Exhibit X

Noise

Bakeoven Solar Project
November 2019

Prepared for

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Acronyms and Abbreviations

Applicant	Bakeoven Solar, LLC
BPA	Bonneville Power Administration
CadnaA	Computer Aided Noise Abatement software program
Corona 3	Corona and Field Effects Program Version 3
Council or EFSC	Oregon Energy Facility Siting Council
dB	decibel
dBA	A-weighted decibels
Facility	Bakeoven Solar Project
FHWA	Federal Highway Administration
HVAC	heating, ventilation, and air conditioning
Hz	hertz
ISO	International Organization for Standardization
kV	kilovolt
L_{10}	intrusive sound level
L_{50}	median sound level
L_{90}	residual sound level
L_{eq}	equivalent sound level
NSR	Noise Sensitive Receptor
OAR	Oregon Administrative Rule
UTM	Universal Transverse Mercator

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1.0 Introduction

Bakeoven Solar, LLC (Applicant) proposes to construct and operate a solar energy generation facility and related or supporting facilities in Wasco County, Oregon. This Exhibit X was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(x).

2.0 Analysis Area

The analysis area for noise impacts is defined in OAR 345-021-0010 as including noise sensitive receptors (NSRs) within 1 mile of the site boundary. The site boundary is defined in detail in Exhibits B and C, and the site boundary and analysis area are depicted on Figures X-1 and X-2.

3.0 Regulatory Environment

A review was conducted of noise regulations applicable to the Bakeoven Solar Project (Facility) at the federal, state, county, and local levels. There are no federal environmental noise requirements specific to this Facility. In addition, Wasco County has no noise requirements for consideration in this analysis.

The following subsections describe the regulations at the State level that apply to the Facility, including the Oregon Energy Facility Siting Council (EFSC or Council) rule regarding the contents of Exhibit X, and the Oregon Department of Environmental Quality's (ODEQ) noise control standards in OAR 340-035-0035 (ODEQ Noise Rules).

3.1 Required Contents of Exhibit X

In accordance with OAR 345-021-0010(1)(x), Exhibit X must include the following:

> *Information about noise generated by construction and operation of the proposed facility, providing evidence to support a finding by the Council that the proposed facility complies with the Oregon Department of Environmental Quality's noise control standards in OAR 340-035-0035. The applicant shall include:*
>
> *(A) Predicted noise levels resulting from construction and operation of the proposed facility.*
>
> *(B) An analysis of the proposed facility's compliance with the applicable noise regulations in OAR 340-035-0035, including a discussion and justification of the methods and assumptions used in the analysis.*
>
> *(C) Any measures the applicant proposes to reduce noise levels or noise impacts or to address public complaints about noise from the facility.*
>
> *(D) Any measures the applicant proposes to monitor noise generated by operation of the facility.*

(E) *A list of the names and addresses of all owners of noise sensitive property, as defined in OAR 340-035-0015, within one mile of the proposed site boundary.*

3.2 ODEQ Noise Rules

The ODEQ Noise Rules relevant to the Facility are provided in OAR 340-035-0035, and are incorporated in the Council's general standard of review, OAR 345-022-0000. The ODEQ Noise Rules provide an antidegradation standard and maximum permissible statistical noise levels for new industrial or commercial noise sources on a previously unused site.[1]

OAR 340-035-0035(1)(b)(B)(i)

No person owning or controlling a new industrial or commercial noise source located on a previously unused industrial or commercial site shall cause or permit the operation of that noise source if the noise levels generated or indirectly caused by that noise source increase the ambient statistical noise levels, L_{10} or L_{50}, by more than 10 dBA in any one hour, or exceed the levels specified in Table 8, as measured at an appropriate measurement point, as specified in subsection (3)(b) of this rule, except as specified in subparagraph (1)(b)(B)(iii).

OAR 340-035-0035(1)(b)(B)(ii)

The ambient statistical noise level of a new industrial or commercial noise source on a previously unused industrial or commercial site shall include all noises generated or indirectly caused by or attributable to that source including all of its related activities. Sources exempted from the requirements of section (1) of this rule, which are identified in subsections (5)(b) - (f), (j), and (k) of this rule, shall not be excluded from this ambient measurement."

The specific levels of "Table 8" of OAR 340-035-0035(1)(b)(A) are listed in Table X-1 below for reference. All levels are presented in terms of dBA, which is a weighting scaled for human hearing. The L_{50} is the median sound level (50 percent of the measurement interval is above this level, 50 percent is below). The noise limits apply at "appropriate measurement points" on "noise sensitive property"[2] as defined in OAR 340-035-0035(3)(b). The appropriate measurement point is defined as whichever of the following is farther from the noise source:

- 25 feet toward the noise source from that point on the noise sensitive building nearest the noise source; or
- The point on the noise-sensitive property line nearest the noise source.

"Noise sensitive property" is defined in OAR 340-035-0035(3)(b) as "real property normally used for sleeping, or normally used as schools, churches, hospitals or public libraries. Property used in

[1] A "previously unused industrial or commercial site" is defined in OAR 340-035-0015(47) as property which has not been used by any industrial or commercial noise source during the 20 years immediately preceding commencement of construction of a new industrial or commercial source on that property.
[2] For purposes of this exhibit, "noise sensitive property" is the same as an NSR.

industrial or agricultural activities is not Noise Sensitive Property unless it meets the above criteria in more than an incidental manner." Noise-sensitive properties are referred to as NSRs in this exhibit and are identified in Attachment X-1. A total of 23 NSRs were identified within 1 mile of the site boundary, also referred to as the analysis area.

Table X-1. New Industrial and Commercial Noise Standards

Statistical Descriptor	Maximum Permissible Statistical Noise Levels (dBA)	
	Daytime (7:00 AM – 10 PM)	Nighttime (10 PM – 7 AM)
L_{50}	55	50
L_{10}	60	55
L_{1}	75	60
Source: OAR 340-035-0035, Table 8. dBA = A-weighted decibel		

In accordance with the regulatory definitions in OAR Chapter 340-035, the analysis presented in this Exhibit X assumes that both the solar facility and the 230-kilovolt (kV) transmission line will constitute an industrial or commercial use, predominantly located on previously unused sites. Therefore, to be compliant with OAR 340-035-0035(1)(b)(B)(i), the Facility must demonstrate that, as a result of operation, the ambient statistical noise level must not be increased by more than 10 dBA in any one hour at any identified NSR. In the absence of actual ambient sound data, the Oregon Department of Energy has previously allowed transmission line applicants to assume a default rural background sound level[3]. The applied default background sound levels are further discussed in Section 4.2.

Because the operations of solar facilities change from the daytime to nighttime periods this analysis evaluates compliance for each period separately. The compliance point at the identified NSRs presented within this analysis is 25 feet toward the noise source from the noise-sensitive building. Property line compliance will not be evaluated due to the agricultural use of land in the vicinity of the analysis area and because the property line is generally located closer to Facility sound sources in relation to the 25-foot point of compliance as defined in OAR 340-035-0035(3)(b).

3.2.1 Exemptions to State Noise Regulations

OAR 340-035-0035(5) specifically exempts construction activity from the state noise standards and regulations, as indicated below.

OAR 340-035-0035(5) Exemptions:

[3] The Applicant has conservatively modeled all locations, but reserves the right to argue that portions of the Facility constitute new sources located on previously used sites, and that these locations will not exceed the absolute limits provided in Table 8 or as per OAR 340-035-0035(1)(b)(A).

Except as otherwise provided in subparagraph (1)(b)(B)(ii) of this rule, the rules in section (1) of this rule shall not apply to:

[section abridged for brevity]

(b) Warning devices not operating continuously for more than 5 minutes;

(g) Sounds that originate on construction sites.

