Hessler Associates, Inc.
WORLDWIDE CONSULTING IN ENGINEERING ACOUSTICS

1012 W Las Colinas Drive
St. George, UT 84790 USA
703-303-0341
www.hesslernoise.com

TECHNICAL REPORT

Title:	Existing Conditions Background Sound Survey and Noise Impact Assessment
Project:	Willowbrook Solar
Location:	Highland County, OH
Prepared For:	Willowbrook Solar, LLC/Open Road Renewables, LLC
Prepared By:	David M. Hessler, P.E., INCE
Revision:	A
Issue Date:	July 27, 2018
Reference No:	TM-2114-070118-A
Attachments:	**Table T-2114-070218-0** Substation Sound Propagation Calculations

1.0 Introduction

A study has been carried out for Willowbrook Solar, LLC to evaluate the sound emissions from the proposed Willowbrook Solar Project located in Concord and White Oak Townships in Highland County and partially in Eagle Township in Brown County, Ohio in order to identify and quantitatively evaluate any possible community noise issues. Compared to other types of power generation facilities, potential noise impacts from a photovoltaic solar energy project are relatively few, relatively mild and, moreover, have the unusual characteristic of only occurring during the daylight hours when noise is much less likely to be an issue in the first place. In this case, any possible concerns about noise are largely confined to the step up transformer in the new substation, electrical inverters within the various solar fields and some short-lived activities during construction. In an effort to methodically evaluate the potential impact of the substation, a field survey was conducted to establish the current levels of background sound at the nearest residences to the existing and proposed substations so that projections of future transformer sound could be evaluated within an appropriate context. This report summarizes the findings from that field survey and discusses the potential noise impacts associated with the project.

1.1 Executive Summary

A seven day field survey of the existing ambient sound levels in the immediate vicinity of the future substation associated with the Willowbrook Solar Project was carried out to establish what the baseline environmental conditions are and determine what effect the sound emissions from the transformers at the existing substation might be having at the nearest residences. The survey results indicate that the sound emissions from the existing substation are largely or totally insignificant during the day at the nearest homes, irrespective of time of day. Environmental sound levels in the vicinity of the substation are driven by sources unrelated to the existing substation, such as distant traffic, wind rustle, birds, etc.

The sound power level of the step up transformer associated with the proposed substation was calculated from its expected maximum MVA rating of 158 and mathematically projected to the nearest potentially sensitive receptors. This projection indicates that any sound emissions from the new transformer will likely be comparable to the current natural background sound level making it largely imperceptible most of the time at the nearest residences. Generally speaking, no significant adverse community noise impact is expected from the proposed substation.

Beyond the substation, there will some sound from the electrical inverters distributed throughout the solar fields. While the sound emissions from this equipment are not negligible in overall magnitude and tonal in character close to these units, the higher frequency tonal aspect drops away very quickly with distance and field measurements indicate that inverter sound fades to insignificance relative to normal background levels at a distance of 150 ft. Moreover, inverter sound is rarely audible at the perimeter fence of typical solar fields so an adverse noise impact at the nearest residences beyond the project boundary appears to be highly unlikely from this equipment. In any event, options exist to mitigate inverter sound emissions should any problem arise.

In contrast to other forms of power generation, sound emissions during construction are expected to be dramatically lower in magnitude and duration. Some unavoidable disturbance is possible when the mounting posts are driven in but this activity will be fairly short-lived in any particular location. Other sounds from trenching and road building will also be brief in duration and will progress from place to place avoiding prolonged exposure at any specific location.

In general, the potential noise impacts from all aspects of the project are expected to minimal.

2.0 Existing Conditions Sound Survey

The new substation associated with the project is currently planned for a location immediately adjacent to the southwest corner of the existing AEP Wildcat substation on Wildcat Road in Concord Township. Several residences are located near this substation on the north side of the road. In order to evaluate the sound emissions that currently exist at these homes, a series of sound monitors were set up at progressive distances from the existing substation. The new substation may potentially add sound that is similar in character to what is currently being experienced – as opposed to the introduction of a completely new sound source at a greenfield site. Consequently, the survey was designed to determine just how significant or insignificant this existing sound is and what the effect of the new substation might have in that context.

The survey was carried out over a 7 day period from Wednesday, April 11th through Wednesday, April 18th, 2018 using continuously recording sound monitors in general accordance with ANSI S12.9-R2013 “Quantities and Procedures for Description and Measurement of Environmental Sound. Part 2: Measurement of Long-term, Wide-Area Sound”.

2.1 Measurement Locations

As illustrated in Figure 2.1.1 on the following page, three monitoring locations were used to evaluate the sound levels associated with the existing substation:

- **Position 1** – Control - At the northern fence of the substation closest to the transformer
- **Position 2** – Nearest Residences –300 ft. north of the transformer, representative of the distances to the nearest homes
- **Position 3** – 600 ft. from the transformer, to evaluate sound decay beyond the nearest houses

Figure 2.1.1
Substation Vicinity Showing Sound Measurement Locations

The specific monitoring locations are described in further detail below.

2.1.1 Position 1 – Control

A 1/3 octave band frequency analyzer (along with a back-up unit) was set up as a continuous sound monitor just outside the northern fence of the existing substation at the nearest point to the transformer, which was only vaguely audible. The purpose of this test location was to create a time history of any variance in the substation's sound emissions over the survey period and to continuously record its frequency spectrum, since transformers are tonal sound sources that generate a hum at harmonics of 60 Hz.

Photographs of the instrument set up at Position 1 are shown below.

