PIKE COUNTY
SOLAR PROJECT

Exhibit D
Acoustic Assessment Report

Acoustic Assessment Report

Pike County Solar Project

PREPARED FOR
Pike County Solar Project, LLC

DATE
17 April 2024

REFERENCE
0718089

CONTENTS

ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ANSI	American National Standards Institute
dB	decibels
dBA	A-weighted decibels
DC	Direct Current
ERM	Environmental Resources Management, Inc.
FHWA	Federal Highway Administration
Hz	Hertz
IEEE	Institute of Electrical and Electronics Engineers
ISO	Organization for Standardization
kVA	Kilo-volt Ampere
L_{eq}	The equivalent noise level
L_{dn}	The day-night noise level
Lmax	The maximum noise level
LOD	Level of Disturbance
MVA	Mega-volt Ampere
MW	Megawatts
NSA	Noise Sensitive Area

1. INTRODUCTION

Pike County Solar Project, LLC (Applicant) proposes to construct and operate the Pike County Solar Project (Project), a photovoltaic (PV) solar facility in Pike County, Kentucky. The Applicant has engaged Environmental Resources Management, Inc. (ERM) to conduct a noise assessment for the proposed Project.

This report presents the results of construction and operational noise predictions. The noise assessment was carried out to understand the noise levels that would be generated from the construction and operation of the Project. This report also provides general information on noise and comparisons of the expected Project noise levels to estimated existing ambient conditions and guidelines.

1.1 General Information on Noise

Noise is defined as unwanted sound. Excessive noise can cause annoyance and adverse health effects. Annoyance can include sleep disturbance and speech interference. It can also distract attention and make activities more difficult to perform (USEPA 1978).

The range of pressures that cause the vibrations that create noise is large. Noise is therefore measured on a logarithmic scale, expressed in decibels (dB). The frequency of a sound is the “pitch”. The unit for frequency is hertz (Hz), or cycles per second. Most sounds are composed of a composite of frequencies. The human ear can usually distinguish frequencies from 20 Hz (low frequency) to about 20,000 Hz (high frequency), although people are most sensitive to frequencies between 500 and 4000 Hz. The individual frequency bands can be combined into one overall dB level.

Noise is typically measured on the A-weighted scale (dBA). The A-weighting scale has been shown to provide a good correlation with the human response to sound and is the most widely used descriptor for community noise assessments (Harris, 1991). The faintest sound that can be heard by a healthy ear is about 0 dBA, while an uncomfortably loud sound is about 120 dBA. In order to provide a frame of reference, ERM has listed some common sound levels below.

- Pile Driver at 100 feet 90 to 100 dBA
- Chainsaw at 30 feet 90 dBA
- Truck at 100 feet 85 dBA
- Noisy Urban Environment 75 dBA
- Lawn Mower at 100 feet 65 dBA
- Average Speech 60 dBA
- Average Office 50 dBA
- Rural Residential During the Day 40 dBA
- Quiet Suburban nighttime 35 dBA
- Soft Whisper at 15 feet 30 dBA

Common terms used in this noise analysis are defined below.

- *L_{eq}* – The equivalent noise level over a specified period of time (i.e., 1-hour). It is a single value of sound that includes all the varying sound energy in a given duration.
- *L_{dn}* – the day-night noise level, is the A-weighted L_{eq} sound level over a 24-hour period with an additional 10 dB penalty imposed on sounds that occur between 10 p.m. and 7 a.m. to account for the increased sensitivity to noise during these periods.

1.2 Applicable Noise Standards

1.2.1 Noise Ordinances and Standards

No local noise ordinances or Commonwealth of Kentucky noise standards applicable to the Project were identified.

1.2.2 United States Environmental Protection Agency Guidelines

In 1974, the U.S. Environmental Protection Agency (USEPA) published its document entitled "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin on Safety" (USEPA 1974). This publication evaluated the effects of environmental noise with respect to health and safety. The USEPA recommended in the document that environmental noise levels should not exceed a day-night sound level (L_{dn}) of 55 dBA. A 55 dBA L_{dn} noise level equates to a continuous sound level of 48.6 dBA (i.e., a facility that does not exceed a continuous noise level of 48.6 dBA for a 24-hour period will not exceed 55 dBA L_{dn}). This level was developed for "outdoor residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use". The USEPA considers this level as protective of the public health and welfare from the effects of environmental noise and notes that this criterion was developed without regard to technical or economic feasibility and contains a margin of safety.