(h) Sounds created in construction or maintenance of capital equipment;

(j) Sounds generated by the operation of aircraft and subject to pre-emptive federal regulation. This exception does not apply to aircraft engine testing, activity conducted at the airport that is not directly related to flight operations, and any other activity not pre-emptively regulated by the federal government or controlled under OAR 340-035-0045;

(k) Sounds created by the operation of road vehicle auxiliary equipment complying with the noise rules for such equipment as specified in OAR 340-035-0030(1)(e);

(m) Sounds created by activities related to the growing or harvesting of forest tree species on forest land as defined in subsection (1) of ORS 526.324.

In accordance with the allowable exemptions, the Applicant will claim noise produced during construction as an exemption to the ODEQ Noise Rules.

4.0 Existing Conditions

The Facility will be located in a rural area with low population density. Within the analysis area, there are a total of 23 NSRs. All NSRs were identified as single-family residential structures. Given the lack of industrial and commercial sound sources, the Applicant expects the existing area of the Facility to have low ambient sound levels.

A wide range of noise settings occur within the acoustic analysis area. The background sound level will vary spatially and is related to various physical characteristics such as topography, land use, proximity to transportation corridors and terrain coverage including extent and height of exposed vegetation. The acoustic environment will also vary due in part to surrounding land use and population density. Existing noise sources in the vicinity of the Facility site include Bonneville Power Administration (BPA) Maupin Interconnection Substation, transmission lines, and local roadways. Table X-2 shows the relative A-weighted noise levels of common sounds measured in the environment and industry.

Table X-2. Typical Sound Levels Measured in the Environment and Industry

Sound Source or Activity	Sound Level (dBA)	Subjective Impression	Relative Loudness (Perception of Different Sound Levels)
Jet aircraft takeoff from carrier (50 feet)	140	Threshold of pain	64 times as loud
50-horsepower (hp) siren (100 feet)	130		32 times as loud
Loud rock concert near stage Jet takeoff (200 feet)	120	Uncomfortably loud	16 times as loud
Float plane takeoff (100 feet)	110		8 times as loud
Jet takeoff (2,000 feet)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 feet)	90		2 times as loud
Garbage disposal Food blender (2 feet) Pneumatic drill (50 feet)	80	Loud	Reference loudness
Vacuum cleaner (10 feet)	70	Moderate	1/2 as loud
Passenger car at 65 mph (25 feet)	65		
Large store air-conditioning unit (20 feet)	60		1/4 as loud
Light auto traffic (100 feet)	50	Quiet	1/8 as loud
Quiet rural residential area with no activity	45		
Bedroom or quiet living room Bird calls	40	Faint	1/16 as loud
Typical wilderness area	35		
Quiet library, soft whisper (15 feet)	30	Very quiet	1/32 as loud
Wilderness with no wind or animal activity	25	Extremely quiet	
High-quality recording studio	20		1/64 as loud
Acoustic test chamber	10	Just audible	
	0	Threshold of hearing	

Adapted from: Beranek 1988, EPA 1971.
dBA = A-weighted decibels

For the purposes of the acoustic analysis and the regulatory compliance assessment, the Applicant completed a baseline sound monitoring program in the vicinity of the Facility to demonstrate compliance with OAR 340-035-0035(1)(b)(B)(i), which establishes criteria incrementally relative to existing conditions.

4.1 Field Measurement Methodology

Collection of field data was necessary to define the existing daytime and nighttime ambient sound levels at NSRs in the analysis area. A total of four short-term (30-minute) sound measurement locations were selected within the analysis area at publicly accessible land in proximity to NSRs.

These measurement locations were selected to represent the nearest NSAs to the Facility within the analysis area. The short-term monitors consisted of a sound level analyzer directly mounted to a tripod with the microphone and windscreen at a height of approximately 5 feet above ground.

All measurements were taken with a Larson Davis 831 real-time sound level analyzer, equipped with a PCB model 377B02 ½-inch precision condenser microphone. This instrument has an operating range of 5 decibels (dB) to 140 dB, and an overall frequency range of 8 to 20,000 hertz (Hz) and meets or exceeds all requirements set forth in the American National Standards Institute standards for Type 1 sound level meters for quality and accuracy.

Prior to any field measurements, all test equipment was field calibrated with an American National Standards Institute Type 1 calibrator that has accuracy traceable to the National Institute of Standards and Technology. Each sound analyzer was programmed to measure and log broadband A-weighted sound pressure levels in 10- and 1-minute time intervals as well as a number of statistical sound levels (L_n). The statistical sound levels provide the sound level exceeded for that percentage of time over the given measurement period. For example, the L_{10} level is often referred to as the intrusive noise level, and is the sound level that is exceeded 10 percent of the measurement period. The equivalent sound level (L_{eq}), L_{10} (intrusive noise level), L_{50} (median), and L_{90} (residual sound level) sound metrics were data-logged for the duration of the monitoring period to fully characterize the ambient acoustic environment. Data were collected for 1/1 and 1/3 octave band data spanning the frequency range of 8 Hz to 20 kilohertz. The locations of monitoring locations were recorded using a global positioning system unit, and photographs were taken to document surroundings. Following the completion of the measurement period all monitored data was downloaded to a computer and backed up on an external hard drive for further analysis.

When sound measurements are attempted in the presence of elevated wind speeds, extraneous noise can be self-generated across the microphone and is often referred to as "pseudonoise." Air blowing over a microphone diaphragm creates a pressure differential and turbulence. All sound level analyzer microphones were protected from wind-induced pseudonoise by a 7-inch-diameter foam windscreen made of specially prepared open-pored polyurethane. By using this microphone protection, the pressure gradient and turbulence are effectively moved farther away from the microphone, minimizing self-generated wind-induced noise. Weather conditions during the baseline sound survey were conducive for accurate data collection.

Several statistical sound levels were measured by the monitors in consecutive 1-second and 1-minute intervals during each 30-minute measurement period. Of these, the median, or L_{50}, level (the sound level exceeded 50 percent of the time), is considered the most meaningful quantity for this type of survey. It captures the consistently present sound level that exists during each period in the absence of sporadic and extraneous noise events, such as wind gusts or aircraft overflights. The results of the baseline monitoring program were used to establish a range of existing ambient sound levels within the analysis area and assist in determining compliance with OAR 340-035-0035(1)(b)(B)(i), which prescribes an incremental increase limit of 10 dBA over the ambient statistical noise levels of either the L_{10} or L_{50}.

4.2 Sound Survey Analysis and Results

Measurements of the existing sound levels were conducted for both the daytime and nighttime periods. OAR 340-035-0035(1)(b)(A) defines daytime (7:00 AM – 10:00 PM) and nighttime (10:00 PM – 7:0 AM) statistical noise limits as summarized in Table X-1. A solar facility will operate primarily during the daytime period; however, the facility transformers will also operate during nighttime hours. Therefore, the baseline measurement data were correlated by daytime and nighttime measurement periods, for purposes of assessing compliance with the ambient degradation test.

Table X-3 presents a summary of ambient sound survey results at each monitoring location, providing information including Universal Transverse Mercator (UTM) coordinates and distance to the nearest Facility fence line (see Exhibit C, Figure C-2 for proposed fence line). In addition, daytime and nighttime L_{eq}, L_{10}, L_{50}, and L_{90} parameters are provided. Figure X-1 shows the monitoring locations selected for the baseline sound survey. Measurements were collected on publicly accessible land closest to the corresponding NSRs.