Figure 2.1.1.1
Control Position 1 Looking S towards Substation Transformer

Figure 2.1.1.2
Control Position 1 Looking NW towards the Nearest Residences

2.1.2 Position 2 – Nearest Residence

A second 1/3 octave band frequency analyzer and another redundant data logger were set up in the transmission line right-of-way at a distance of 300 ft. from the transformer to record the sound emissions from the substation as observed at the nearest homes.

Figure 2.1.2.1
Measurement Position 2 Looking S towards Substation

Figure 2.1.2.2
Measurement Position 2 Looking W towards Nearest Houses

2.1.3 Position 3 – 600 ft. from Transformer

In order to evaluate the decay in sound from the substation with additional distance, a third monitor was set up in the transmission line right of way at 600 ft. from the substation transformer.

Figure 2.1.3.1
Measurement Position 3 Looking S towards Substation

2.2 Survey Equipment and Measurement Parameters

Norsonic N-140, ANSI S1.4-1983(R2006) Type 1 precision, frequency analyzers were used at all locations along with Rion Model NL-22, ANSI Type 2, environmental sound monitors for redundancy. Each instrument was field calibrated with a Brüel and Kjær Type 4230, ANSI S1.40-1984(R1990) Type 1 calibrator at the beginning and end of the survey and all the instruments exhibited either no drift or a drift of +0.3 dB or less. Weather-treated 7 in. diameter windscreens were used at all positions. As is evident in the photos above, the microphones were fixed to temporary posts at a standard height of 1.2 m above local grade.

A variety of statistical sound levels, such as the minimum, average, maximum, etc. were measured in 10 minute increments over the 7 day survey period; however, the parameter of primary relevance and importance to this kind of survey is the L90 percentile level, which is the sound level exceeded 90% of the time over each measurement period. Put another way, this level captures the quietest (not necessarily consecutive) 1 minute of each 10 minute interval, which in this particular environment, tends to capture any momentary lulls in traffic making it a very conservative measure of the near-minimum background sound level.

2.3 Survey Conditions

The weather conditions over the survey period were generally mild and unseasonably warm. There were some windy periods on the afternoons of April 11, 12 and 13th, several short periods of rain on April 14th and 16th and an all-day rain on April 15th.

3.0 Survey Results

The survey results, in terms of the L90(10 min.) sound levels for the three test locations are plotted below. Periods of high wind and rain are marked as W and R, respectively.

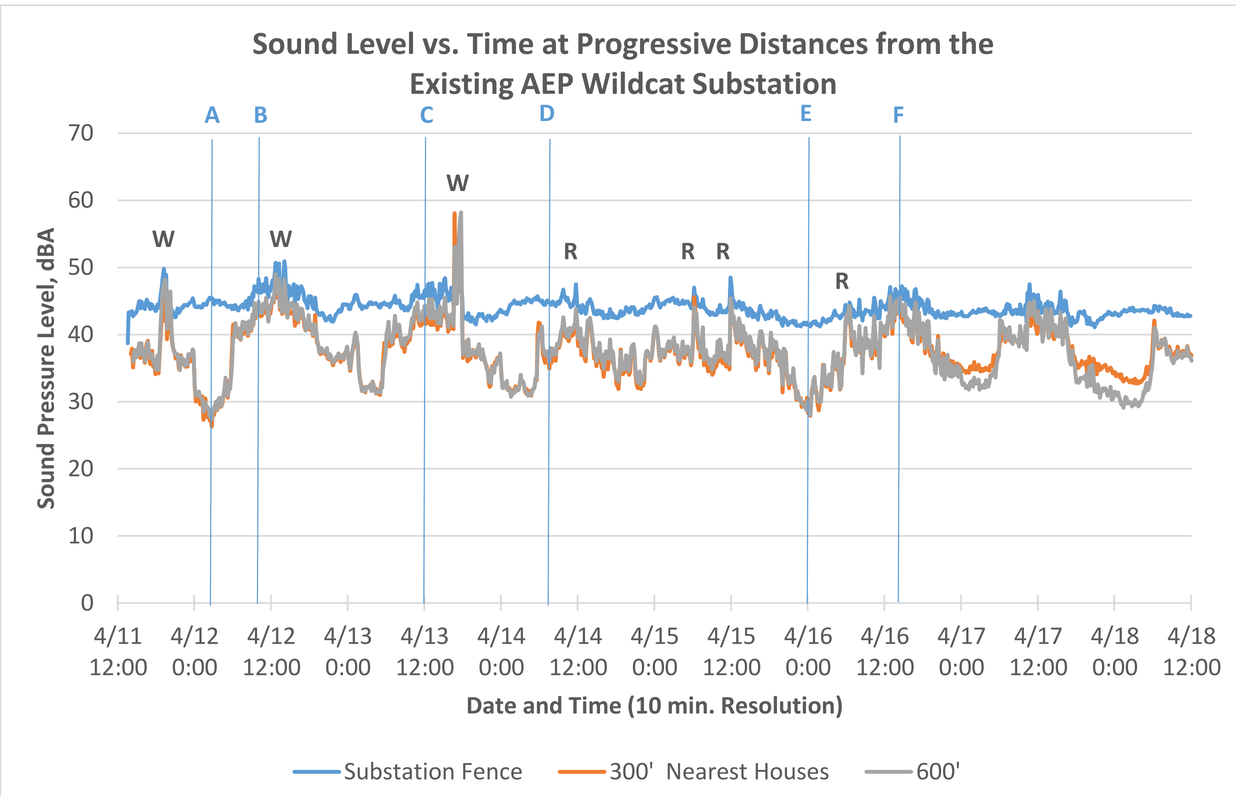

Figure 3.0.1

What these results generally show is that the sound emissions from the existing substation are largely constant at the fence. What this consistency implies is that the ups and downs that are evident in the sound levels at 300 feet (representative of the nearest homes) and 600 feet away are not attributable to the substation, but rather are driven by other, varying environmental influences, such as traffic volumes, wind, birds, man-made sounds, etc. Moreover, if Positions 2 and 3 were being influenced by substation noise there should be a differential between them, ideally, of about 6 dBA. The fact that they are essentially the same means that these sound levels are indicative of the general ambient sound level in the area and that substation noise is insignificant.

