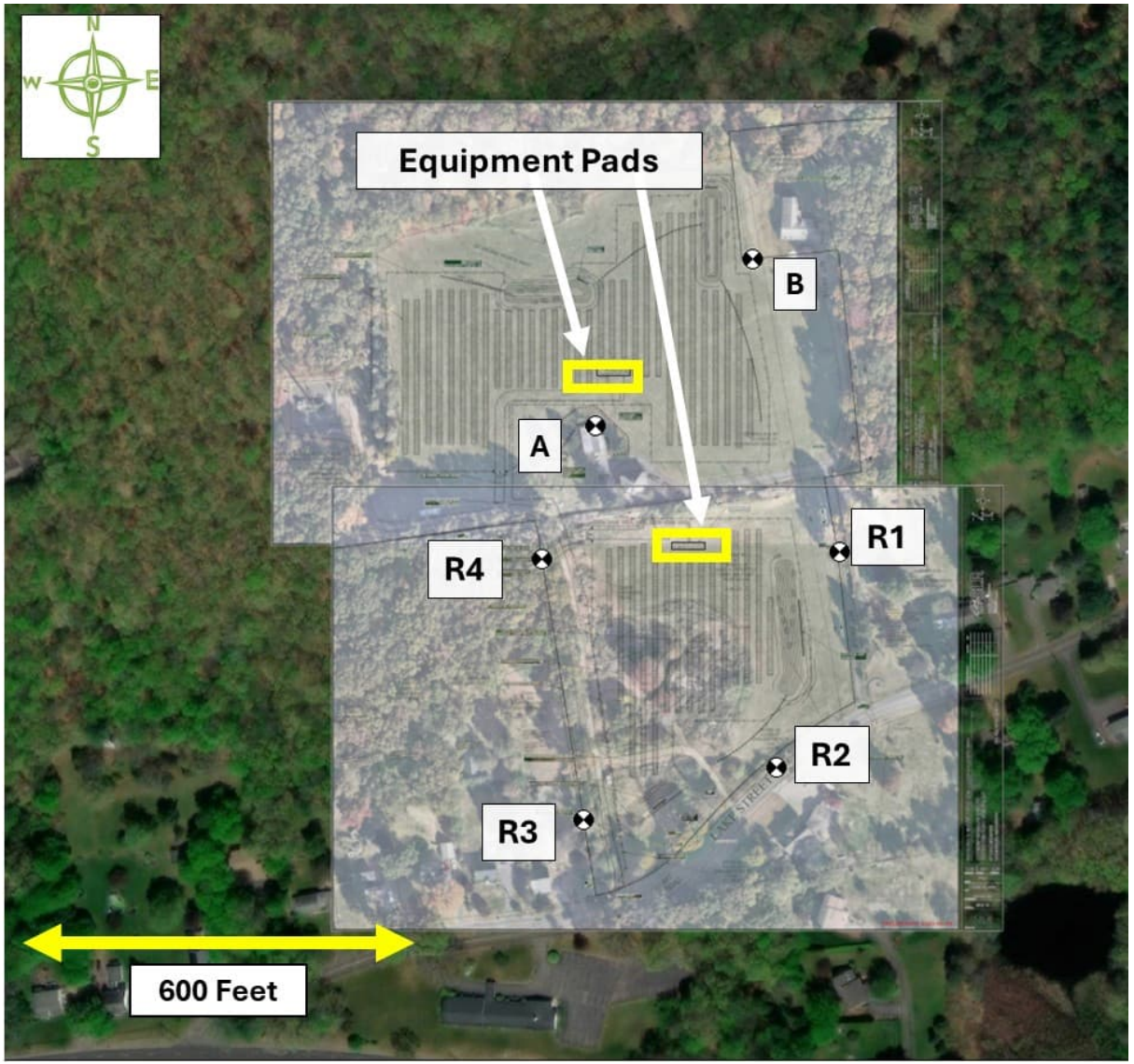

Figure 2: Pad Operation A-Weighted Sound Propagation Contours, dBA