Table X-3. Summary of Ambient Sound Survey Results

Noise Sensitive Location ID	UTM Coordinates		Distance to Nearest Facility Fence Line (feet/meters)	Time Period	Baseline Sound Level Metric			
	Easting (meters)	Northing (meters)			L_{eq}	L_{10}	L_{50}	L_{90}
ST-1	665823	5002689	1,161/354	Day	54	44	26	21
				Night	47	35	25	21
ST-2	667176	5000847	800/244	Day	55	36	29	26
				Night	27	26	22	20
ST-3	667663	5000076	465/142	Day	54	39	29	23
				Night	23	28	17	16
ST-4	670181	4997481	5,585/1,703	Day	33	37	31	24
				Night	35	31	29	16

L_{eq} = equivalent sound level; L_{10} = intrusive sound level; L_{50} = median sound level; L_{90} = residual sound level; UTM = Universal Transverse Mercator

Ambient sound level measurements were not conducted along the proposed transmission line. Based on precedent set by previously approved transmission line projects, the Applicant assumed the default rural background sound level for NSRs located along the transmission line of 20 dBA during fair weather. The 20 dBA was determined based on the average L_{50} nighttime noise levels collected at the ambient sound monitoring locations near the Facility. The average sound level was approximately 23 dBA and a 3 dB reduction was applied to be conservative. However, applying a 20 dBA ambient noise level during rainfall is not a reasonable assumption because moderate rainfall can generate noise levels of up to 50 dBA[4,5]. Therefore, Facility noise levels were also evaluated for rainy conditions, but a 6 dB increase was applied to the 20 dBA ambient sound level to account for increased sound levels generated by rainfall, resulting in an applied ambient sound level of 26 dBA for rainy conditions. A 6 dB increase represents a human's noticeable perception in the change of sound. Humans perceive a change in sound of 3 dB as barely perceptible and 6 dB as a noticeably perceptible. Applying a 6 dB increase, which is a noticeable perceived change in sound, is a conservative assumption to account for increases due to rainfall that can generate noise levels up to 50 dBA.

Furthermore, during moderate rainfall, people would typically be located indoors. Interior noise levels during rainfall can range from 52 dBA to 69 dBA depending on roofing material[6]. This increased noise level is due to the impact of rain drops on roofs. The impact noise from rain would typically be much louder than the corona noise generated from the transmission line. Therefore, applying the 20 dBA default background would not be a reasonable assumption. A 26 dBA default background for rainy conditions would be considered a conservative assumption given the elevated noise from rain and that people would typically be located indoors during a moderate rain fall event.

5.0 Predicted Noise Levels and Assessment of Compliance with Applicable Noise Regulations

> *OAR 345-021-0010(1)(x) Information about noise generated by construction and operation of the proposed facility, providing evidence to support a finding by the Council that the proposed facility complies with the Oregon Department of Environmental Quality's noise control standards in OAR 340-035-0035. The applicant shall include:*
>
> *(A) Predicted noise levels resulting from construction and operation of the proposed facility.*
>
> *(B) An analysis of the proposed facility's compliance with the applicable noise regulations in OAR 340-035-0035, including a discussion and justification of the methods and assumptions used in the analysis.*

5.1 Construction Noise Assessment

OAR 340-035-0035(5)(g) exempts noise emanating from construction activities from compliance with the state noise regulations. Therefore, the Applicant provides the following information on construction noise sources for reference.

The Applicant predicted construction noise levels using a semi-qualitative approach based on equipment sound levels provided in the *Federal Highway Administration Roadway Construction*

[4] https://www.asha.org/public/hearing/Loud-Noise-Dangers/
[5] https://chchearing.org/noise/common-environmental-noise-levels/
[6] https://www.bre.co.uk/filelibrary/rpts/IP02_06_Rain_noise.pdf

Noise Model (Federal Highway Administration [FHWA] 2006). This equipment is also used on solar projects, so the FHWA's sound levels are applicable to incorporate into the Facility. Construction activities associated with the Facility have the potential for localized sound on a temporary basis, as construction activities progress through certain locations within the Facility area. Construction activities at the Facility can be generally divided into five phases:

- Preparation of the site and staging areas, including grading and on-site access roads;
- Installation of array foundations, conductors, the operations and maintenance building, and the control enclosure;
- Assembly of solar panels and electrical connection components;
- Construction of the inverter pad, substation, cabling, terminations, and transmission lines; and
- Commissioning of the array and interconnection, revegetation, and waste removal and recycling facilities.

These activities will occur sequentially for discrete groupings of solar arrays, with the potential for overlap. In addition to the solar panels, construction activities will also occur for supporting infrastructure. The inverters and distribution transformers are likely to be completed while respective solar arrays are being constructed; completion of other Facility-related elements, such as the operations and maintenance building, will occur independently.

Sound generated by Facility construction is expected to vary depending on the construction phase. Table X-4 lists the typical sound levels associated with common construction equipment at various distances. Periodically, sound levels may be higher or lower; however, the overall sound levels should generally be lower due to excess attenuation.

Table X-4. Sound Levels from Common Construction Equipment at Various Distances

Construction Equipment	Expected Sound Level by Distance (dBA)			
	50 feet	1,000 feet	2,500 feet	5,000 feet
Bulldozer (250 to 700 horsepower [hp])	88	62	54	43
Front-end loader (6 to 15 cubic yards)	88	62	54	43
Truck (200 to 400 hp)	86	60	52	41
Grader (13- to 16-foot blade)	85	59	51	40
Shovel (2 to 5 cubic yards)	84	58	50	39
Portable generators (50 to 200 kilowatts)	84	58	50	39
Mobile crane (11 to 20 tons)	83	57	49	38
Concrete pumps (30 to 150 cubic yards)	81	55	47	36
Tractor (0.75 to 2 cubic yards)	80	54	46	35
Source: Bolt, Beranek, and Newman, Inc. 1977; FHWA 1992, 2006. dBA = A-weighted decibel				

Overhead transmission line construction is typically completed in the following stages, but various construction activities may overlap, with multiple construction crews operating simultaneously:

- Preparing the site and site access;
- Installing structure foundations;
- Erecting of support structures; and
- Stringing of conductors, shield wire and fiber optic ground wire.

Work in proximity of any single NSR will likely last no more than a few weeks, as construction activities move along the corridor. Therefore, no one NSR will be exposed to significant noise levels for an extended period.

Construction of the Facility will require the use of heavy equipment that will be periodically audible outside the immediate transmission line right-of-way. Construction may generate noise levels that exceed the ambient levels and have the potential to cause a temporary and short-term disturbance.

5.2 Operational Noise Assessment

The Applicant modeled noise sources from the Facility to demonstrate that operation of the Facility will not exceed the noise levels outlined in the ODEQ Noise Rules. Inputs for the acoustic model included the maximum proposed number of inverters, transformers, and battery storage system components (see Exhibits B and C). This analysis presents the noise outputs from the full build out of the Facility; however it may be built in phases. Any individual phase will have less noise output than described in this exhibit.

5.2.1 Acoustic Modeling

Two programs were used for the acoustic analysis, the Corona and Field Effects Program Version 3 (Corona 3) and the Computer Aided Noise Abatement program (CadnaA; DataKustik 2014). The Corona 3 model was used to derive the sound power characteristics of the transmission line. The CadnaA model was used to evaluate the sound emissions associated with the entire Facility and resulting received sound levels throughout the analysis area.

5.2.2 Corona and Field Effects Program

Transmission line corona sound levels were evaluated using the Corona 3 a DOS-based computer model developed by the BPA. The Corona 3 program uses the algorithms to predict a variety of outputs including electric and magnetic fields and audible noise. The inputs to the Corona 3 model are line voltage, load flow (current), the physical dimensions of the line (number of phases, conductor diameter, spacing, height, and subconductor configuration), and site elevation. This method of calculating audible noise from transmission lines is based on long-term statistical data collected from operating and test transmission lines. It calculates the L_{50} noise level during both fair weather conditions and during rainy conditions of 1 inch of precipitation/hour. Long-term measurements show that L_{50} audible noise levels occur at this rain rate. Results during fair weather conditions are also evaluated. Additional details regarding the Corona 3 program are provided in Exhibit AA.

5.2.3 CadnaA

The Applicant performed acoustic modeling for the inverters, transformers, battery storage cooling equipment, and transmission line using CadnaA to calculate received sound levels at identified NSRs within the analysis area. CadnaA conforms to the International Organization for Standardization's (ISO) standard ISO 9613-2 "Attenuation of Sound during Propagation Outdoors" (ISO 1996), which has engineering algorithms that incorporate such factors as geometric divergence, atmospheric absorption, reflection from surfaces, screening by topography and obstacles, terrain complexity and ground effects, source directivity factors, seasonal foliage effects, and meteorological conditions.