In order to further investigate the link, or lack thereof, between the sound emissions from the substation and what is actually heard at the nearest residence, a series of frequency spectrum comparisons are plotted below. These samples, taken at the points designated as A through F in Figure 3.1.1, were randomly selected for different days and times of day. These plots are A-weighted, which means, in simple terms, that the highest values in each spectrum represent the frequencies that are the most perceptible to the human ear, while the lower values are generally insignificant or completely inaudible. In general, these frequency cross-sections show that at the control position the existing transformer produces a tonal sound at the harmonics of 240 and 720 Hz. The dominance of the 720 Hz harmonic[1] is highly unusual.

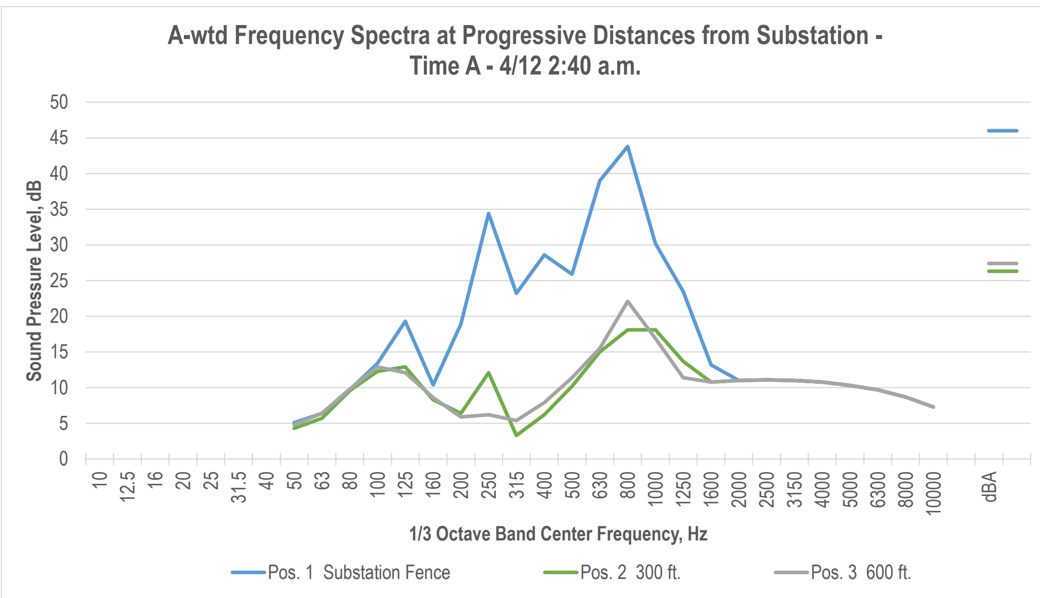

Figure 3.1.2

Time A (Fig. 3.1.2) represents a calm nighttime minimum occurring at 2:40 a.m. when all other sounds are at a minimum. The transformer tones are certainly evident at the substation fence but fall to insignificant magnitudes of about 20 dB or less at 300 and 600 ft. While these peaks can be detected with instrumentation at the off-site monitoring points, they are generally below the subjective threshold of perception and therefore essentially inaudible.

[1] Tones from transformers occur at multiples of the fundamental line frequency of 60 Hz. The 720 Hz harmonic appears mainly in the 800 Hz 1/3 octave band and partially in the adjacent 630 Hz 1/3 octave band, which each represent segments of the spectrum. The boundary between these two bands is 708 Hz, which is close to the tone maximum so some energy spills over into the lower band.

Time B (Fig. 3.1.3) represents the situation during the day at 10 a.m. that morning. The prominence of transformer noise at the station fence is substantially muted due to the presence of normal daytime ambient sounds, such as from traffic and wind. The sound levels at the houses and beyond don't exhibit any hint of tonal noise in the 250 and 800 Hz bands.