1.3 Project Description and Noise Sensitive Areas

The Project evaluated herein would be capable of generating up to 100 megawatts (MW) of electricity and would consist of an estimated 191,436 photovoltaic modules located on approximately 500 acres (array) within an overall project evaluation area of 1,543 acres (Project Boundary). The main noise generating components during the operational phase of the project include 25 direct current (DC) to alternating current (AC) power inverters, 25 auxiliary transformers, and one 150 megavolt-amperes (MVA) main step-up transformer. Noise sensitive areas (NSAs) consist of light density residential uses around the Project Boundary. A review of aerial photography identified 21 NSAs in proximity to the Project to be evaluated. NSA receptor locations, distances/directions from the property line of participating landowners, and distances to the nearest Project Boundary limits, solar panel, inverter, and substation are provided in Table 1 and depicted on Figure 1.

Table 1. Noise Sensitive Area Receptors

Receiver	Land Use Type	Approximate Distance (feet) to Nearest Project Structure			
		Project Boundary	Panel	Inverter	Substation
NSA 1	Residential	1530	1954	2651	16780
NSA 2	Residential	3675	3983	4413	18946
NSA 3	Residential	2321	2888	3593	14318
NSA 4	Residential	928	2282	3103	11879
NSA 5	Residential	2114	2225	2759	8607
NSA 6	Residential	2888	2688	3186	17163
NSA 7	Residential	432	1780	2232	4605
NSA 8	Residential	687	1861	2432	4564
NSA 9	Residential	2405	3751	4186	6517
NSA 10	Residential	3735	4414	4793	4012
NSA 11	Residential	4044	4209	4841	4713
NSA 12	Residential	1189	3051	3341	3119
NSA 13	Residential	2496	2818	3299	2534
NSA 14	Residential	25	2600	3297	4307
NSA 15	Residential	724	2486	2907	3561
NSA 16	Residential	24	3470	4800	8404
NSA 17	Residential	994	4335	4939	9234
NSA 18	Residential	1353	4012	4921	11360
NSA 19	Residential	1407	3300	4445	13316
NSA 20	Residential	670	2259	3403	13407
NSA 21	Residential	865	1094	2131	13601

2. EXISTING CONDITIONS

Existing sources of noise in the area likely include vehicular traffic noise from U.S. Highway 119, vehicular traffic on other roadways in the area, and natural sounds (e.g., birds and insects). Existing ambient noise levels in the area were estimated by evaluating the land uses in the area and the aforementioned noise sources. General ambient noise levels by land use have been estimated by the USEPA (USEPA 1978). However, a more detailed estimate is provided in American National Standards Institute (ANSI) standard 12.9-2013/Part 3 (ANSI 2013). The standard provides estimates of existing noise levels based on detailed descriptions of land use categories. The levels are in general agreement with those published by USEPA. The ANSI standard noise estimation divides land uses into six (6) distinct categories. These categories, their descriptions, and the estimated existing daytime and nighttime L_{eq} sound levels, are provided in Table 2.

Table 2. Measured Sound Levels at the Noise Sensitive Area

Category	Land Use	Description	Estimated Existing Daytime L_{eq}	Estimated Existing Nighttime L_{eq}
1	Noisy Commercial and Industrial Areas	Very heavy traffic conditions, such as in busy downtown commercial areas, at intersections of mass transportation and other vehicles, including trains, heavy motor trucks and other heavy traffic, and street corners where motor buses and heavy trucks accelerate.	66	58
2	Moderate Commercial and Industrial Areas, and Noisy Residential Areas	Heavy traffic areas with conditions similar to Category 1 but with somewhat less traffic, routes of relatively heavy or fast automobile traffic but where heavy truck traffic is not extremely dense, and motor bus routes.	61	54
3	Quiet Commercial, Industrial Areas, and Normal Urban and Noisy Residential Areas	Light traffic conditions where no mass transportation vehicles and relatively few automobiles and trucks pass, and where these vehicles generally travel at low speeds. Residential areas and commercial streets and intersections with little traffic comprise this category.	55	49
4	Quiet Urban and Normal Residential Areas	These areas are similar to Category 3 above but, for this group, the background is either distant traffic or is unidentifiable.	50	44
5	Quiet Suburban Residential Areas	Isolated areas, far from significant sources of sound.	45	39
6	Very Quiet, Sparse Suburban or Rural Areas	These areas are similar to Category 5 above but are usually in unincorporated areas and, for this group, there are few if any near neighbors.	40	34

Source: ANSI 2013

Existing ambient noise levels at the NSAs in the area were estimated utilizing the ANSI standard. Based upon a review of the land uses, the NSAs in the area are conservatively estimated to fall into a Category 6 land use (Very Quiet, Sparse Suburban or Rural Areas), with estimated daytime L_{eq} sound levels of 40 dBA and nighttime L_{eq} sound levels of 34 dBA.