CadnaA allows for three basic types of sound sources to be introduced into the model: point, line, and area sources. Each noise-radiating element was modeled based on its noise emission pattern. Point sources were programmed for concentrated small dimension sources such as heating, ventilation, and air conditioning (HVAC) units that radiate sound hemispherically. Line sources assume sound emission along their length, which were used to represent transmission lines in the model. Larger dimensional sources such as the transformers and inverters were modeled as area sources.

Topographical information was imported into the acoustic model using U.S. Geological Survey 10-meter digital elevation models to represent terrain in three dimensions (USGS 2019). Terrain conditions, vegetation type, ground cover, and the density and height of foliage can influence the absorption that takes place when sound waves travel over land. The ISO 9613-2 standard accounts for ground absorption rates by assigning a numerical coefficient of G=0 for acoustically hard, reflective surfaces and G=1 for absorptive surfaces and soft ground. If the ground is hard-packed dirt (which is typically found in industrial complexes), pavement, or water, the absorption coefficient is defined as G=0 to account for reduced sound attenuation. In contrast, ground covered in snow (common at the area during the winter season) or vegetation (including suburban lawns, livestock and agricultural fields; both fallow with bare soil and planted with crops) will be acoustically absorptive and aid in sound attenuation (i.e., G=1.0). For the acoustic modeling analysis, a conservative ground absorption rate of 0.5 was selected, accounting for a semi-reflective ground surface.

Sound propagation in the atmosphere is not strongly dependent on temperature and humidity. The sound level variations caused by wind and temperature gradients are most pronounced for large separation distances. Calculations were completed for meteorological conditions corresponding to moderate downwind propagation (i.e., moderate downward refraction). In other words, the modeling assumes a downwind scenario in all directions. While this wind condition is an impossibility, it tends to result in a conservative assessment of received sound levels from the Facility instead of assuming the predominant wind patterns in the area. Modeling using these conditions assumes efficient outdoor sound propagation between a source and receptor, and is consistent with the ISO 9613-2 standard. Sound attenuation through foliage, and diffraction around and over existing anthropogenic structures such as buildings, were ignored under all acoustic modeling scenarios. The results are therefore representative of defoliate winter conditions.

5.2.4 Acoustic Modeling Input Parameters

5.2.4.1 Solar Facility

The primary sources of noise during operations of the solar facility are the inverters, transformers, battery storage cooling equipment, or HVAC units. Table X-5 summarizes setup parameters used in the Facility acoustic modeling analysis.

Table X-5. Acoustic Model Input Parameters

Model Input	Parameter Value
Acoustic Modeling Software	DataKustik CadnaA v 2018 MR1
Standards	ISO 9613-2: Acoustics – Attenuation of sound during propagation outdoors
Facility Layout Date Received	January 10, 2019
Sources Modeled	152 Inverters, 152 Distribution Transformers, 2 Substation Transformer, 208 HVAC Units, 103 Battery Storage Transformers, 1 230-kV Transmission Line
Receiver Height	1.52 meters
Terrain Parameters	U.S. Geological Survey digital elevation data Agricultural rough fields
Specify Vegetation Areas for Attenuation	No
Ground Absorption	0.5 (semi-reflective), spectral
Temperature	10 degrees Celsius (50 degrees Fahrenheit)
Relative Humidity	70%

Reference sound power levels input into CadnaA were derived from a combination of sources, including manufacturer specifications, reference documents, empirical methods, and field measurements. Actual field measurements were collected on site during normal operation of an existing solar project in nearby Crook County, Oregon. Measurement data were collected at set distances from the inverters and inverter distribution transformers. The collected measurement data were used to calibrate and characterize the inverter and inverter distribution transformer sound sources within the Facility acoustic model. A summary of sound power data for the inverters, transformers, and battery storage cooling equipment is presented in Table X-6.

Table X-6. Sound Power Level by Octave Band Center Frequency for Major Solar Facility Noise Sources

Noise Sources	Octave Band Sound Power Level by Frequency (Hz) dBA									Broadband (dBA)
	31.5	63	125	250	500	1000	2000	4000	8000	
Inverters	77	80	82	95	84	78	75	71	58	88
Inverter Distribution Transformers	69	75	73	81	77	70	66	58	45	77
Substation Transformers	103	109	111	106	106	100	95	90	83	106
Battery Storage HVAC Units	---	94	83	83	85	86	82	76	70	89
Battery Storage Transformers	69	75	73	81	77	70	66	58	45	77
dBA = A-weighted decibels; Hz – hertz										

5.2.4.2 Transmission Line

Audible noise levels are dependent upon the configuration of the transmission line. The Facility will include a new 230-kV overhead transmission line and a new 34.5-kV collector line. This analysis did not include the 34.5-kV collector line, because the noise generated by the overhead and underground portions of this line is well below existing ambient noise levels. Therefore, this analysis only includes noise generated from the 230-kV transmission line. This analysis incorporates the July 2019 realignment of the last 2.5 miles of the transmission line (See Exhibit B). As described in Exhibit AA, the following assumptions were made when modeling the 230-kV transmission line using Corona 3:

- The transmission structure will be an H-frame with three conductors;
- The conductor diameters are 1.345 inches;
- A minimum ground clearance of 30 feet was used for the conductors;
- Rain rate is 1 inch per hour; and
- Wind speed is 2 miles per hour.

The noise emission level for the 230-kV transmission line incorporates the effects of rain, which is considered conservative. However, a fair weather condition was also evaluated in this analysis. A summary of the sound power data for the 230-kV transmission line is presented in Table X-7.

Table X-7. Sound Power Level by Octave Band Center Frequency for the 230-kV Transmission Line

Noise Sources	Octave Band Sound Power Level by Frequency (Hz) dBA									Broadband (dBA)
	31.5	63	125	250	500	1000	2000	4000	8000	
Fair Conditions	33	42	57	57	63	68	69	70	67	76
Rainy Conditions	56	65	80	80	86	91	92	93	90	99
dBA = A-weighted decibels; Hz = hertz.										

5.3 Acoustic Modeling Results

The Facility has been designed to comply with the ODEQ Noise Rules. Modeling results are presented for the solar facility and transmission line, and are provided assuming all components are operating concurrently for the daytime period. For the nighttime period, the Applicant assumed that only the transformers, battery storage HVAC units, and the transmission line would operate. The analysis included evaluations of fair weather and rainy conditions for both the daytime and nighttime.

The Applicant calculated broadband sound pressure levels for expected, normal Facility operation, assuming that all previously identified components operate continuously and concurrently at the representative manufacturer-rated sound level during the daytime, and only the transformers and transmission line operate during the nighttime period in both fair and rainy weather conditions. Tables X-8 and X-9 provides the received sound level at NSRs within 1 mile of the Facility site boundary.

