ATTACHMENT Q: ACOUSTIC ASSESSMENT REPORT

Acoustic Assessment Report

Hop Hill Solar and Storage Project

December 2022

Prepared for:

HOHI bn, LLC
13123 E Emerald Coast Pkwy, Suite B #158
Inlet Beach, FL 32461

Prepared by

TETRA TECH
1750 S Harbor Way, Suite 400
Portland, OR 97201

Table of Contents

List of Tables

List of Figures

Acronyms and Abbreviations

AC	alternating current
BESS	battery energy storage system
BPA	Bonneville Power Administration
CadnaA	Computer-Aided Noise Abatement
dB	decibel
dBA	A-weighted decibel
dBL	linear decibel
DC	direct current
EDNA	Environmental Designation for Noise Abatement
EFSEC	Energy Project Site Evaluation Council
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
gen-tie line	generation-tie transmission line
HOHI	HOHI bn, LLC, a subsidiary of BNC DEVCO, LLC, which is a joint venture between BrightNight and Cordelio Power
Hz	hertz
ISO	International Organization for Standardization
kV	kilovolt
L_{dn}	day-night average sound level
L_{eq}	equivalent sound level
L_{max}	maximum sound level
LP	sound pressure level
L_w	sound power level
µPa	microPascal
NSR	noise sensitive receptor
POI	point of interconnection
Project	Hop Hill Solar and Storage Project
PV	photovoltaic
Tetra Tech	Tetra Tech, Inc.
WAC	Washington Administrative Code

1.0 INTRODUCTION

HOHI bn, LLC (HOHI), a subsidiary of BNC DEVCO, LLC, which is a joint venture between BrightNight and Cordelio Power, is seeking to develop the Hop Hill Solar and Storage Project (Project) on up to 6,000 acres of agricultural land located approximately 11 miles north of the city of Prosser, Washington, in unincorporated Benton County. The Project would generate up to 500 megawatts (MW) of solar power coupled with up to 500 MW of battery storage and include related interconnection and ancillary support infrastructure. The Project will consist of a solar photovoltaic energy generation system and associated supporting Project facilities such as the battery energy storage system (BESS), network of electrical collector lines, inverter units, step-up transformers, collector substation and transformer, approximately 17.8-mile-long overhead generation-tie transmission line (gen-tie line; a portion of which will occur on U.S. Department of Energy land), internal access roads, operations and maintenance (O&M) structure, and temporary laydown (i.e., staging) areas for construction.

Tetra Tech, Inc. (Tetra Tech) has prepared this acoustic assessment for the Project, evaluating potential sound impacts relative to the applicable noise regulations prescribed in the Washington Administrative Code (WAC). The existing ambient acoustic environment was characterized based on land use, population density, and proximity to major roadways. An acoustic modeling analysis was conducted simulating sound produced during both construction and operation. Operational sound sources consisted primarily of the inverters, step-up transformers, battery storage, and transformer at the on-site substation. The overall objectives of this assessment were to 1) identify Project sound sources and estimate sound propagation characteristics, 2) computer-simulate sound levels using internationally accepted calculation standards, and 3) confirm that the Project will operate in compliance with the applicable noise regulations.

1.1 Project Area

The Project Siting Area is approximately 22,020 acres that encompasses the boundaries of 58 assessor parcels for which HOHI has executed or is pursuing Lease or Easement Option Agreements with the underlying property owner. The Siting Area consists of mostly vacant rangeland with some farmland, farmsteads, and residences. The following terms describe areas associated with Project development:

- Solar Array Siting Area: This is a subset of the "Siting Area" described above. The Solar Array Siting Area is the approximately 11,179-acre buildable area encompassed by the boundaries of 21 privately owned assessor parcels within the Siting Area (Figure 1). The Solar Array Siting Area is the focus of analysis provided in this acoustic assessment.
- Transmission Line Corridor Siting Area: This area is a subset of the "Siting Area" described above. The Project's overhead 230-kilovolt (kV) / 500-kV gen-tie line, approximately 150-foot-wide gen-tie line corridor, three point of interconnection (POI) options, and two switchyard options are within the Transmission Line Corridor Siting Area shown on Figure 1. The Project will use up to two POI and switchyard options depending on the outcome of HOHI's interconnection studies with the Bonneville Power Administration (BPA). These interconnection facilities will be located along the proposed gen-tie routes and the final design will be located within the approximately 340-acre 150-foot-wide gen-tie line corridor

that occurs within the approximately 10,841-acre Transmission Line Corridor Siting Area. The Transmission Line Corridor Siting Area includes additional area along the gen-tie line corridor to accommodate siting flexibility for development of the final POI and selected switchyard option(s). The Transmission Line Corridor Siting Area is larger than the Project's anticipated final developed footprint to allow for minor rerouting and optimization of the overhead 230-kV / 500-kV gen-tie line at final design.

- Project Area: This area is a subset of the "Solar Array Siting Area" and "Transmission Line Corridor Siting Area" described above, and includes up to approximately 6,000 acres where the solar array and associated supporting components, which incorporate the overhead 230-kV / 500-kV gen-tie line, will be sited during final engineering design. HOHI is considering various solar array design layouts within the Project Area and the final design of the solar array and associated supporting components will not exceed approximately 6,000 acres. The Project Area may shift within the Solar Array Siting Area to allow for site optimization of the final design.

Figure 1 provides an overview of the Project Siting Area, Solar Array Siting Area, and Transmission Line Corridor Siting Area and provides the locations of nearby residences, which are considered noise sensitive receptors (NSRs).

Hop Hill Solar and Storage Project

Figure 1
Project Area Extent

Benton County, Washington

Siting Area
Solar Array Siting Area
Transmission Line Corridor Siting Area
Receptor
Participating
Non-Participating
Project Parcels
County Boundary

N

0 1 2 4
Miles

NOT FOR CONSTRUCTION

1.2 Acoustic Metrics and Terminology

All sounds originate with a source, whether it is a human voice, motor vehicles on a roadway, or a combustion turbine. Energy is required to produce sound, and this sound energy is transmitted through the air in the form of sound waves – tiny, quick oscillations of pressure just above and just below atmospheric pressure. These oscillations, or sound pressures, impinge on the ear, creating the sound we hear. A sound source is defined by a sound power level (L_W), which is independent of any external factors. By definition, sound power is the rate at which acoustical energy is radiated outward and is expressed in units of watts.