3. NOISE MODELING

3.1 Operational Noise Modeling Methodology

ERM performed computer modeling to calculate noise levels that will be generated during Project operation and used the commercially available CadnaA model developed by DataKustik GmBH for the analyses (DataKustik GmBH 2006). The software has the ability to account for spreading losses, ground and atmospheric effects, shielding from barriers and buildings, and reflections from surfaces. The software is standards-based. ERM used the International Organization for Standardization (ISO) 9613 standard for air absorption and other noise propagation calculations (ISO 1996). ERM assumed a partially acoustically reflective ground surface (0.5 setting in the model). A setting of "0" corresponds to an acoustically reflective surface, such as pavement or water, while a setting of 1.0 corresponds to loose soils and grassy surfaces. ERM also included area topography. ERM did not account for any vegetation or foliage in order to develop a conservative assessment.

Modeling was conducted for daytime and nighttime operation with Project sources in operation at full load conditions. All sources were included for daytime operation. The inverters would not operate at night when no electricity is being produced, and inverter noise was therefore not included in the nighttime model. Discrete model receptors were placed at the location of the NSA locations. Noise contours were also produced such that noise levels at any location, including along the property line of participating landowners, could be visualized.

A summary of the equipment sources included in the noise modeling assessment and their height above grade is provided in Table 3. Table 4 provides the noise emissions data at maximum load and the derivation of each.

Table 3. Equipment Source Listing

Equipment	Number of Each	Height Above Grade (feet)
Inverter	25	7.5
5 kVA Auxiliary Transformer	25	5
150 MVA Main Step-Up Transformer	1	13

kVA = Kilovolt-amperes

Table 4. Noise Emissions Derivation for Project Sources

Equipment	Noise Emissions Data	Data Source/Vendor
Inverter	81 dBA at 3 feet	SMA[a]
5 kVA Auxiliary Transformer	59 dBA at 3 feet	IEEE[b]
150 MVA Main Step-Up Transformer	82 dBA at 3 feet	IEEE[b]

a. SMA Solar Technology AG

b. Emissions data developed utilizing Institute of Electrical and Electronics Engineers (IEEE) Standard C57.12.90-2010 based on transformer MVA rating.

3.2 Operational Noise Model Results

Model results for Project operation with Project sources operating simultaneously at full load conditions are provided in Table 5 for both daytime and nighttime conditions at all NSA locations and at the property line of participating landowners. The modeled levels are also compared to the estimated existing ambient conditions and to the USEPA's impact guideline. While the USEPA guideline is not a regulatory requirement, it is useful as a guide to evaluate potential noise impacts.

Table 5. Noise Modeling Results

Receiver	Modeled Daytime Noise Level (dBA)	Estimated Daytime Ambient Condition (dBA)	Modeled Nighttime Noise Level (dBA)	Estimated Nighttime Ambient (dBA)	USEPA Recommended Protective Guideline (dBA)
NSA 1	6	40	0	34	48.6
NSA 2	0	40	0	34	48.6
NSA 3	15	40	0	34	48.6
NSA 4	9	40	2	34	48.6
NSA 5	4	40	0	34	48.6
NSA 6	6	40	0	34	48.6
NSA 7	5	40	0	34	48.6
NSA 8	7	40	0	34	48.6
NSA 9	19	40	4	34	48.6
NSA 10	3	40	0	34	48.6
NSA 11	6	40	1	34	48.6
NSA 12	18	40	7	34	48.6
NSA 13	10	40	7	34	48.6
NSA 14	14	40	4	34	48.6

Receiver	Modeled Daytime Noise Level (dBA)	Estimated Daytime Ambient Condition (dBA)	Modeled Nighttime Noise Level (dBA)	Estimated Nighttime Ambient (dBA)	USEPA Recommended Protective Guideline (dBA)
NSA 15	20	40	19	34	48.6
NSA 16	9	40	0	34	48.6
NSA 17	16	40	10	34	48.6
NSA 18	13	40	7	34	48.6
NSA 19	11	40	0	34	48.6
NSA 20	12	40	0	34	48.6
NSA 21	8	40	0	34	48.6
Project Boundary [a]	51	40	50	34	48.6

[a] Highest modeled noise level for any location along the Project Boundary line. No NSAs are present in this area.