Table X-8. Bakeoven Solar Facility Acoustic Modeling Results for Fair Weather Conditions

NSR ID	Time Period	Background Noise (dBA)	Solar Facility Noise (dBA)	Combined Noise (Background/Solar Facility) (dBA)	Change in Noise (dBA)	Compliance with OAR 340-035-0035
1	Day	20	<10	20	<1	Yes
	Night	20	<10	20	<1	Yes
2	Day	29	26	31	2	Yes
	Night	22	17	23	1	Yes
3	Day	31	<10	31	<1	Yes
	Night	29	<10	29	<1	Yes
4	Day	31	21	31	<1	Yes
	Night	29	15	29	<1	Yes
5	Day	31	29	33	2	Yes
	Night	29	24	30	1	Yes

NSR ID	Time Period	Background Noise (dBA)	Solar Facility Noise (dBA)	Combined Noise (Background/Solar Facility) (dBA)	Change in Noise (dBA)	Compliance with OAR 340-035-0035
6	Day	31	16	31	<1	Yes
	Night	29	11	29	<1	Yes
7	Day	31	<10	31	<1	Yes
	Night	29	<10	29	<1	Yes
8	Day	31	<10	31	<1	Yes
	Night	29	<10	29	<1	Yes
9	Day	31	18	31	<1	Yes
	Night	29	13	29	<1	Yes
10	Day	20	<10	20	<1	Yes
	Night	20	<10	20	<1	Yes
11	Day	31	17	31	<1	Yes
	Night	29	12	29	<1	Yes
12	Day	31	17	31	<1	Yes
	Night	29	12	29	<1	Yes
13	Day	26	26	29	3	Yes
	Night	25	15	25	<1	Yes
14	Day	20	<10	20	<1	Yes
	Night	20	<10	20	<1	Yes
15	Day	20	10	20	<1	Yes
	Night	20	10	20	<1	Yes
16	Day	20	<10	20	<1	Yes
	Night	20	<10	20	<1	Yes
17	Day	31	<10	31	<1	Yes
	Night	29	<10	29	<1	Yes
18	Day	31	<10	31	<1	Yes
	Night	29	<10	29	<1	Yes
19	Day	29	22	30	1	Yes
	Night	22	14	23	1	Yes
20	Day	29	31	33	4	Yes
	Night	22	22	25	3	Yes
21	Day	29	34	35	6	Yes
	Night	17	25	26	9	Yes
22	Day	31	<10	31	<1	Yes

NSR ID	Time Period	Background Noise (dBA)	Solar Facility Noise (dBA)	Combined Noise (Background/Solar Facility) (dBA)	Change in Noise (dBA)	Compliance with OAR 340-035-0035
	Night	29	<10	29	<1	Yes
23	Day	20	10	20	<1	Yes
	Night	20	<10	20	<1	Yes
dBA = A-weighted decibels; NSR = noise sensitive receptor						

Table X-9. Bakeoven Solar Facility Acoustic Modeling Results for Rainy Weather Conditions

NSR ID	Time Period	Background Noise (dBA)	Solar Facility Noise (dBA)	Combined Noise (Background/Solar Facility) (dBA)	Change in Noise (dBA)	Compliance with OAR 340-035-0035
1	Day	26	<10	26	<1	Yes
	Night	26	<10	26	<1	Yes
2	Day	29	26	31	2	Yes
	Night	22	18	23	1	Yes
3	Day	31	<10	31	<1	Yes
	Night	29	<10	29	<1	Yes
4	Day	31	21	31	<1	Yes
	Night	29	20	29	<1	Yes
5	Day	31	29	33	2	Yes
	Night	29	29	32	3	Yes
6	Day	31	16	31	<1	Yes
	Night	29	16	29	<1	Yes
7	Day	31	<10	31	<1	Yes
	Night	29	<10	29	<1	Yes
8	Day	31	<10	31	<1	Yes
	Night	29	<10	29	<1	Yes
9	Day	31	18	31	<1	Yes
	Night	29	17	29	<1	Yes
10	Day	26	<10	26	<1	Yes
	Night	22	<10	22	<1	Yes
11	Day	31	17	31	<1	Yes
	Night	29	17	29	<1	Yes
12	Day	31	17	31	<1	Yes

NSR ID	Time Period	Background Noise (dBA)	Solar Facility Noise (dBA)	Combined Noise (Background/Solar Facility) (dBA)	Change in Noise (dBA)	Compliance with OAR 340-035-0035
	Night	29	16	29	<1	Yes
13	Day	26	26	29	3	Yes
	Night	25	15	25	<1	Yes
14	Day	26	27	30	4	Yes
	Night	26	27	30	4	Yes
15	Day	26	33	34	8	Yes
	Night	26	33	34	8	Yes
16	Day	26	31	32	6	Yes
	Night	26	31	32	6	Yes
17	Day	31	<10	31	<1	Yes
	Night	29	<10	29	<1	Yes
18	Day	31	<10	31	<1	Yes
	Night	29	<10	29	<1	Yes
19	Day	29	22	30	1	Yes
	Night	22	15	23	1	Yes
20	Day	29	31	33	4	Yes
	Night	22	22	25	3	Yes
21	Day	29	34	35	6	Yes
	Night	17	26	26	9	Yes
22	Day	31	<10	31	<1	Yes
	Night	29	<10	29	<1	Yes
23	Day	26	32	33	7	Yes
	Night	26	32	33	7	Yes
dBA = A-weighted decibels; NSR = noise sensitive receptor						

Results show there are no predicted noise exceedances. Figures X-1 through X-4 show sound contour plots displaying broadband sound levels presented as color-coded isopleths for both fair and rain conditions. The noise contours are graphical representations of the cumulative noise associated with full operation of the solar facility components and transmission line, and show how the operational noise would be distributed over the surrounding area within a 1-mile radius of the Facility.

The primary noise sources for the Facility are the substation and battery storage area. The location of the substation and battery storage area in the evaluated design is considered the worst-case location in terms of potential noise impacts. During facility micrositing, the substation and battery storage system could be sited at another location along the transmission line within the micrositing corridor, farther away from NSRs. If these components were relocated within the proposed micrositing corridor, there would be a decrease in Facility noise levels relative to those presented in Table X-8. Therefore, any relocation of the substation and battery storage area northwest along the proposed transmission line micrositing corridor will comply with OAR 340-035-0035(1)(b)(B)(iii)(IV).

6.0 Measures to Reduce Noise Levels or Impacts to Address Public Complaints

OAR 345-021-0010(1)(x)(C) Any measures the applicant proposes to reduce noise levels or noise impacts or to address public complaints about noise from the facility.

The Applicant has demonstrated compliance with the ODEQ Noise Rules at all NSRs within the analysis area. Final equipment specifications and noise warranty data will be reviewed by an acoustician to ensure compliance with OAR 340-035-0035.

The acoustic analysis presented in this exhibit included a number of conservative assumptions. For instance, no additional attenuation for foliage was accounted for and the analysis did not incorporate diffraction around and over existing anthropogenic structures such as buildings. Furthermore, the noise predictions included the wet conditions for corona noise from the 230-kV transmission line. Based on these factors, the predicted noise levels presented in this exhibit are likely more conservative and higher than what will occur during the actual Facility operation. Therefore, no additional noise reduction measures are necessary for operation of the Facility.

7.0 Monitoring

OAR 345-021-0010(1)(x)(D) Any measures the applicant proposes to monitor noise generated by operation of the facility.

No noise monitoring is proposed for the Facility. No exceedances of the OAR 340-035-0035 anti-degradation rule or the fixed thresholds are predicted with implementation of the mitigation measures presented in Section 6.0. Additionally, the legislative authority granted to the Council in OAR 345-026-0010(1) states that under Oregon Revised Statute 469.430, "the Council has continuing authority over the site for which a site certificate is issued and may inspect, direct the Department of Energy to inspect, or ask another state agency or local government to inspect, the site at any time to ensure that the certificate holder is operating the facility in compliance with the terms and conditions of the site certificate."

8.0 Owners of Noise Sensitive Property

OAR 345-021-0010(1)(x)(E) A list of the names and addresses of all owners of noise sensitive property, as defined in OAR 340-035-0015, within one mile of the proposed site boundary.

Attachment X-1 provides the names and addresses, UTM coordinates, and a summary of modeled received sound levels at all noise sensitive properties within 1 mile of the site boundary.