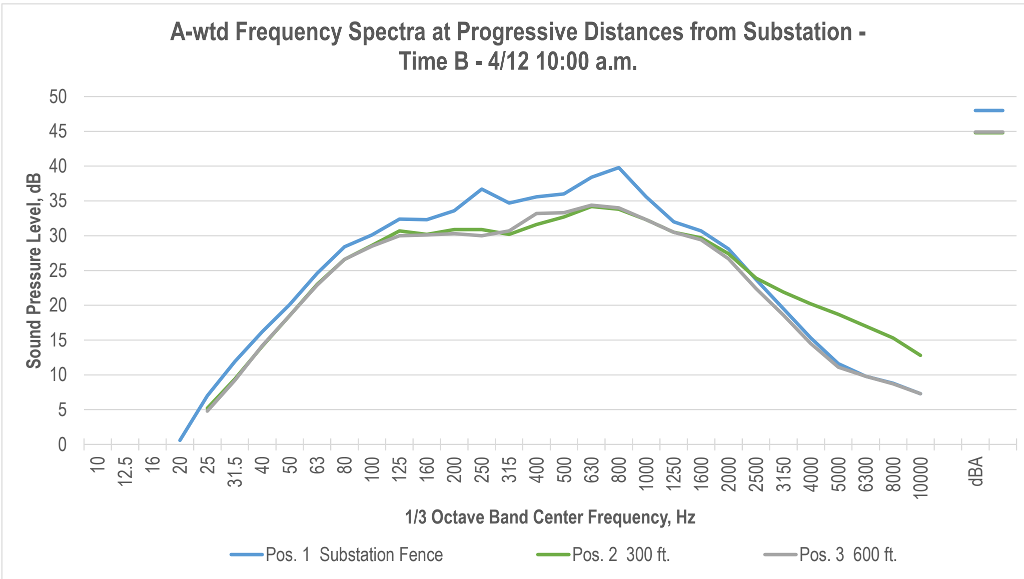

Figure 3.1.3

These same general characteristics can be seen in the remaining cross-sections below.