As provided in Table 5, daytime operational noise levels at the NSA locations are shown to be very low, ranging from 0 dBA to 20 dBA, well below the estimated existing daytime ambient noise levels (40 dBA). Nighttime Project noise levels, with only the transformers in operation, were also very low, ranging from 0 dBA to 19 dBA. The existing topographical features result in significant shielding effects from the Project sources to the NSAs, resulting in very low modeled noise levels. Project generated noise levels for daytime and nighttime operation are well below the USEPA's recommended protective noise level of 48.6 dBA for 24-hour operation at the NSA locations.

The highest noise level modeled for any location along the Project Boundary is 51 dBA. This point on the Project property line is approximately a half-mile from the nearest NSA (NSA 13). All modeled noise levels assume Project sources operating at full load conditions. There will often be times when sources are operating at lower loads, with subsequently lower noise levels at the NSAs and the property line.

Noise contour maps depicting the modeled noise levels for daytime and nighttime operating conditions are provided in Figures 2 and 3, respectively.

3.3 Construction Noise

3.3.1 Pile Driving

A total of 38,953 piles will be installed to support the solar panels. The installation of each pile occurs very quickly, typically requiring 90 seconds or less per pile. It is estimated that pile driving will occur over a 40-day period, six days per week, during daylight hours.

Maximum sound level (Lmax) pile driving noise levels of 101 dBA at 50 feet were obtained from the Federal Highway Administration's Roadway Construction Noise Model. No usage factors were incorporated into the analysis so that Lmax sound levels would be calculated at the various distances rather than time-averaged sound levels.

Pile driving noise levels were modeled using the same methodology as utilized for the operational noise modeling, including the existing topographic features in the area. The modeled expected pile driving noise level at each NSA is provided in Table 6. The noise levels presented are for the nearest approach any one single pile driver will be to the respective NSA. As provided in Table 6, pile driving noise levels are shown to be below the estimated existing ambient condition at most NSA locations, due to the shielding effect provided by area topography. Only a few NSA locations are shown to have pile driving noise levels above ambient, and only when pile driving is occurring at the nearest approach to the NSA. Pile driving activity will occur over a very large area, and no one NSA will experience the same or a constant noise level. As piles are quickly installed, noise levels will decrease as piles are installed at greater distances away from an NSA. As a noise mitigation measure, no nighttime pile driving will be conducted, with pile driving scheduled to only occur between the hours of 8 a.m. and 8 p.m. Additionally, NSAs within 1,500 feet of where pile driving will occur will be notified prior to commencing construction.

Table 6. Maximum Expected Pile Driving Noise from Nearest Pile Driver (dBA)

Receiver	Maximum Pile Driving Noise from Nearest Pile Driver
NSA 1	40
NSA 2	33
NSA 3	35
NSA 4	38
NSA 5	38
NSA 6	47
NSA 7	41
NSA 8	56
NSA 9	33
NSA 10	31
NSA 11	32
NSA 12	40
NSA 13	45
NSA 14	41
NSA 15	50
NSA 16	33
NSA 17	34
NSA 18	32
NSA 19	41
NSA 20	39

Receiver	Maximum Pile Driving Noise from Nearest Pile Driver
NSA 21	50

3.3.2 General Construction

Construction typically includes the following phases:

- Site preparation
- Excavation
- Foundation Construction
- Building Construction
- Restoration/Finishing

The construction equipment utilized will differ from phase to phase but will include dozers, pile drivers, cranes, cement mixers, dump trucks, and loaders. Noise is generated during construction primarily from diesel engines, which power the equipment. Exhaust noise usually is the predominant source of diesel engine noise, which is the reason that maintaining functional mufflers on all equipment will be a requirement.

Table 1 provided the closest distance any NSA would be to the panel. However, the Project Boundary covers a very large area. The actual sound levels that will be experienced by NSAs surrounding the site during construction will be a function of distance and which equipment are in operation. As such, no single existing NSA will be exposed to the same sound levels over an extended period of time, as construction progresses through the site.

Construction noise transmitted from the site will be attenuated by a variety of mechanisms. The most significant of these mechanisms are the divergence of the sound waves with distance (attenuation by divergence), and the significant shielding effect of the existing topographical features. Additional reductions in noise are achieved through absorption by the atmosphere. Noise levels of construction equipment that may be used for the Project are summarized in Table 7 (FHWA 2006). Provided in Table 8 are the modeled noise levels for the range of construction equipment presented at each NSA location. General construction noise levels were modeled using the same methodology as utilized for the operational and pile driving noise modeling, including the existing topographic features in the area.