9.0 Submittal Requirements and Approval Standards

9.1 Submittal Requirements

Table X-10. Submittal Requirements Matrix

Requirement	Location
OAR 345-021-0010(1)(x) Information about noise generated by construction and operation of the proposed facility, providing evidence to support a finding by the Council that the proposed facility complies with the Oregon Department of Environmental Quality's noise control standards in OAR 340-035-0035. The applicant shall include:	–
(A) Predicted noise levels resulting from construction and operation of the proposed facility	Section 5.0
(B) An analysis of the proposed facility's compliance with the applicable noise regulations in OAR 340-035-0035, including a discussion and justification of the methods and assumptions used in the analysis.	Section 4.0, Section 5.0
(C) Any measures the applicant proposes to reduce noise levels or noise impacts or to address public complaints about noise from the facility.	Section 6.0
(D) Any measures the applicant proposes to monitor noise generated by operation of the facility.	Section 7.0
(E) A list of the names and addresses of all owners of noise sensitive property, as defined in OAR 340-035-0015, within one mile of the proposed Site Boundary.	Section 8.0, Attachment X-1

9.2 Approval Standards

OAR 345 Division 22 does not provide an approval standard specific to Exhibit X.

10.0 References

Beranek, L. 1988. Noise and Vibration Control, Chapter 7 - Sound Propagation Outdoors. Institute of Noise Control Engineering, Washington, DC.

Bolt, Beranek, and Newman, Inc. 1977. Power Plant Construction Noise Guide, prepared for the Empire State Electric Energy Research Corporation, Report No. 3321, 1977.

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EPA (U.S. Environmental Protection Agency). 1971. Community Noise. NTID300.3 (N-96-01 IIA-231). Prepared by Wylie Laboratories.

FHWA (Federal Highway Administration). 1992. "Procedures for Abatement of Highway Traffic Noise and Construction Noise". Code of Federal Regulations, Title 23, Part 772, 1992.

FHWA. 2006. FHWA Roadway Construction Noise Model User's Guide, FHWA-HEP-05-054, January 2006.

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

USGS (U.S. Geological Survey). 2019. National Geospatial Program, USGS National Elevation Dataset 1/3 arc-second (publish date unknown): U.S. Geological Survey. Accessed April 2019. https://www.arcgis.com/home/item.html?id=988463d698004560b594105967feaaa1#%20.

Figures

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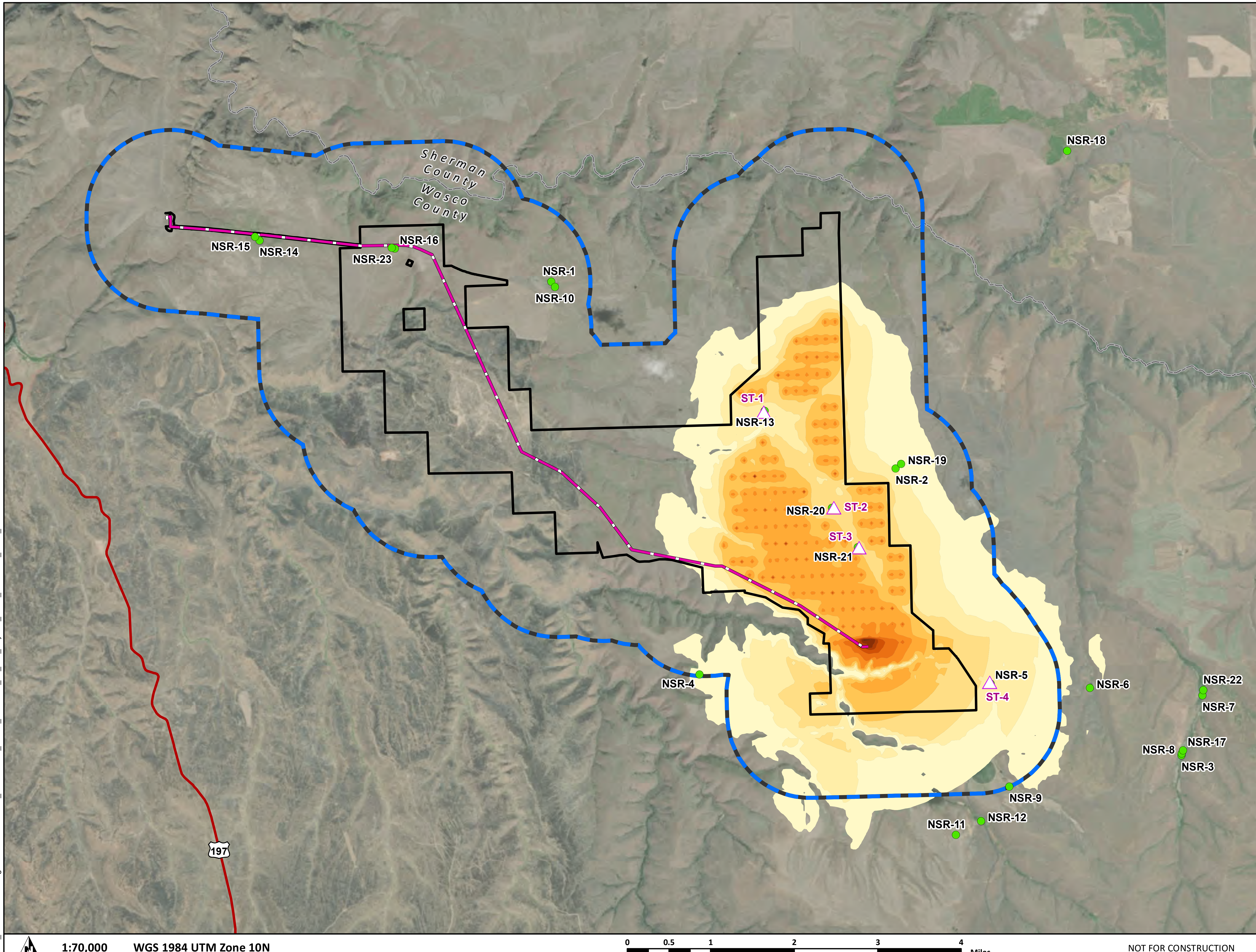


Bakeoven Solar Project

Figure X-1
Summary of Acoustic Modeling Results in Fair Conditions – Daytime Operations

WASCO COUNTY, OREGON

Proposed Site Boundary
Analysis Area (1-mile Buffer)
Noise Sensitive Receptor
Measurement Location

Basemap Features

US Highway
County Boundary

Proposed Facility Layout

Transmission Line (230 kV)

Daytime Noise Contours (dB)