A source sound power level cannot be measured directly. It is calculated from measurements of sound intensity or sound pressure at a given distance from the source outside the acoustic and geometric near-field. A sound pressure level (L_P) is a measure of the sound wave fluctuation at a given receiver location and can be obtained through the use of a microphone or calculated from information about the source sound power level and the surrounding environment. The sound pressure level in decibels (dB) is the logarithm of the ratio of the sound pressure of the source to the reference sound pressure of 20 microPascals (μPa), multiplied by 20.1. The range of sound pressures that can be detected by a person with normal hearing is very wide, ranging from about 20 μPa for very faint sounds at the threshold of hearing, to nearly 10 million μPa for extremely loud sounds such as a jet during take-off at a distance of 300 feet.

Broadband sound includes sound energy summed across the entire audible frequency spectrum. In addition to broadband sound pressure levels, analysis of the various frequency components of the sound spectrum can be completed to determine tonal characteristics. The unit of frequency is hertz (Hz), measuring the cycles per second of the sound pressure waves. Typically, the frequency analysis examines 11 octave bands ranging from 16 Hz (low) to 16,000 Hz (high). Since the human ear does not perceive every frequency with equal loudness, spectrally-varying sounds are often adjusted with a weighting filter. The A-weighted filter is applied to compensate for the frequency response of the human auditory system and is represented in A-weighted decibels (dBA).

Sound can be measured, modeled, and presented in various formats, with the most common metric being the equivalent sound level (L_{eq}). The L_{eq} has been shown to provide both an effective and uniform method for comparing time-varying sound levels and is widely used in acoustic assessments in the state of Washington. Estimates of noise sources and outdoor acoustic environments, and the comparison of relative loudness, are presented in Table 1. Table 2 presents additional reference information on terminology used in the report.

Table 1. Sound Pressure Levels and Relative Loudness of Typical Noise Sources and Acoustic Environments

Noise Source or Activity	Sound Level (dBA)	Subjective Impression
General		
Vacuum cleaner (10 feet)	70	Moderate
Passenger car at 65 miles per hour (25 feet)	65	
Large store air-conditioning unit (20 feet)	60	
Light auto traffic (100 feet)	50	Quiet
Quiet rural residential area with no activity	45	
Bedroom or quiet living room; bird calls	40	Faint
Typical wilderness area	35	
Quiet library, soft whisper (15 feet)	30	Very quiet
Wilderness with no wind or animal activity	25	Extremely quiet
High-quality recording studio	20	
Acoustic test chamber	10	Just audible
	0	Threshold of hearing
Agricultural Related Activities		
Shotgun	150	Threshold of pain
Hand Grinding of Metal	108	Uncomfortably loud
Unsilenced Air Discharge	105	
Chainsaw	100	
Circular Saw	100	
Petrol-driven Grass Mower	96	
Tractor Cab Maximum	90	
Electrical Drill	87	Loud
Modern Tractor Cab	80	

Adapted from: Beranek (1988) and EPA (1971a), HSE

Table 2. Acoustic Terms and Definitions

Term	Definition
Noise	Typically defined as unwanted sound. This word adds the subjective response of humans to the physical phenomenon of sound. It is commonly used when negative effects on people are known to occur.
Sound Pressure Level (LP)	Pressure fluctuations in a medium. Sound pressure is measured in dB referenced to 20 μPa, the approximate threshold of human perception to sound at 1,000 Hz.
Sound Power Level (LW)	The total acoustic power of a sound source measured in dB referenced to picowatts (one trillionth of a watt). Noise specifications are provided by equipment manufacturers as sound power as it is independent of the environment in which it is located. A sound level meter does not directly measure sound power.
Equivalent Sound Level (L_{eq})	The L_{eq} is the continuous equivalent sound level, defined as the single sound pressure level that, if constant over the stated measurement period, would contain the same sound energy as the actual monitored sound that is fluctuating in level over the measurement period.
A-Weighted Decibel (dBA)	Environmental sound is typically composed of acoustic energy across all frequencies. To compensate for the auditory frequency response of the human ear, an A-weighting filter is commonly used for describing environmental sound levels. Sound levels that are A-weighted are presented as dBA in this report.
Unweighted Decibels (dBL)	Unweighted sound levels are referred to as linear. Linear decibels are used to determine a sound's tonality and to engineer solutions to reduce or control noise as techniques are different for low and high frequency noise. Sound levels that are linear are presented as dBL in this report.

Term	Definition
Propagation and Attenuation	Propagation is the decrease in amplitude of an acoustic signal due to geometric spreading losses with increased distance from the source. Additional sound attenuation factors include air absorption, terrain effects, sound interaction with the ground, diffraction of sound around objects and topographical features, foliage, and meteorological conditions including wind velocity, temperature, humidity, and atmospheric conditions.

1.3 Noise Regulations and Guidelines

1.3.1 Federal Regulations

There are no federal noise regulations applicable to the Project.

1.3.2 Washington Administrative Code State Regulations

Environmental noise limits have been established by the Washington Administrative Code (WAC 173-60). WAC 173-60 establishes noise limits based on the Environmental Designation for Noise Abatement (EDNA) of the sound source and the receiving properties.

- Class A EDNA – Lands where people reside and sleep. They typically include residential property; multiple family living accommodations; recreational facilities with overnight accommodations such as camps, parks, camping facilities, and resorts; and community service facilities including orphanages, homes for the aged, hospitals, and health and correctional facilities.
- Class B EDNA – Lands involving uses requiring protection against noise interference with speech. These typically will include commercial living accommodations; commercial dining establishments; motor vehicle services; retail services; banks and office buildings; recreation and entertainment property not used for human habitation such as theaters, stadiums, fairgrounds, and amusement parks; and community service facilities not used for human habitation (e.g., educational, religious, governmental, cultural and recreational facilities).
- Class C EDNA –Lands involving economic activities of a nature that noise levels higher than those experienced in other areas are normally to be anticipated. Typical Class A EDNA uses generally are not permitted in such areas. Typically, Class C EDNA include storage, warehouse, and distribution facilities; industrial property used for the production and fabrication of durable and nondurable man-made goods; and agricultural and silvicultural property used for the production of crops, wood products, or livestock.