Table 7. Construction Equipment Noise Levels (dBA)

Equipment Type	Maximum Sound Level [a]
	50 Feet
Cement Trucks	79
Front End Loaders	79
Graders	85
Dozers	82
Pickup Trucks	55

Equipment Type	Maximum Sound Level [a]
	50 Feet
Backhoes	78
Concrete Mixers	79
Air Compressor	78
Dump Trucks	77
Cranes	81
Flatbed Trucks	74
Pile Driving	101

[a] Source: FHWA, 2006

Table 8. General Construction Equipment Noise Assessment (dBA)

Receiver	Range of Construction Equipment Noise Levels Operating at Nearest Panel
NSA 1	0 to 24
NSA 2	0 to 17
NSA 3	0 to 19
NSA 4	0 to 22
NSA 5	0 to 22
NSA 6	1 to 31
NSA 7	0 to 25
NSA 8	10 to 40
NSA 9	0 to 17
NSA 10	0 to 15
NSA 11	0 to 16
NSA 12	0 to 24
NSA 13	0 to 29
NSA 14	0 to 25
NSA 15	4 to 34
NSA 16	0 to 17
NSA 17	0 to 18
NSA 18	0 to 16
NSA 19	0 to 25
NSA 20	0 to 23
NSA 21	4 to 34

General construction related noise levels will be lower than pile driving noise levels. As noted above, the project site covers a very large area, and the noise levels experienced at any NSAs will vary depending on what areas of the site are being constructed at any given time. It is important to note that all of the equipment listed is not used in all phases of construction. Further, the equipment used generally is not operated continuously, nor is the equipment always operated simultaneously or at full load conditions.

Construction is a temporary activity, and there are no known noise limits applicable to construction. Exhaust noise from diesel engines that power the equipment is usually the predominant source of construction equipment noise. Accordingly, maintaining functional mufflers on all diesel-powered equipment will be a mitigation measure and a requirement of the project. As an additional mitigation measure, construction will only occur during daytime hours.

4. CONCLUSION

This report presents the results of the noise assessment ERM conducted for the Pike County Solar Project in Pike County, Kentucky. The assessment included a noise model of the construction noise and major facility noise generating equipment operating under full load conditions during both daytime and nighttime operating conditions. ERM evaluated the operational noise model results against estimated existing ambient conditions and the USEPA noise guidance.

The construction noise assessment, conducted for both pile driving and general construction activity, revealed that pile driving noise levels would be below the estimated existing ambient condition at most NSA locations, due to the shielding effect provided by area topography. Only a few NSA locations were shown to have pile driving noise levels above ambient, and only when pile driving is occurring at the nearest approach to the NSA. General construction related noise levels would be lower than pile driving noise.

The operational noise assessment revealed that Project-generated noise levels would be well below estimated existing conditions at all identified NSA locations during daytime hours with all equipment in operation at full load. Much lower operational noise levels, well below the estimated ambient condition, would occur during nighttime hours when the Project inverters are not in operation. Modeled levels were also shown to be well below the USEPA recommended protective noise level at all nearby NSAs during both daytime and nighttime operating conditions.

5. REFERENCES

American National Standards Institute (ANSI). 2013. S12.9-2013/Part 3 (Quantities and Procedures for Description and Measurement of Environmental Sound. Part 3: Short-Term Measurements with an Observer Present).

DataKustik GmbH. 2006. Computer Aided Noise Abatement Model CadnaA. Munich, Germany.

Federal Highway Administration (FHWA). 2006. FHWA Roadway Construction Noise Model User's Guide

Harris, Cyril M. 1991. Handbook of Acoustical Measurements and Noise Control, Third Edition (McGraw-Hill, Inc.).

Institute of Electrical and Electronics Engineers. (IEEE). 2010. Standard C57.12.90-1999. General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

International Organization for Standardization (ISO). 1996.. Standard ISO 9613-2 Acoustics – Attenuation of Sound During Propagation Outdoors, Part 2 General Method of Calculation. Geneva, Switzerland.

United States Environmental Protection Agency (USEPA). 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. Office of Noise Abatement & Control. Report Number EPA 550/9-74-009. Washington, D. C. 20460

USEPA. 1978. Protective Noise Levels. Office of Noise Abatement & Control. Report Number EPA 550/9-79-100. Washington, D. C. 20460.