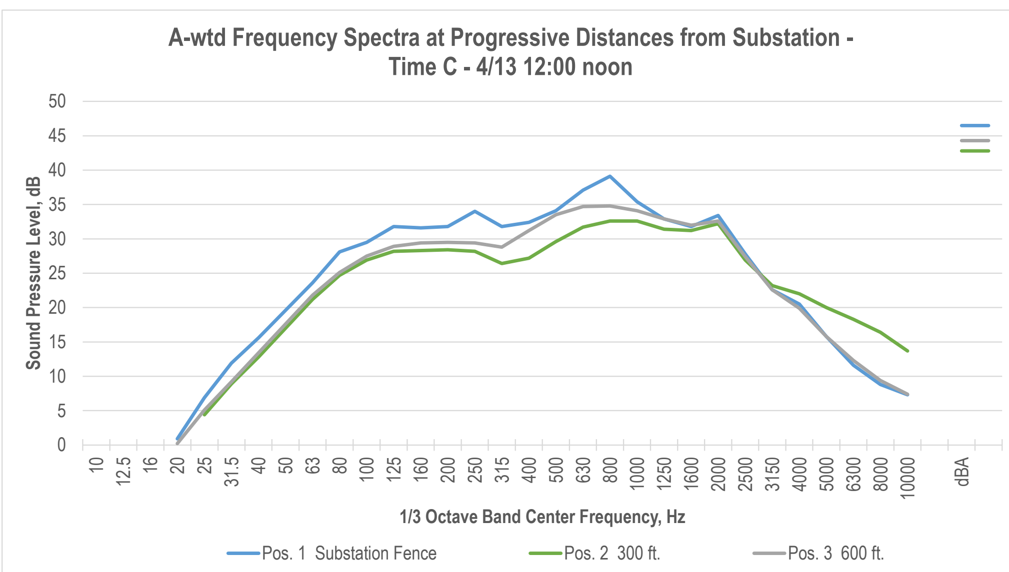

Figure 3.1.4

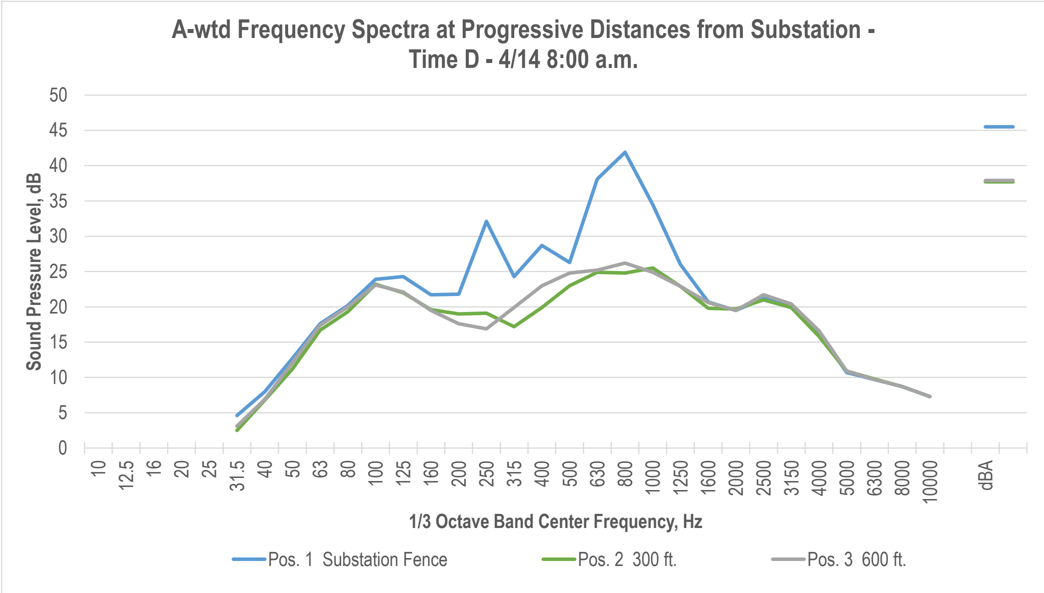

Figure 3.1.5

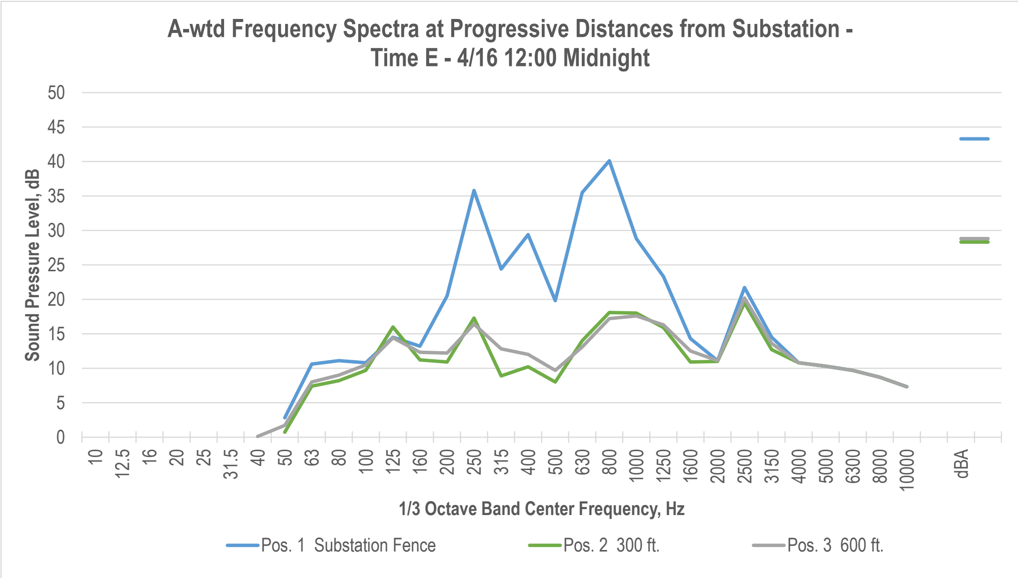

Figure 3.1.6

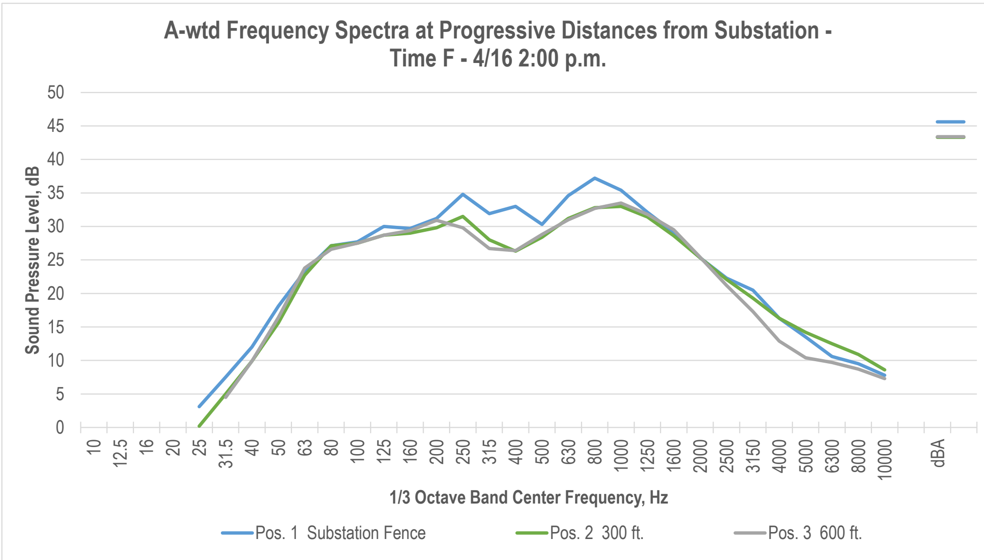

Figure 3.1.7

4.0 Sound Emissions from the New Substation

4.1 Transformer Sound Level

The only noise source of any potential consequence in the new substation is the step up transformer. Any crackle from the electric lines is something that's only noticeable in or immediately around the substation itself and therefore of no significance at the nearest residences hundreds of feet away.

The input sound power level for this transformer has been very conservatively estimated in octave bands in **Table T-2114-070218-0** based on the unit's maximum expected megavolt ampere (MVA) rating of 158 using empirically derived algorithms from the "Electric Power Plant Environmental Noise Guide[2]" published by the Edison Electric Institute (EEI). Numerous transformers over a wide range of sizes and manufacturers were measured in the EEI study to develop a formulaic relationship between the MVA rating and sound power. The precise transformer model, rating and manufacturer for this project have not yet been finalized, but the best estimate at this time is for a 158 MVA unit.

---

[2] "Electric Power Plant Environmental Noise Guide", Prepared by Bolt Beranek and Newman for the Edison Electric Institute, 2nd Ed., 1984.

For this size transformer, the EEI methodology nominally predicts a near field sound pressure level of 82 dBA and an associated sound power level (Lw) of 101 dBA re 1 pW[3]. Experience suggests, however, that this prediction methodology is highly conservative for modern transformers[4] and a substantially lower sound power level from the actual transformer is very likely. In cases where the actual measured performance has been determined, a sound level of about 6 dB lower has been observed. In order to be more realistic in the analysis this reduction has been taken into account in the modeled transformer sound power level, which is tabulated below.

Table 4.1.1
Estimated 158 MVA Transformer Sound Power Level (Lw) Spectrum

OBCF, Hz	31.5	63	125	250	500	1k	2k	4k	8k	**dBA**
Lw, dB re 1 pW	98	104	106	101	101	95	90	85	78	**95**

4.2 Sound Propagation Calculations

Based on the sound power level spectrum above, the sound emissions from the substation have been calculated at the nearest potentially sensitive receptors (residences) in strict accordance with ISO 9613-2 *Acoustics –Attenuation of Sound during Propagation Outdoors*[5].

In this instance, a mid-range, somewhat conservative ground absorption coefficient (Ag from ISO 9613-2) of 0.5 (on a scale of 0 to 1) has been used to represent the site vicinity, which consists of open fields. There are no appreciable undulations in the area topography so a flat plane is assumed along with ISO "standard day" conditions (10 deg C/70% RH).