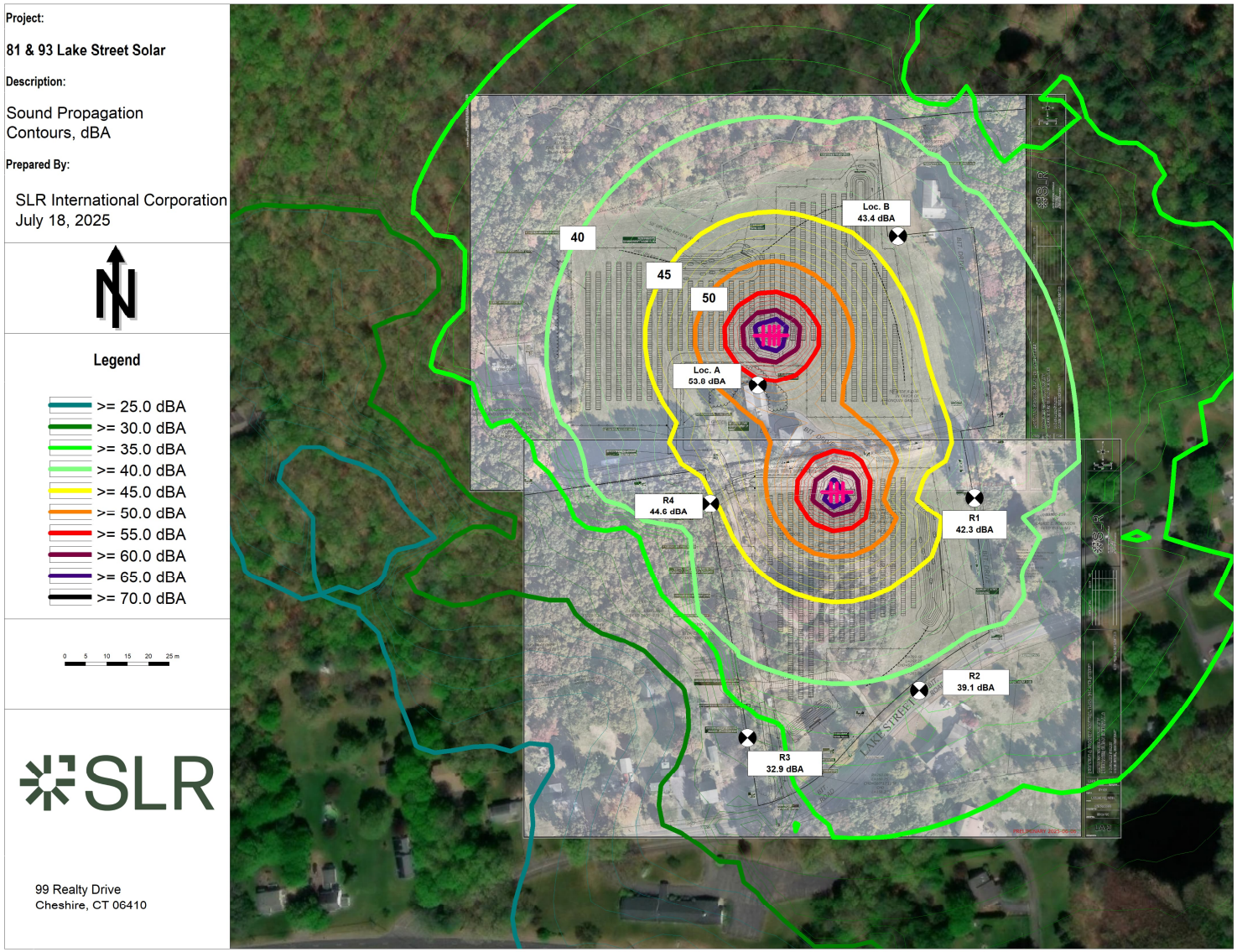

Figure 3: Tracker Operation A-Weighted Sound Propagation Contours, dBA