APPENDIX A FIGURES

M:\US\Projects\S-U\Savion\Pike_County_Solar_ArcGIS\Pike County NSAs.aprx\NSA Map, REVISED: 03/18/2024, SCALE: 1:40,000 when printed at 8.5x11

Drawn By: Casey.Brotman

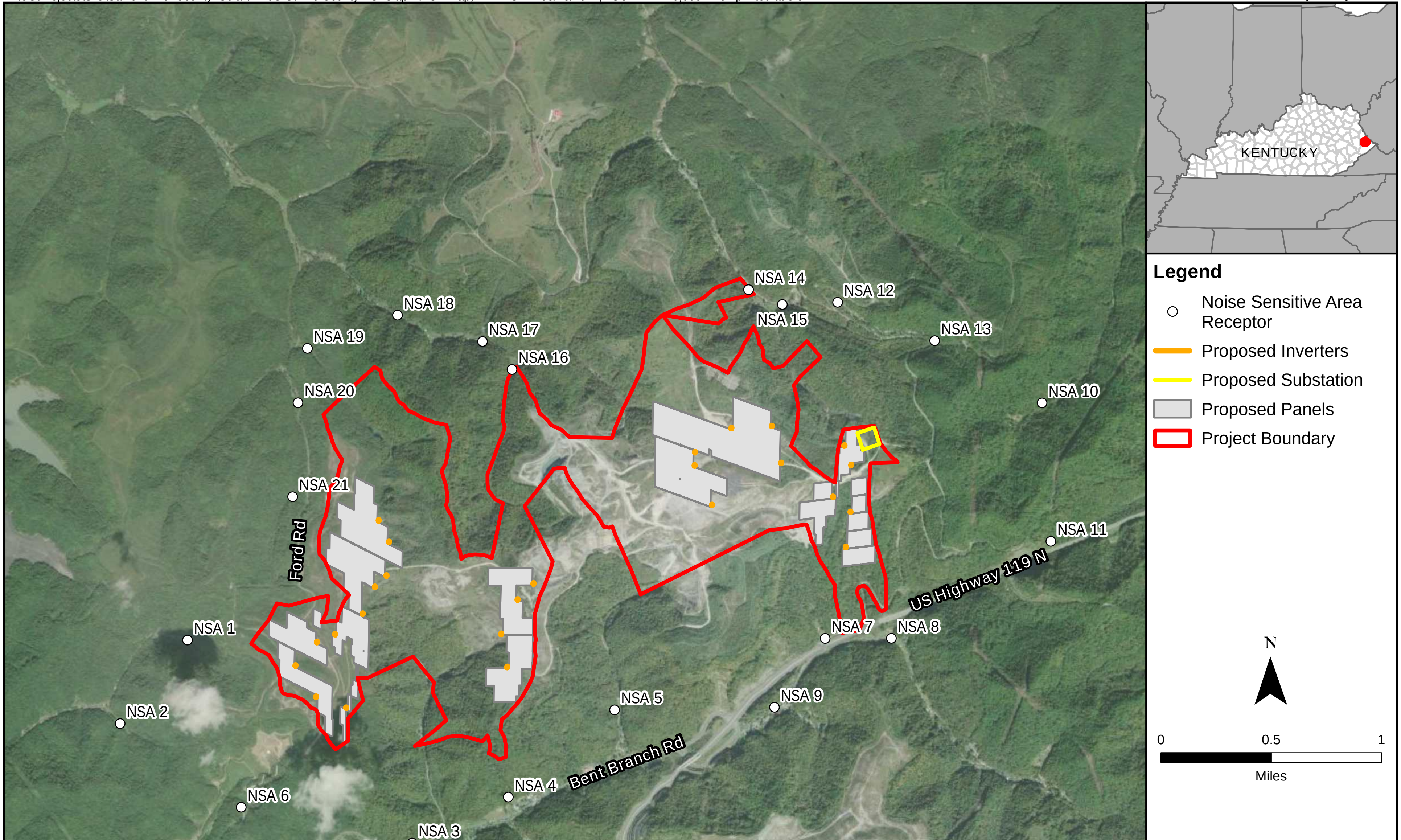


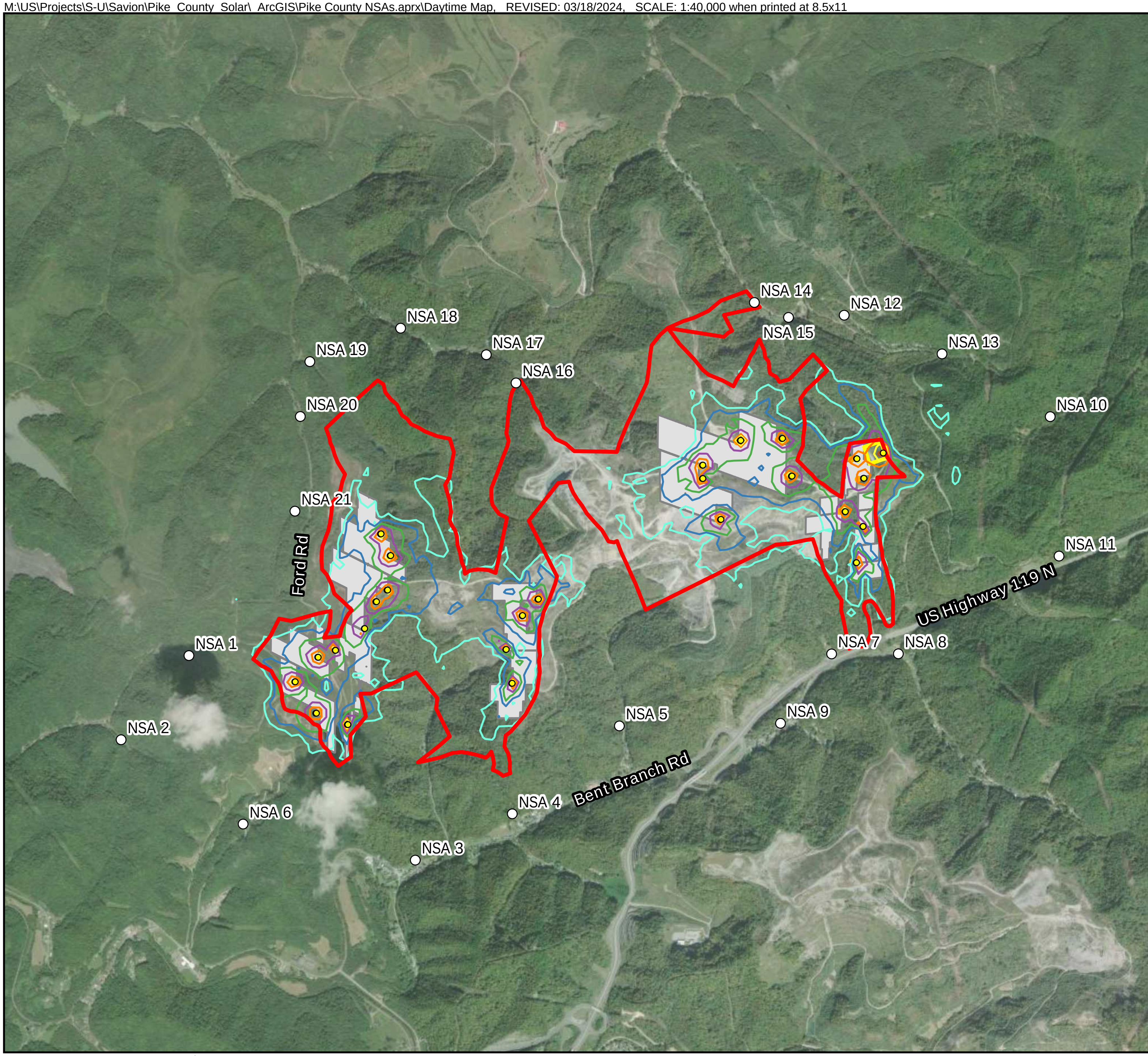
Figure 1
Noise Sensitive Areas Map
Pike County Solar Project
Pike County Solar Project, LLC
Pike County, Kentucky

ERM

Source: World Imagery (Map Service) NAD 1983 UTM Zone 17N

M:\US\Projects\S-U\Savion\Pike_County_Solar_ArcGIS\Pike County NSAs.aprx\Daytime Map, REVISED: 03/18/2024, SCALE: 1:40,000 when printed at 8.5x11

Drawn By: Casey.Brotman



Legend

- Noise Sensitive Area Receptor
- Daytime Point Sources
- Proposed Inverters
- Proposed Substation
- Proposed Panels
- Project Boundary

Operational Daytime Sound Level Contours

- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA
- 55 dBA
- 60 dBA
- 65 dBA