4.3 Substation Sound Levels at the Nearest Residences

The nearest residences to the proposed new substation are illustrated in Figure 4.3.1 and designated as Design Points 1 through 4.

[3] Sound power level is an essentially intangible quantity, used only for modeling purposes, that is calculated from the measured sound pressure level and the radiating wave front area at the point of the measurement. It is expressed in units of Watts and the designation "re 1 pW", or 'with reference to one picoWatt', is used by convention to distinguish power levels from pressure levels, which are measured in units of pressure, Pascals.
[4] The EEI study was carried out 34 years ago.
[5] *Acoustics – Attenuation of Sound during Propagation Outdoors*, Part 2, "A General Method of Calculation," ISO 9613-2, International Organization for Standardization, Geneva, Switzerland, 1989.

Figure 4.3.1
Substation Vicinity Showing Distances to Nearest Residences

The overall A-weighted sound level from the proposed substation transformer at each of these receptors is calculated in Table T-2114-070218-0. The results for DP-1, assuming operation only during the daylight hours from 7 a.m. to 7 p.m., are plotted graphically below along with the measured existing sound level. Generally speaking, to be clearly audible a sound must exceed the background sound level by about 5 dBA. Anything equal to or below the background is essentially drowned out by it.

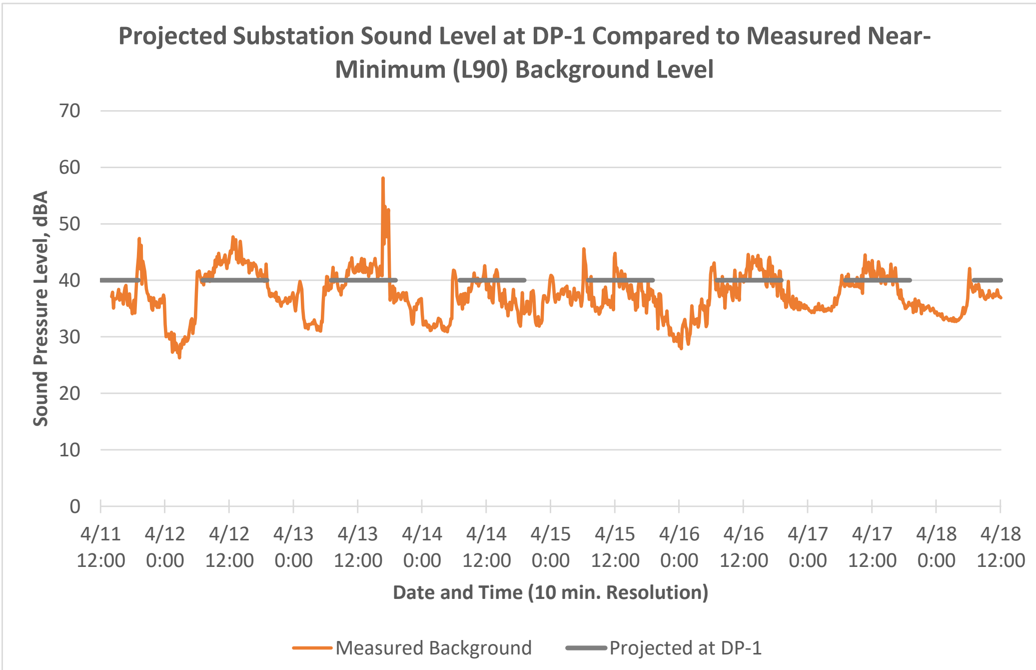

Figure 4.3.1

This plot indicates that the daytime-only sound emissions from the proposed substation will be comparable to the existing near-minimum (L90) background level as measured at survey Position 2 making it largely imperceptible under most normal circumstances. At worst it may be faintly audible during periods of very low background noise and/or when certain atmospheric conditions favor sound propagation. In general, however, little or no adverse impact is anticipated from the proposed substation at the nearest residence, DP-1, or at any of the more distant residences in the vicinity of the substation, Design Points 2, 3 and 4.

Because the sound emissions from the project substation are expected to be essentially negligible at the nearest residence across the street, modeling predictions have not been made at all further potentially sensitive receptors as would normally occur per State guidelines (OAC 4906-4-08(A)(3)(c) for a wind turbine or fossil fuel project.

5.0 Sound Emissions from Other Sources

With the possible exception of substations, photovoltaic power projects generate very little environmental noise. The only other sound sources of any possible significance are the electrical inverters used to convert locally generated DC current into AC power that is then routed to the substation through underground collector cables. Typically these electrical cabinets are situated within and near the center of each solar field, or independent group of solar panels, so they are usually a considerable distance from the perimeter fence and potential neighbors beyond.

Generally speaking, these electrical cabinets emit sound levels on the order of 60 to 70 dBA at 10 ft. due mostly to the cooling fans and, at this very close-in distance, the sound can be characterized as a hum sometimes with overlying ringing tones in the high frequencies. Since high frequency sound diminishes rapidly with distance the ringing aspect of the sound, if present, dies out very quickly and the sound at any significant distance consists of bland, broadband fan noise, if it is audible at all.

The precise make and model of the inverters for the Willowbrook project has not yet been selected so their sound emissions cannot be modeled or rigorously evaluated at this time. However, a field study of typical inverter sound emissions at several existing large-scale solar facilities - that was carried out for the Massachusetts Clean Energy Center, an agency of the State government, in 2012[6] - indicates that any noise from these cabinets generally drops into the background level and becomes insignificant at a distance of 150 feet and that they are rarely audible at or beyond the perimeter fence. Consequently, it is expected that any conventional solar field layout will result in a situation where inverter noise is inconsequential at the project boundary making any adverse impact on neighbors highly unlikely. Nevertheless, if this sound source were to unexpectedly generate complaints, options, such as cabinet damping and ventilation silencers, would be available to retroactively mitigate noise from these devices and resolve any issue.