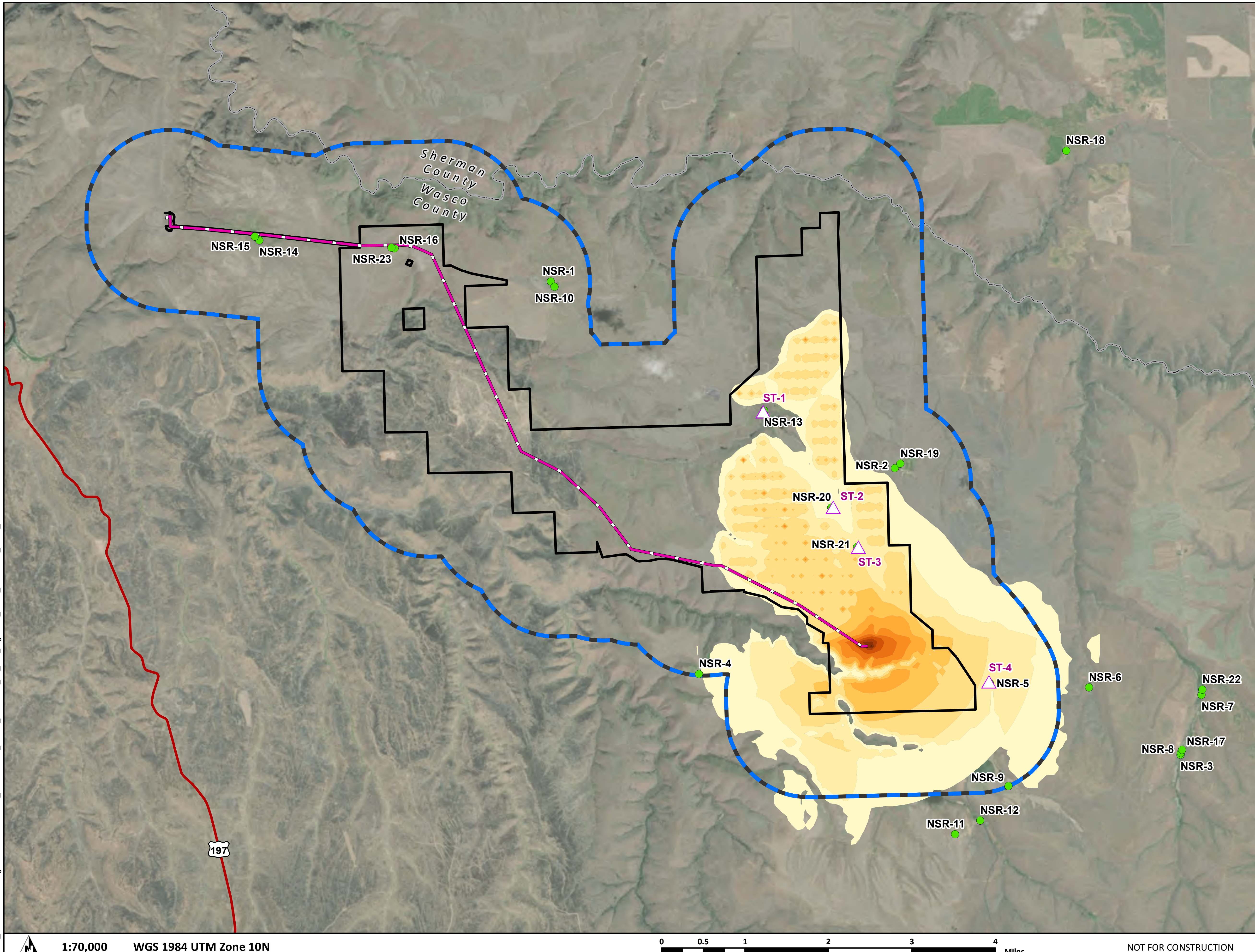
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75

TETRA TECH
AVANGRID RENEWABLES

Data Sources

Avangrid-Project Infrastructure; USDA-Aerial Imagery; Census Bureau-Tiger Roads

Reference Map



Bakeoven Solar Project

Figure X-2
Summary of Acoustic Modeling Results in Fair Conditions – Nighttime Operations

WASCO COUNTY, OREGON

Proposed Site Boundary
Analysis Area (1-mile Buffer)
Noise Sensitive Receptor
Measurement Location

Basemap Features

US Highway
County Boundary

Proposed Facility Layout

Transmission Line (230 kV)

Nighttime Noise Contours (dB)

20 - 25
25 -30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75

TETRA TECH
AVANGRID RENEWABLES

Data Sources

Avangrid-Project Infrastructure; USDA-Aerial Imagery; Census Bureau-Tiger Roads

Reference Map

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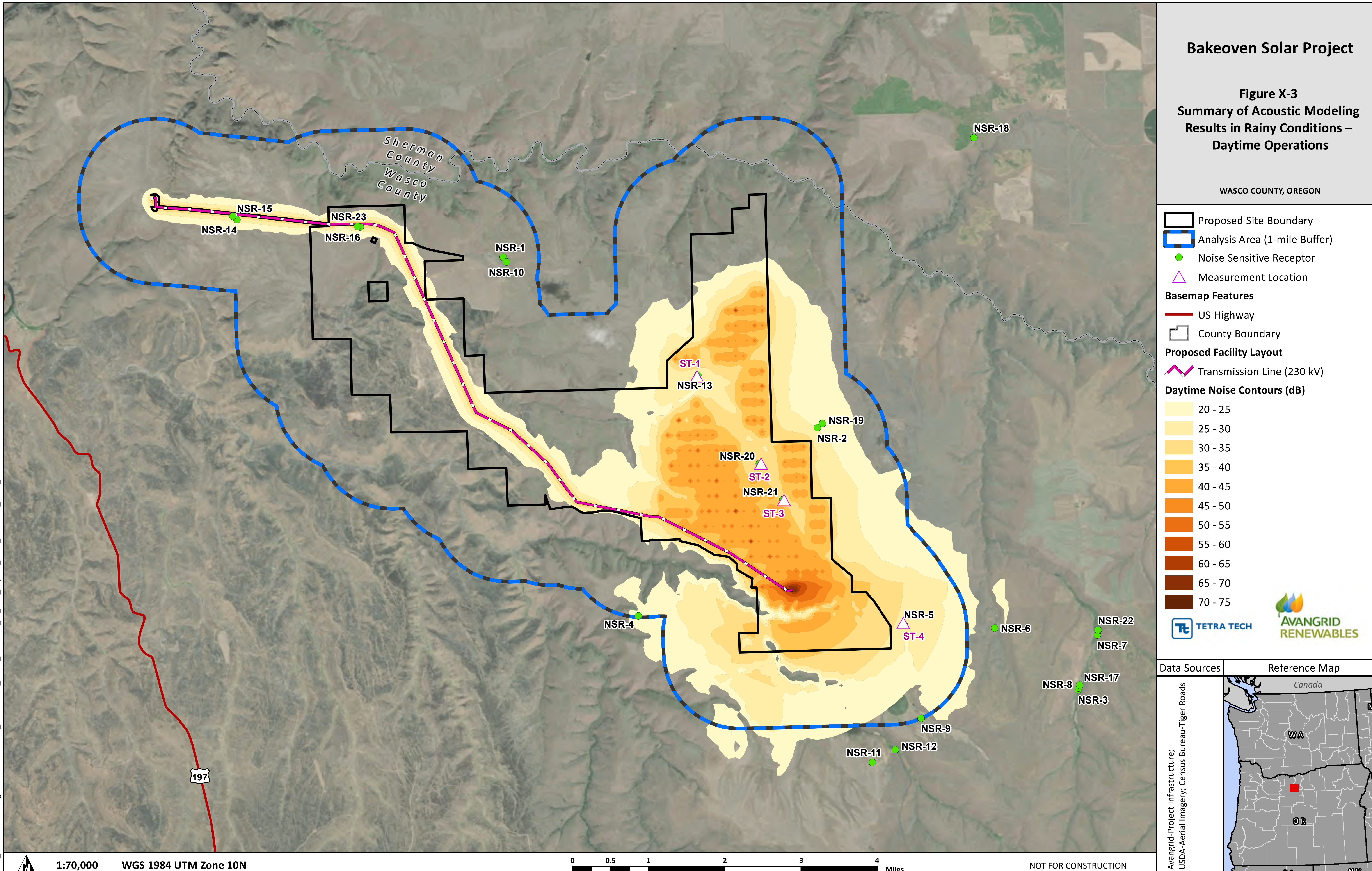
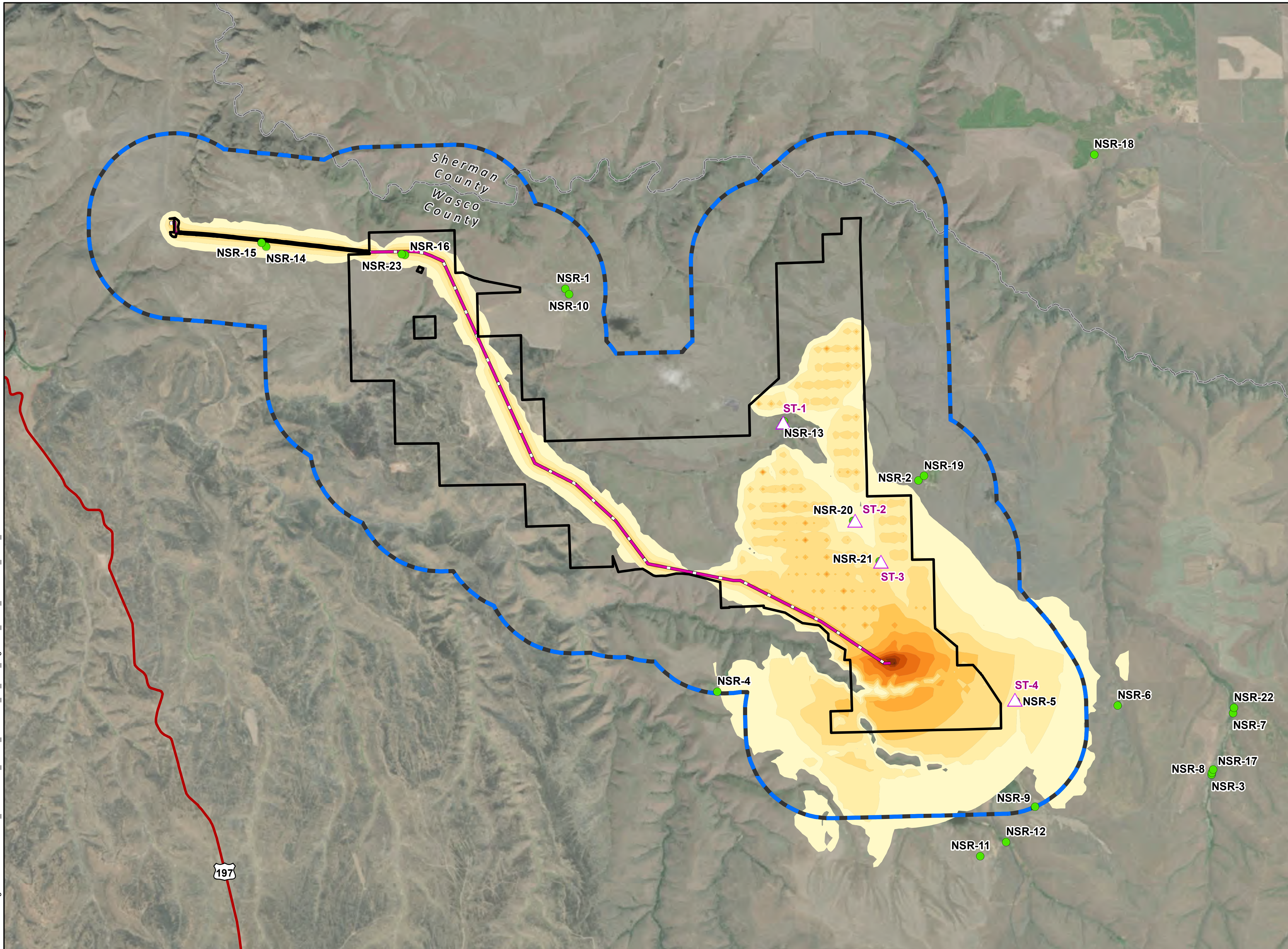