N

0 0.5 1

Miles

Figure 2

Operational Noise Contours

Daytime Map

Pike County Solar Project

Pike County Solar Project, LLC

Pike County, Kentucky

ERM

Source: World Imagery (Map Service) NAD 1983 UTM Zone 17N

M:\US\Projects\S-U\Savion\Pike_County_Solar_ArcGIS\Pike County NSAs.aprx\Nighttime Map, REVISED: 03/18/2024, SCALE: 1:40,000 when printed at 8.5x11

Drawn By: Casey.Brotman

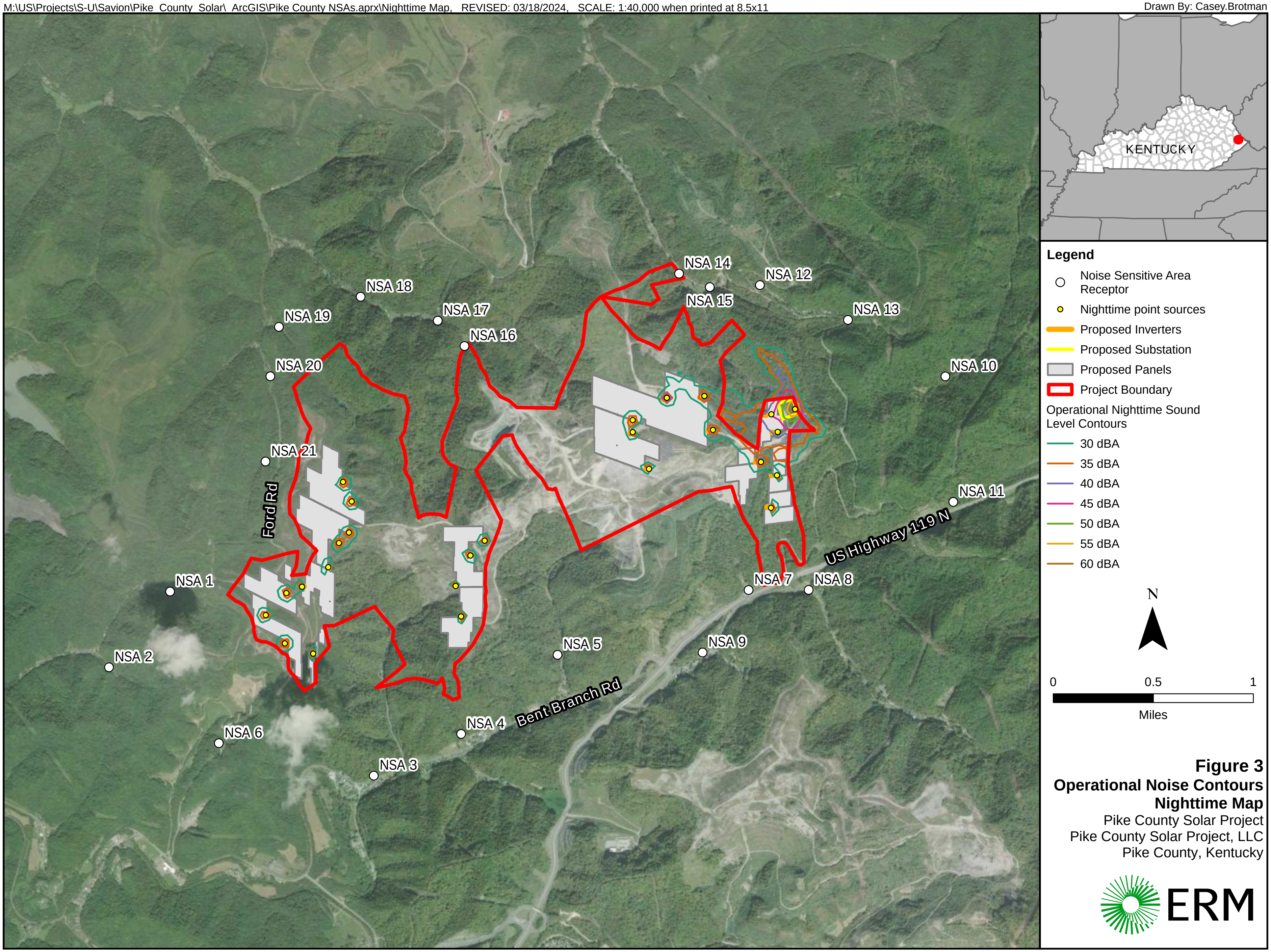


Figure 3
Operational Noise Contours
Nighttime Map
Pike County Solar Project
Pike County Solar Project, LLC
Pike County, Kentucky

ERM

Source: World Imagery (Map Service) NAD 1983 UTM Zone 17N