One other possible sound source might be the small motors that (very) slowly rotate the panels so that they track the sun over the course of each day. However, the sound emissions from these motors are thought to be inconsequential even immediately adjacent to them, so no significant community noise impact is anticipated.

During normal operation the facility does not require an operator or any full time staff, so there clearly wouldn’t be any noise impacts from traffic. The site would only be occasionally visited by maintenance personnel.

6.0 Sound Emissions during Construction

In contrast to other forms of power generation, the construction phase of a solar energy facility is remarkably short and the activities that generate any significant noise are few. Where a fossil or wind project would require extensive earthworks and the pouring of massive concrete foundations, a solar plant only involves the installation of the mounting posts for the panel racks, which generally follow the existing topography. No concrete foundations are used for the panel arrays. There are two basic methods of erecting the posts, driving or rotating screw bases. If the posts are driven in, it is essentially a small-scale pile driving operation that produces a repetitive, metallic pounding noise, which will be clearly audible for some distance and could cause some unavoidable disturbance. On the other hand, this activity is short-lived and would proceed fairly quickly, only

[6] Guldberg, P., Tech Environmental, “Study of Acoustic and EMF Levels from Solar Photovoltaic Projects”, Prepared for the Massachusetts Clean Energy Center, Boston, Dec. 2012.

occurring for a period of days or a couple of weeks in any one locality. If the posts are screwed in there might be some local noise from the driving apparatus; however, any community impact is likely to be minimal.

In terms of the more traditional construction phases, the table below gives some representative sound levels from construction equipment at 50 feet[7], which, in this case, may be conservatively interpreted as the site property boundary. These sound levels might be temporarily produced very close to where the work is occurring.

Table 6.0.1
Typical Construction Equipment Sound Levels per FHWA by Phase

Equipment Description	Typ. Sound Level at 50 ft., dBA	Est. Maximum Total Level at 50 ft. (Property Boundary) per Phase, dBA[1]
Blasting		
n/a		n/a
Earthmoving Road Construction and Electrical Line Trenching		
Dozer	85	85
Front End Loader	80	
Grader	85	
Backhoe	80	
Pile (Support Post) Installation		
Vermeer PD10 Pile Driver[2]	84	84 (Impulsive, Driven Posts)
Drill Rig Truck	84	84 (Broadband, Screwed Posts)
Truck Traffic Material Delivery		
Flatbed Truck	84	84
Erection Panel Installation		
Mobile Crane	85	85

Note 1: Not all vehicles are likely to be in simultaneous operation. Maximum level represents the highest level realistically likely at any given time.
Note 2: Based on manufacturer's information.

As indicated in the table, no blasting is anticipated for the project. Additionally, there is no need for concrete pouring throughout the solar fields. The base slabs for the inverters and other electrical equipment will be precast and dropped in place. Concrete pouring is only likely for the transformer base in the substation. A concrete pump truck typically generates a sound level of

[7] U. S. Dept. of Transportation, Federal Highway Administration, *Roadway Construction Noise Model User's Guide*, Table 1, Jan. 2006.

about 82 dBA at 50 feet[8], or the boundary of the substation. At the nearest house (DP-1, 530 ft.) this sound level would decrease to around 60 dBA and occur only intermittently during the day; most likely only for a day or two.

7.0 Conclusions

A seven day field survey of the existing ambient sound levels in the immediate vicinity of the future substation associated with the Willowbrook Solar Project was carried out to establish what the baseline environmental conditions are and determine what effect the sound emissions from the transformers at the existing substation might be having at the nearest residences. The survey results indicate that the sound emissions from the existing substation are largely or totally insignificant during the day at the nearest homes, irrespective of time of day. Environmental sound levels in the vicinity of the substation are driven by sources unrelated to the existing substation, such as distant traffic, wind rustle, birds, etc.

The sound power level of the step up transformer associated with the proposed substation was calculated from its expected maximum MVA rating of 158 and mathematically projected to the nearest potentially sensitive receptors. This projection indicates that any sound emissions from the new transformer will likely be comparable to the current natural background sound level making it largely imperceptible most of the time at the nearest residences. Generally speaking, no significant adverse community noise impact is expected from the proposed substation.

Beyond the substation, there will some sound from the electrical inverters distributed throughout the solar fields. While the sound emissions from this equipment are not negligible in overall magnitude and tonal in character close to these units, the higher frequency tonal aspect drops away very quickly with distance and field measurements indicate that inverter sound fades to insignificance relative to normal background levels at a distance of 150 ft. Moreover, inverter sound is rarely audible at the perimeter fence of typical solar fields so an adverse noise impact at the nearest residences beyond the project boundary appears to be highly unlikely from this equipment. In any event, options exist to mitigate inverter sound emissions should any problem arise.

In contrast to other forms of power generation, sound emissions during construction are expected to be dramatically lower in magnitude and duration. Some unavoidable disturbance is possible when the mounting posts are driven in but this activity will be fairly short-lived in any particular location. Other sounds from trenching and road building will also be brief in duration and will progress from place to place avoiding prolonged exposure at any specific location.

In general, the potential noise impacts from all aspects of the project are expected to minimal.

[8] Ibid.