Land use that is considered agricultural is defined as Class C receiving properties. Conversely, agricultural properties principally used for residential purposes with no clearly visible farming or ranching activities are identified as Class A receiving properties. The WAC does maintain flexibility for interpretation in the classification of the appropriate EDNA on both the state and local level. In this assessment, receiving properties consist of Class C Lands and Class C Lands containing Class A residential structures. Between the hours of 10:00 p.m. and 7:00 a.m., the noise limitations are reduced by 10 dBA for receiving property within Class A EDNAs. WAC 173.60.050 exempts temporary construction noise from the state noise limits.

The noise level limits by EDNA classifications are presented in Table 3. The WAC allows these limits to be exceeded for certain periods of time: 5 dBA for no more than 15 minutes in any hour, 10 dBA for no more than 5 minutes of any hour, and 15 dBA for no more than 1.5 minutes of any hour; these are commonly presented as L_n statistical sound levels as well as maximum sound levels (L_{max}), as shown in Table 4.

Table 3. Washington State Environmental Noise Limits

EDNA of Source Property	EDNA of Receiving Property		
	Class A Land Day/Night	Class B Land	Class C Land
Class A Land	55/45	57	60
Class B Land	57/47	60	65
Class C Land	60/50	65	70

Source: WAC 173-60-040

Table 4. L_n Environmental Noise Limits for Class C Sources

EDNA of Source Property	Statistical Sound Level Limits			
	LN_{25}	$LN_{8.3}$	$LN_{2.5}$	L_{MAX}
Class A Land	60/50	65/55	70/60	75/65
Class B Land	65	70	75	80
Class C Land	70	75	80	85

Source: WAC 173-60-040 (b) and (c)

The Project Siting Area is located on land zoned GMAAG (Benton County), which is considered Class C land. Adjacent land also is zoned GMAAG in Benton County, and zoned Agriculture in Yakima County immediately to the west of the Solar Array Siting Area boundary. Agricultural land is considered Class C under the definitions provided above; however, some of these agricultural lands contain residential structures. This analysis conservatively considers agricultural lands with non-participating residences to be Class A receptors. Table 3 shows that the applicable daytime and nighttime noise limits will vary based on each abutting land use class and will be assessed at the Project Siting Area boundary. For Class C land containing non-participating Class A residential structures, limits of 60 dBA and 50 dBA apply to daytime and nighttime hours, respectively. For Class C land containing participating Class A residential structures, the daytime limit of 60 dBA and the nighttime limit of 50 dBA may be waived. For Class C land, a daytime and nighttime limit of 70 dBA is applicable. The WAC regulatory limits are absolute and independent of the existing acoustic environment; therefore, a baseline noise survey is not requisite to determine conformance.

1.3.3 Benton County Code

Chapter 6A.15 in the Benton County Code regulates noise as a public nuisance and does not provide numerical decibel limits.

2.0 EXISTING SOUND ENVIRONMENT

The degree of audibility of a new or modified sound source is dependent, in a large part, on the relative level of the ambient noise. A range of noise settings occurs within the Project Siting Area. Variations in acoustic environment are due, in part, to existing land uses, population density, and proximity to transportation corridors. Elevated existing ambient sound levels in the region occur near major transportation corridors such as interstate highways and in areas with higher population densities. Nearby rural airstrips and airports, including the Desert Aire Regional Airport and Sunnyside Municipal Airport, also contribute to ambient noise levels in both surrounding urban and rural areas. Principal contributors to the existing acoustic environment likely include motor vehicle traffic, mobile farming equipment, all-terrain vehicles, local roadways, periodic aircraft flyovers, and natural sounds such as birds, insects, and leaf or vegetation rustle during elevated wind conditions. Diurnal effects result in sound levels that are typically quieter during the night than during the daytime, except during periods when evening and nighttime insect noise dominates in warmer seasons.

The analysis area is inclusive of areas that could be potentially affected by construction or operational noise resulting from the Project. The analysis area for noise around the Project was defined as the area bounded by a perimeter extending approximately 1.2 miles (2 kilometers) from the Solar Array Siting Area. NSRs within the acoustic assessment analysis area were identified using Benton County Assessor records and aerial imagery. Assessor parcel information is based on current Benton County assessment records last updated by the County on March 2, 2022. In the absence of ambient measurement data, the existing sound level environment in the vicinity of Project was estimated with a method published by the Federal Highway Administration (FHWA) in its Transit Noise and Vibration Impact Assessment (FHWA 2006). This document presents the general assessment of existing noise exposure based on the population density per square mile and proximity to area sound sources such as roadways and rail lines.

The proposed Project is approximately 11 miles (17.7 kilometers) north of the city of Prosser, which has a population density of 1,302 per square mile according to the U.S. Census Bureau (2020). Table 5 indicates the estimated baseline sound levels based on population density for daytime, evening, and nighttime L_{eq}, as well as the day-night average sound level (L_{dn}). The L_{dn} is the average equivalent sound level over a 24-hour period, with a 10 dB penalty added for noise during the nighttime hours of 10:00 p.m. – 7:00 a.m.

Table 5. Estimated Baseline Sound Levels in Proximity to the Project

	L_{eq} (Day)	L_{eq} (Evening)	L_{eq} (Night)	L_{dn}
Average Sound Level (dBA)	50	45	40	50

3.0 PROJECT CONSTRUCTION

Construction of the Project is expected to be typical of other solar power generating facilities in terms of schedule, equipment, and activities. Construction is anticipated to occur over approximately 24 months and would require a variety of equipment and vehicles.

3.1 Noise Calculation Methodology

Acoustic emission levels for activities associated with Project construction were based on typical ranges of energy equivalent noise levels at construction sites, as documented by the U.S. Environmental Protection Agency (EPA; 1971b) and the EPA's "Construction Noise Control Technology Initiatives" (EPA 1980). The EPA methodology distinguishes between type of construction and construction stage. Using those energy equivalent noise levels as input to a basic propagation model, construction noise levels were calculated at a series of set reference distances.

The basic model assumed spherical wave divergence from a point source located at the closest point of the Project site. Furthermore, the model conservatively assumed that all pieces of construction equipment associated with an activity would operate simultaneously for the duration of that activity. An additional level of conservatism was built into the construction noise model by excluding potential shielding effects due to intervening structures and buildings along the propagation path from the site to receiver locations.