Bakeoven Solar Project
Figure X-3
Summary of Acoustic Modeling Results in Rainy Conditions – Daytime Operations
WASCO COUNTY, OREGON
Proposed Site Boundary
Analysis Area (1-mile Buffer)
Noise Sensitive Receptor
Measurement Location
Basemap Features
US Highway
County Boundary
Proposed Facility Layout
Transmission Line (230 kV)
Daytime Noise Contours (dB)
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
TETRA TECH
AVANGRID RENEWABLES
Data Sources
Avangrid-Project Infrastructure; USDA-Aerial Imagery; Census Bureau-Tiger Roads
Reference Map
Canada
WA
MT
ID
OR
CA
NV
Sherman County
Wasco County
NSR-1
NSR-2
NSR-3
NSR-4
NSR-5
NSR-6
NSR-7
NSR-8
NSR-9
NSR-10
NSR-11
NSR-12
NSR-13
NSR-14
NSR-15
NSR-16
NSR-17
NSR-18
NSR-19
NSR-20
NSR-21
NSR-22
NSR-23
ST-1
ST-2
ST-3
ST-4
197
1:70,000
WGS 1984 UTM Zone 10N
0 0.5 1 2 3 4 Miles
NOT FOR CONSTRUCTION

Bakeoven Solar Project

Figure X-4
Summary of Acoustic Modeling Results in Rainy Conditions – Nighttime Operations

WASCO COUNTY, OREGON



Proposed Site Boundary

Analysis Area (1-mile Buffer)

Noise Sensitive Receptor

Measurement Location

Basemap Features

US Highway

County Boundary

Proposed Facility Layout

Transmission Line (230 kV)

Nighttime Noise Contours (dB)

20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75

TETRA TECH

AVANGRID RENEWABLES

Data Sources

Avangrid-Project Infrastructure; USDA-Aerial Imagery; Census Bureau-Tiger Roads

Reference Map

1:70,000 WGS 1984 UTM Zone 10N

0 0.5 1 2 3 4 Miles

NOT FOR CONSTRUCTION

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Attachment X-1. Owners of Noise Sensitive Properties

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NSR ID	UTM Easting (meters)	UTM Northing (meters)	Maximum Solar Facility Sound Levels (dBA)	Name	Address
1	661725.2	5005203.0	<10	Ashley Larry C & Vicki	90530 Bakeoven Rd, Maupin, Oregon, 97037
2	668366.2	5001599.0	26	Lindley Ruth	87670 Bakeoven Rd, Maupin, Oregon, 97037
3	673874.3	4996067.3	<10	Lindley Ruth	87670 Bakeoven Rd, Maupin, Oregon, 97037
4	664580.9	4997629.0	21	Ashley L Steven et al.	3633 Washington St, San Francisco, California, 94118-1832
5	670195.1	4997450.5	29	Ashley L Steven et al.	3633 Washington St, San Francisco, California, 94118-1832
6	672112.5	4997367.2	16	Connolly Land & Livestock Inc	19570 Pinehurst Rd, Bend, Oregon, 97701-9089
7	674282.3	4997221.3	<10	Connolly Land & Livestock Inc	19570 Pinehurst Rd, Bend, Oregon, 97701-9089
8	673883.7	4996102.3	<10	Brown Lonny & Pamela	PO Box 879, Fairview, Oregon, 97024
9	670558.6	4995465.3	18	Brown Lonny & Pamela	PO Box 879, Fairview, Oregon, 97024
10	661799.6	5005098.7	<10	Conroy Joanne L Trust	541 Summit Ridge Dr, The Dalles, Oregon, 97058
11	669527.6	4994534.8	17	Phillips Don W et al.	PO Box 689, Beavercreek, Oregon, 97004-0689
12	670015.4	4994798.8	17	Phillips Don W et al.	PO Box 689, Beavercreek, Oregon, 97004-0689
13	665838.5	5002711.2	26	Chrisman Levi Family LLC	62261 Deer Trial Rd, Bend, Oregon, 97701
14	656103.8	5005994.4	27	Chrisman Levi Family LLC	62261 Deer Trial Rd, Bend, Oregon, 97701
15	656013.2	5006066.9	33	Carver Daniel L	92462 Hinton Rd, Maupin, Oregon, 97037
16	658712.0	5005840.6	31	Carver Daniel L	92462 Hinton Rd, Maupin, Oregon, 97037
17	673906.7	4996160.5	<10	Carver Daniel L	92462 Hinton Rd, Maupin, Oregon, 97037
18	671672.2	5007728.5	<10	Carver Daniel L	92462 Hinton Rd, Maupin, Oregon, 97037
19	668473.1	5001684.7	24	Carver Daniel L	92462 Hinton Rd, Maupin, Oregon, 97037
20	667139.2	5000838.8	32	Carver Blaine D	91443 Hinton Rd, Maupin, Oregon, 97037
21	667635.1	5000079.8	35	Warnock Ranches Inc	91440 Bakeoven Rd, Maupin, Oregon, 97037
22	674297.3	4997324.2	<10	Warnock Ranches Inc	91440 Bakeoven Rd, Maupin, Oregon, 97037
23	658651.9	5005853.5	32	Ashley Larry C & Vicki	90530 Bakeoven Rd, Maupin, Oregon, 97037

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