Hessler Associates, Inc.
WORLDWIDE CONSULTING IN ENGINEERING ACOUSTICS

Table: T-2114-070218-0
Title: Substation Transformer Sound Propagation Calculations
Project: Willowbrook Solar
Revision: 0
Date: 7/1/18

Descriptor			31.5	63	125	250	500	1000	2000	4000	8000	dBA	dBC
			Octave Band Center Frequency, Hz										
1. Sound Power Level Estimate Based on MVA Rating, Assume Standard Core													
Maximum Expected MVA Rating	**158**	MVA										101	
Standard NEMA Rating		NEMA = 55 +12 log (MVA), per EEI Guide*										81	
Size Factor (10 log s) Based on MVA												19	
Frequency Adjustment Factors			-3	3	5	0	0	-6	-11	-16	-23		
Near Field Lp Based on NEMA Rating			78	84	86	81	81	75	70	65	58	82	
Nom. Lw = NEMA Rating + 10 log s			98	104	106	101	101	95	90	85	78	101	
Observed Conservatism Calc vs. Meas.			-6	-6	-6	-6	-6	-6	-6	-6	-6		
Likely Actual Lw			**92**	**98**	**100**	**95**	**95**	**89**	**84**	**79**	**72**	**95**	

* Edison Electric Institute, "Electric Power Plant Environmental Noise Guide", 2nd Ed., BBN, 1984.

2. Calculated Sound Pressure at DP-1

Descriptor			31.5	63	125	250	500	1000	2000	4000	8000	dBA	dBC
Path Attenuation:													
Source Receiver Distance	**162**	m		**530** ft.									
Hemispherical Distance Loss, m	162		-52	-52	-52	-52	-52	-52	-52	-52	-52		
Air Absorption (10°C / 70%RH), m	162		0	0	0	0	0	-1	-1	-3	-8		
Anomalous Attenuation, m	162		0	0	0	0	-1	-1	-1	-2	-2		
Number of Sources	1		0	0	0	0	0	0	0	0	0		
Ground Attenuation per ISO 9613-2	Ag = 0.5		0	0	-2	-6	-3	-1	-1	-1	-1		
Sum of Path Attenuation:			-52	-52	-55	-59	-56	-55	-56	-58	-64		
Est. Receptor Lp			**40**	**45**	**45**	**36**	**39**	**34**	**28**	**21**	**8**	**40**	

3. Calculated Sound Pressure at DP-2

Descriptor			31.5	63	125	250	500	1000	2000	4000	8000	dBA	dBC
Path Attenuation:													
Source Receiver Distance	**177**	m		**580** ft.									
Hemispherical Distance Loss, m	177		-53	-53	-53	-53	-53	-53	-53	-53	-53		
Air Absorption (10°C / 70%RH), m	177		0	0	0	0	0	-1	-2	-4	-9		
Anomalous Attenuation, m	177		0	0	0	0	-1	-1	-1	-2	-2		
Number of Sources	1		0	0	0	0	0	0	0	0	0		
Ground Attenuation per ISO 9613-2	Ag = 0.5		0	0	-2	-6	-3	-1	-1	-1	-1		
Sum of Path Attenuation:			-53	-53	-55	-60	-57	-56	-57	-59	-65		
Est. Receptor Lp			**39**	**45**	**44**	**35**	**38**	**33**	**27**	**20**	**6**	**39**	

4. Calculated Sound Pressure at DP-3

Descriptor			31.5	63	125	250	500	1000	2000	4000	8000	dBA	dBC
Path Attenuation:													
Source Receiver Distance	**229**	m		**750** ft.									
Hemispherical Distance Loss, m	229		-55	-55	-55	-55	-55	-55	-55	-55	-55		
Air Absorption (10°C / 70%RH), m	229		0	0	0	0	0	-1	-2	-5	-12		
Anomalous Attenuation, m	229		0	0	0	-1	-1	-1	-2	-2	-3		
Number of Sources	1		0	0	0	0	0	0	0	0	0		
Ground Attenuation per ISO 9613-2	Ag = 0.5		0	0	-4	-6	-3	-1	0	0	0		
Sum of Path Attenuation:			-55	-56	-60	-62	-59	-58	-59	-62	-70		
Est. Receptor Lp			**36**	**42**	**40**	**33**	**35**	**31**	**25**	**17**	**2**	**36**	

Notes:
Lp = Sound Pressure Level, dB re 20 mPa
Lw = Sound Power Level, dB re 1 pW

Table: T-2114-070218-0
Title: Substation Transformer Sound Propagation Calculations
Project: Willowbrook Solar
Revision: 0
Date: 7/1/18

Descriptor				31.5	63	125	250	500	1000	2000	4000	8000	dBA	dBC
				Octave Band Center Frequency, Hz										
5. Calculated Sound Pressure at DP-4														
Path Attenuation:														
Source Receiver Distance	**366**	m	**1200** ft.											
Hemispherical Distance Loss, m	366			-59	-59	-59	-59	-59	-59	-59	-59	-59		
Air Absorption (10°C / 70%RH), m	366			0	0	0	0	-1	-2	-3	-7	-19		
Anomalous Attenuation, m	366			0	0	-1	-1	-1	-2	-3	-4	-5		
Number of Sources	1			0	0	0	0	0	0	0	0	0		
Ground Attenuation per ISO 9613-2	Ag = 0.5			0	0	-4	-6	-3	-1	0	0	0		
Sum of Path Attenuation:				-60	-60	-64	-67	-64	-64	-65	-70	-83		
Est. Receptor Lp				**32**	**38**	**36**	**28**	**31**	**25**	**19**	**9**	**-11**	**31**	

Notes:
Lp = Sound Pressure Level, dB re 20 mPa
Lw = Sound Power Level, dB re 1 pW