3.2 Projected Noise Levels During Construction

Construction work will not consist of a phased approach. Table 6 summarizes the expected equipment to be used during Project construction. Table 6 also shows the maximum noise level at 50 ft.

Table 6. Project Construction Equipment Noise Levels

Construction Equipment	Maximum (L_{max}) Equipment Noise Level at 50 feet
Pickup Truck	55
Crane	85
Excavator	85
Dozer	85
Backhoe	80
Trencher	82
Compactor	80
Forklift	80
Telescopic Handler	85
Loader	80
Grader	85
Concrete Mixer	85
Semi-Truck	84
Generator	82
Hydraulic Driller	84

Table 7 shows the projected noise levels from Project construction at all NSRs. Periodically, sound levels may be higher or lower than those presented in Table 7.

Noise levels resulting from the construction activities would vary significantly depending on several factors such as the type and age of equipment, specific equipment manufacturer and model, the operations being performed, and the overall condition of the equipment and exhaust system mufflers.

Project construction would generally occur during the day, Monday through Friday. Furthermore, all reasonable efforts would be made to minimize the impact of noise resulting from construction activities including implementation of standard noise reduction measures. Due to the infrequent nature of loud construction activities at the site, the limited hours of construction and the implementation of noise mitigation measures identified in Section 3.3, the temporary increase in noise due to construction is considered to be a less than significant impact.

Table 7. Project Construction Noise Levels

NSR ID	Participation Status	UTM Coordinates (meters) NAD83 UTM Zoning 11		Received Noise Level, dBA
		Easting	Westing	
NSR-1	Non-participant	277458	5138066	71
NSR-2	Non-participant	277405	5138167	67
NSR-3	Non-participant	277569	5138263	67
NSR-4	Non-participant	278217	5136576	77
NSR-5	Non-participant	278261	5136439	76
NSR-6	Non-participant	278267	5136115	78
NSR-7	Non-participant	287788	5135417	74
NSR-8	Non-participant	277845	5135822	73
NSR-9	Non-participant	276856	5135353	53
NSR-10	Non-participant	277122	5135285	67
NSR-11	Non-participant	277193	5134919	67
NSR-12	Non-participant	277514	5134986	70
NSR-13	Non-participant	277515	5135011	70
NSR-14	Non-participant	277589	5134853	66
NSR-15	Non-participant	277985	5134895	72
NSR-16	Non-participant	278050	5134958	73
NSR-17	Non-participant	278095	5134463	67
NSR-18	Non-participant	278766	5134992	77
NSR-19	Non-participant	278770	5134806	73
NSR-20	Participant	278848	5134468	70
NSR-21	Participant	283759	5134718	93
NSR-22	Non-participant	283767	5134776	94
NSR-23	Non-participant	279795	5133604	68
NSR-24	Non-participant	279165	5134005	70
NSR-25	Non-participant	278853	5133855	70
NSR-26	Non-participant	278716	5133834	66

NSR ID	Participation Status	UTM Coordinates (meters) NAD83 UTM Zoning 11		Received Noise Level, dBA
		Easting	Westing	
NSR-27	Non-participant	278744	5133786	66
NSR-28	Non-participant	278742	5133716	65
NSR-29	Non-participant	278487	5133872	69
NSR-30	Non-participant	278446	5133774	65
NSR-31	Non-participant	278343	5133818	68
NSR-32	Non-participant	278242	5134140	70
NSR-33	Non-participant	278216	5134079	70
NSR-34	Non-participant	278050	5134154	67
NSR-35	Non-participant	277954	5134046	66
NSR-36	Non-participant	277944	5134006	66
NSR-37	Non-participant	277966	5133960	68
NSR-38	Non-participant	277933	5133790	67
NSR-39	Non-participant	277773	5133872	67
NSR-40	Non-participant	277664	5133793	66
NSR-41	Non-participant	277312	5134191	64
NSR-42	Non-participant	277396	5134167	64
NSR-43	Non-participant	277481	5133428	60
NSR-44	Non-participant	277664	5133345	61
NSR-45	Non-participant	277831	5133643	65
NSR-46	Non-participant	277619	5133686	65
NSR-47	Non-participant	277698	5133668	65
NSR-48	Non-participant	277734	5133662	65
NSR-49	Non-participant	277999	5133636	64
NSR-50	Non-participant	278248	5133325	62
NSR-51	Non-participant	278932	5133241	64
NSR-52	Non-participant	279003	5133469	66
NSR-53	Non-participant	279571	5133209	66
NSR-54	Non-participant	279525	5132871	64
NSR-55	Non-participant	284420	5131888	73
NSR-56	Non-participant	283622	5132022	72
NSR-57	Non-participant	283539	5131881	71
NSR-58	Non-participant	282416	5131862	69
NSR-59	Non-participant	281956	5132172	69
NSR-60	Non-participant	281318	5132241	68
NSR-61	Non-participant	280836	5132553	72
NSR-62	Non-participant	280155	5132499	64
NSR-63	Non-participant	280292	5132430	64
NSR-64	Non-participant	280418	5131617	62
NSR-65	Non-participant	280305	5131497	61
NSR-66	Non-participant	280616	5131330	62

NSR ID	Participation Status	UTM Coordinates (meters) NAD83 UTM Zoning 11		Received Noise Level, dBA
		Easting	Westing	
NSR-67	Non-participant	281061	5131492	64
NSR-68	Non-participant	281442	5131595	66
NSR-69	Non-participant	281732	5131480	66
NSR-70	Non-participant	281983	5131130	65
NSR-71	Non-participant	283116	5131598	69
NSR-72	Non-participant	286022	5131394	67
NSR-73	Non-participant	286781	5131164	64
NSR-74	Non-participant	286794	5130967	63
NSR-75	Non-participant	288542	5131439	59
NSR-76	Non-participant	288409	5131023	58
NSR-77	Non-participant	286732	5130761	62
NSR-78	Non-participant	286854	5130757	62
NSR-79	Non-participant	286854	5130769	62
NSR-80	Non-participant	286855	5130782	62
NSR-81	Non-participant	285263	5130609	65
NSR-82	Non-participant	285096	5130693	66
NSR-83	Non-participant	283595	5130262	63
NSR-84	Non-participant	281952	5130733	63
NSR-85	Non-participant	284582	5129847	61
NSR-86	Non-participant	284725	5129834	52
NSR-87	Non-participant	284919	5129834	54

3.3 Construction Noise Mitigation

Since construction equipment operates intermittently, noise emitted during construction would be mobile and highly variable, making it challenging to control. The construction management protocols would include the following noise mitigation measures to minimize noise impacts:

- Maintain all construction tools and equipment in good operating order according to manufacturers' specifications;
- Limit use of major excavating and earth-moving machinery to daytime hours per WAC 173.60.050;
- To the extent practicable, schedule construction activity during normal working hours on weekdays when higher sound levels are typically present and are found acceptable. Some limited activities, such as concrete pours for transformer pad foundations or the parking area if needed, would be required to occur continuously until completion;
- Equip any internal combustion engine used for any purpose on the job or related to the job with a properly operating muffler that is free from rust, holes, and leaks;

- For construction devices that utilize internal combustion engines, ensure the engine's housing doors are kept closed, and install noise-insulating material mounted on the engine housing consistent with manufacturers' guidelines, if possible;
- Limit possible evening shift work to low noise activities such as welding, wire pulling, and other similar activities, together with appropriate material handling equipment; and
- Utilize a complaint resolution procedure to address any noise complaints received from residents.

4.0 OPERATIONAL NOISE

This section describes the model used for the assessment, input assumptions used to calculate noise levels due to the Project's normal operation, a conceptual noise mitigation strategy, and the results of the noise impact analysis.

4.1 Noise Prediction Model

The CadnaA (Computer-Aided Noise Abatement) computer noise model was used to calculate sound pressure levels from the operation of the Project equipment in the vicinity of the Project site. An industry standard CadnaA was developed by DataKustik GmbH to provide an estimate of sound levels at distances from sources of known emission. It is used by acousticians and acoustic engineers due to the capability to accurately describe noise emission and propagation from complex facilities consisting of various equipment types like the Project, and in most cases, yields conservative results of operational noise levels in the surrounding community.

The outdoor noise propagation model is based on the International Organization for Standardization (ISO) 9613, Part 2: "Attenuation of Sound during Propagation Outdoors" (1996). The method described in this standard calculates sound attenuation under weather conditions that are favorable for sound propagation, such as for downwind propagation or atmospheric inversion, conditions which are typically considered worst-case. The calculation of sound propagation from source to receiver locations consists of full octave band sound frequency algorithms, which incorporate the following physical effects:

- Geometric spreading wave divergence;
- Reflection from surfaces;
- Atmospheric absorption at 10 degrees Celsius and 70 percent relative humidity;
- Screening by topography and obstacles;
- The effects of terrain features including relative elevations of noise sources;
- Sound power levels from stationary and mobile sources;
- The locations of noise-sensitive land use types such as residential land uses;
- Intervening objects including buildings and barrier walls, to the extent included in the design;
- Ground effects due to areas of pavement and unpaved ground;
- Sound power at multiple frequencies;
- Source directivity factors;

- Multiple noise sources and source type (point, area, and/or line); and
- Averaging predicted sound levels over a given time.

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. Larger dimensional sources such as the transformers and inverters were modeled as area sources.

Off-site topography was obtained using the publicly available U.S. Geological Survey digital elevation data. A default ground attenuation factor of 0.5 was assumed for off-site sound propagation over acoustically “mixed” ground. A conservative ground attenuation factor of 0.25 for a reflective surface was assumed onsite.

The output from CadnaA includes tabular sound level results at selected receiver locations and colored noise contour maps (isopleths) that show areas of equal and similar sound levels.

4.2 Input to the Noise Prediction Model

The Project’s general arrangement was reviewed and directly imported into the acoustic model so that on-site equipment could be easily identified, buildings and structures could be added, and sound emission data could be assigned to sources as appropriate. The primary noise sources during operations are the inverters, their integrated step-up transformers, BESS units, and substation transformers. Electronic noise from inverters can be audible but is often reduced by a combination of shielding, noise cancellation, filtering, and noise suppression. The Project layout includes 150 step-up transformers and inverters distributed throughout the solar array areas. BESS units will be located in an approximately 40,000 square feet area 200 feet west of the substation. The substation will have two 250 MVA transformers.

Substations have switching, protection, and control equipment, as well as a main power transformer, which generate the sound generally described as a low humming. There are three chief noise sources associated with a transformer: core noise, load noise, and noise generated by the operation of the cooling equipment. The core is the principal noise source and does not vary significantly with electrical load. The load noise is primarily caused by the load current in the transformer’s conducting coils (or windings), and consequently, the main frequency of this sound is twice the supply frequency: 120 Hz for 60 Hz transformers. The cooling equipment (fans and pumps) may also be an important noise component, depending on fan design. During air-forced cooling method, cooling fan noise is produced in addition to the core noise. The resulting audible sound is a combination of hum and the broadband fan noise. Breaker noise is a sound event of very short duration, expected to occur only a few times throughout the year. Just as horsepower ratings designate the power capacity of an electric motor, a transformer’s megavolt amperes rating indicates its maximum power output capacity.

Reference sound power levels input to CadnaA were provided by equipment manufacturers, based on information contained in reference documents or developed using empirical methods. The source levels used in the predictive modeling are based on estimated sound power levels that are generally deemed to be conservative. The projected operational noise levels are based on HOHI-supplied sound power level data for the major sources of equipment. Table 8 summarizes the equipment sound power level data used as inputs to the acoustic modeling analysis. For the purpose of the analysis, it was assumed that all equipment would operate consistently during the daytime, while only the substation transformers and BESS units will operate during the nighttime.

Table 8. Modeled Octave Band Sound Power Level for Major Pieces of Project Equipment

Sound Source	Sound Power Level (L_W) by Octave Band Frequency dBL									Broadband Level
	31.5	63	125	250	500	1k	2k	4k	8k	dBA
Step-up Transformer	73	79	81	76	76	70	65	60	53	77
Inverter	106	99	104	98	94	94	94	101	92	104
BESS	109	94	101	95	88	82	75	68	63	91
Substation Transformer	102	109	110	105	106	100	95	90	83	106

Details pertaining to the transmission line design have not been finalized and have not been included in the modeling analysis. Sound generated from the operation of the transmission line is not expected to impact sensitive receptors. Once the details of the Project's overhead 230-kV / 500-kV gen-tie line have been finalized, the noise analysis can be updated after further review. Transmission lines generate sound referred to as corona. The level of corona noise generated by a transmission line is highly dependent on weather conditions (i.e., foul weather), electrical gradient, altitude, and condition of the conductor wires. The corona effect is initiated where the conductor's electric field is concentrated by imperfections in the conductor surface such as nicks or scratches, or by substances on the lines such as water droplets, dirt or dust, and bird droppings. Corona activity increases with increasing altitude, and with increasing voltage in the line, but is generally not affected by system loading.

4.3 Noise Prediction Model Results

Broadband (dBA) sound pressure levels were calculated for expected normal Project operation assuming that all components identified previously are operating continuously and concurrently at the representative manufacturer-rated sound power level. For the purpose of the analysis, it was assumed that all equipment would operate consistently during the daytime, while only the substation transformers and BESS units will operate during the nighttime. After calculation, the sound energy was then summed to determine the equivalent continuous A-weighted downwind sound pressure level at a point of reception. Sound contour plots displaying broadband (dBA) sound levels presented as color-coded isopleths are provided in Figure 2 for full daytime operations and Figure 3 for nighttime operations. The sound contours are graphical representations of the cumulative noise associated with operation of the equipment and show how operational noise would be distributed over the surrounding area of the Project site. The contour lines shown are analogous to elevation contours on a topographic map (i.e., the sound contours are continuous lines of equal noise level around some source, or sources, of sound).

Table 9 shows the projected exterior sound levels resulting from full, normal operation of the Project during daytime and reduced operation during nighttime hours, at all nearby NSRs. The Project is located on Class C land while the adjacent properties consist of a mix of both Class C land with Class A residential structures, which has a daytime limit of 60 dBA and nighttime limit of 50 dBA, and Class C land, which has a daytime and nighttime limit of 70 dBA.

Table 9 shows that the Project will significantly comply with the 60 dBA daytime limit and 50 dBA nighttime limit at all non-participating NSRs. In addition, based on the results displayed in Figures 2 and 3, the Project will comply with all WAC noise limits at the land use zones adjacent to the Project Solar Array Siting Area. Once the details of the Project's overhead 230-kV / 500-kV gen-tie line have been finalized, the noise analysis can be updated after further review.

Table 9. Acoustic Modeling Results Summary

NSR ID	Participation Status	UTM Coordinates (meters) NAD83 UTM Zone 11		Operational Sound Levels (dBA)	
		Easting	Northing	Daytime Operations	Nighttime Operations
NSR-1	Non-participant	277458	5138066	29	19
NSR-2	Non-participant	277405	5138167	25	18
NSR-3	Non-participant	277569	5138263	25	18
NSR-4	Non-participant	278217	5136576	32	19
NSR-5	Non-participant	278261	5136439	31	18
NSR-6	Non-participant	278267	5136115	33	21
NSR-7	Non-participant	287788	5135417	30	20
NSR-8	Non-participant	277845	5135822	29	20
NSR-9	Non-participant	276856	5135353	18	12
NSR-10	Non-participant	277122	5135285	26	18
NSR-11	Non-participant	277193	5134919	26	18
NSR-12	Non-participant	277514	5134986	27	19
NSR-13	Non-participant	277515	5135011	27	19
NSR-14	Non-participant	277589	5134853	25	18
NSR-15	Non-participant	277985	5134895	28	19
NSR-16	Non-participant	278050	5134958	28	19
NSR-17	Non-participant	278095	5134463	25	19
NSR-18	Non-participant	278766	5134992	31	20
NSR-19	Non-participant	278770	5134806	28	20
NSR-20	Non-participant	278848	5134468	25	17
NSR-21	Participant	283759	5134718	40	25
NSR-22	Participant	283767	5134776	41	25
NSR-23	Non-participant	279795	5133604	24	16
NSR-24	Non-participant	279165	5134005	26	17
NSR-25	Non-participant	278853	5133855	27	19
NSR-26	Non-participant	278716	5133834	23	15
NSR-27	Non-participant	278744	5133786	23	15
NSR-28	Non-participant	278742	5133716	23	15
NSR-29	Non-participant	278487	5133872	26	19
NSR-30	Non-participant	278446	5133774	23	15
NSR-31	Non-participant	278343	5133818	26	18
NSR-32	Non-participant	278242	5134140	27	19

NSR ID	Participation Status	UTM Coordinates (meters) NAD83 UTM Zone 11		Operational Sound Levels (dBA)	
		Easting	Northing	Daytime Operations	Nighttime Operations
NSR-33	Non-participant	278216	5134079	26	18
NSR-34	Non-participant	278050	5134154	25	18
NSR-35	Non-participant	277954	5134046	25	18
NSR-36	Non-participant	277944	5134006	25	18
NSR-37	Non-participant	277966	5133960	25	18
NSR-38	Non-participant	277933	5133790	25	18
NSR-39	Non-participant	277773	5133872	25	18
NSR-40	Non-participant	277664	5133793	25	17
NSR-41	Non-participant	277312	5134191	24	17
NSR-42	Non-participant	277396	5134167	24	17
NSR-43	Non-participant	277481	5133428	21	14
NSR-44	Non-participant	277664	5133345	22	17
NSR-45	Non-participant	277831	5133643	24	18
NSR-46	Non-participant	277619	5133686	24	17
NSR-47	Non-participant	277698	5133668	24	17
NSR-48	Non-participant	277734	5133662	24	17
NSR-49	Non-participant	277999	5133636	24	18
NSR-50	Non-participant	278248	5133325	22	15
NSR-51	Non-participant	278932	5133241	23	18
NSR-52	Non-participant	279003	5133469	24	19
NSR-53	Non-participant	279571	5133209	23	15
NSR-54	Non-participant	279525	5132871	22	14
NSR-55	Non-participant	284420	5131888	27	16
NSR-56	Non-participant	283622	5132022	25	16
NSR-57	Non-participant	283539	5131881	25	16
NSR-58	Non-participant	282416	5131862	24	16
NSR-59	Non-participant	281956	5132172	24	16
NSR-60	Non-participant	281318	5132241	23	16
NSR-61	Non-participant	280836	5132553	27	19
NSR-62	Non-participant	280155	5132499	22	14
NSR-63	Non-participant	280292	5132430	22	14
NSR-64	Non-participant	280418	5131617	21	14
NSR-65	Non-participant	280305	5131497	21	14
NSR-66	Non-participant	280616	5131330	21	14
NSR-67	Non-participant	281061	5131492	21	15
NSR-68	Non-participant	281442	5131595	22	15
NSR-69	Non-participant	281732	5131480	22	15
NSR-70	Non-participant	281983	5131130	22	15
NSR-71	Non-participant	283116	5131598	24	15
NSR-72	Non-participant	286022	5131394	23	15
NSR-73	Non-participant	286781	5131164	22	14

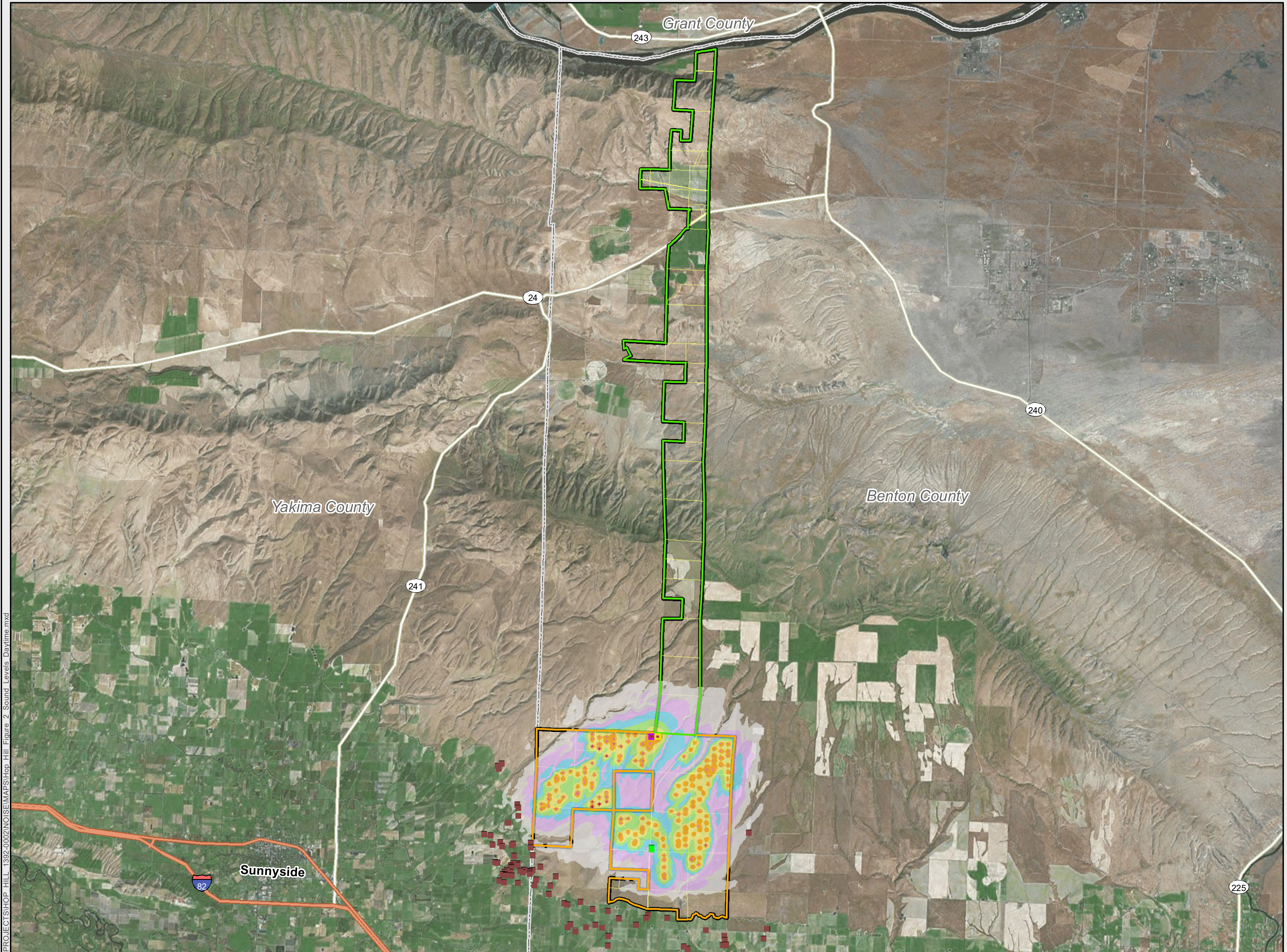
NSR ID	Participation Status	UTM Coordinates (meters) NAD83 UTM Zone 11		Operational Sound Levels (dBA)	
		Easting	Northing	Daytime Operations	Nighttime Operations
NSR-74	Non-participant	286794	5130967	21	14
NSR-75	Non-participant	288542	5131439	20	13
NSR-76	Non-participant	288409	5131023	20	13
NSR-77	Non-participant	286732	5130761	21	14
NSR-78	Non-participant	286854	5130757	21	14
NSR-79	Non-participant	286854	5130769	21	14
NSR-80	Non-participant	286855	5130782	21	14
NSR-81	Non-participant	285263	5130609	22	16
NSR-82	Non-participant	285096	5130693	23	17
NSR-83	Non-participant	283595	5130262	22	14
NSR-84	Non-participant	281952	5130733	21	14
NSR-85	Non-participant	284582	5129847	21	13
NSR-86	Non-participant	284725	5129834	17	11
NSR-87	Non-participant	284919	5129834	18	11

This page intentionally left blank.

Hop Hill Solar and Storage Project

Figure 2
Operational
Received Sound Levels – Daytime Operations

Benton County, Washington



- Siting Area
- Solar Array Siting Area
- Transmission Line Corridor Siting Area

Receptor

- Participating
- Non-Participating
- Collector Substation
- Battery Energy Storage System

Received Sound Levels (dBA):

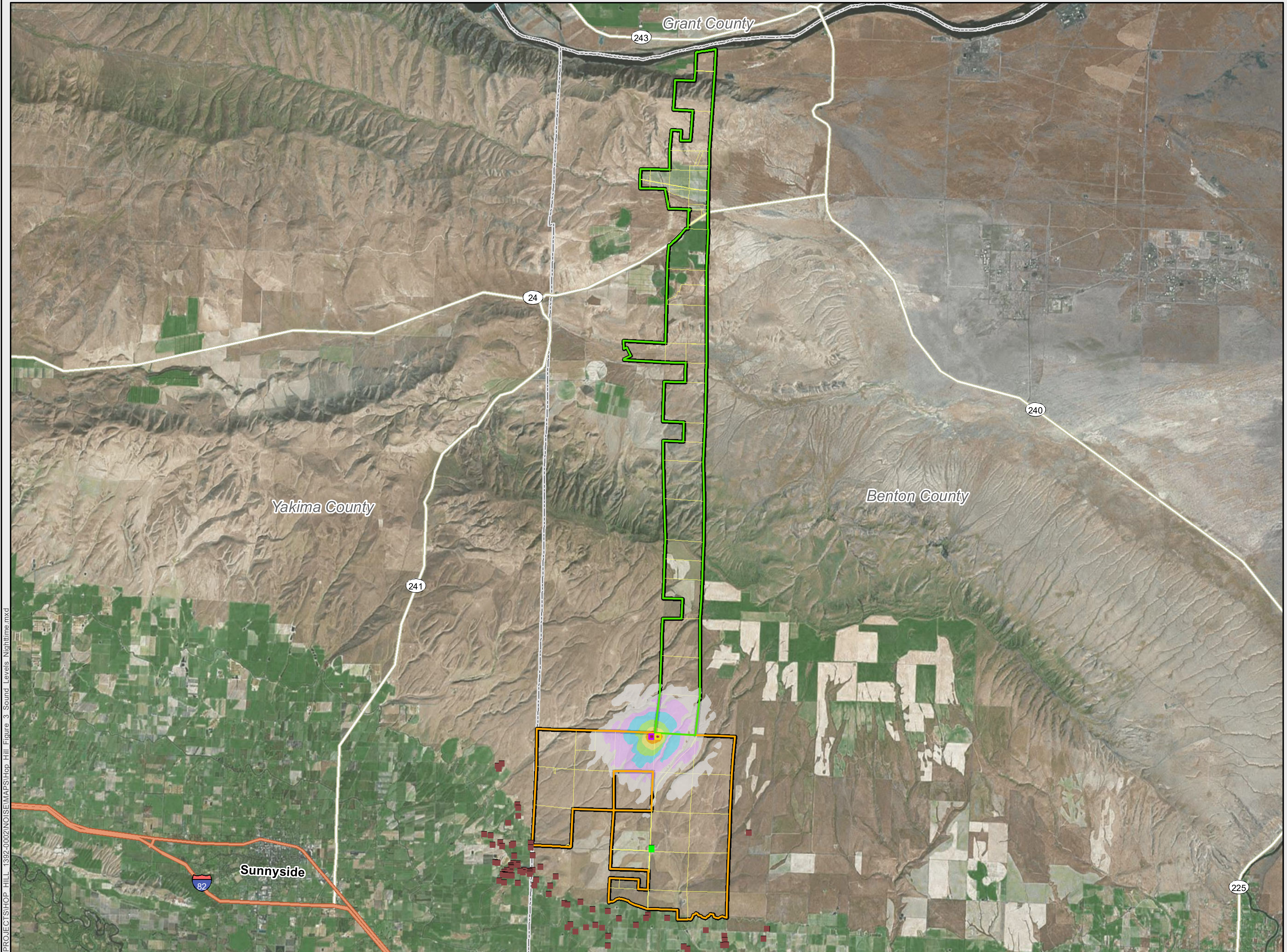
- 30-35
- 35-40
- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- > 70
- Project Parcels
- County Boundary

N

0 1 2 4
Miles

NOT FOR CONSTRUCTION

R:\PROJECTS\HOP_HILL_1392-0002\NOISE\MAPS\Hop_Hill_Figure_2_Sound_Levels_Daytime.mxd



R:\PROJECTS\HOP_HILL_1392-0002\NOISE\MAPS\Hop_Hill_Figure_3_Sound_Levels_Nighttime.mxd

Hop Hill Solar and Storage Project

Figure 3
Operational
Received Sound Levels – Nighttime Operations

Benton County, Washington

- Siting Area
- Solar Array Siting Area
- Transmission Line Corridor Siting Area

Receptor
- Participating
- Non-Participating
- Collector Substation
- Battery Energy Storage System

Received Sound Levels (dBA):
- 30-35
- 35-40
- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- > 70
- Project Parcels
- County Boundary

N

0 1 2 4
Miles

NOT FOR CONSTRUCTION

5.0 CONCLUSION

Tetra Tech completed a detailed acoustic assessment of the HOHI Project proposed in Benton County, Washington. The assessment included an evaluation of potential Project sound level impacts during construction and operation phases.

The construction noise assessment conservatively indicated that construction noise would be periodically audible at off-site locations; however, that noise would be temporary and minimized to the extent practicable through implementation of best management practices and noise mitigation measures as identified in Section 3.3. Traffic noise generated during construction onsite and offsite would also add to overall sound levels, but would be intermittent and short-term.

Operational sound levels were modeled and evaluated at nearby NSRs. Anticipated Project sound sources consist of the collector substation main power transformers, inverter and transformer units, and BESS units. Incorporating a number of conservative assumptions, acoustic modeling results indicate that the Project will significantly comply with the 60 dBA daytime limit and 50 dBA nighttime limit at all non-participating NSRs. In addition, the Project is predicted to comply with all the applicable WAC regulatory limits at the Project Siting Area boundary. Once the details of the Project's overhead 230-kV / 500-kV gen-tie line have been finalized, the noise analysis can be updated after further review.

Sound generated from existing sound sources in the Project Area, such as the operation of agricultural equipment shown in Table 1, would be expected to be relatively higher than Project operations. Overall, sound emissions associated with the Project are expected to remain at a low level, consistent with other solar energy facilities of similar size and design.

6.0 REFERENCES

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

DataKustik GmbH. 2020. Computer-Aided Noise Abatement Model CadnaA, Version MR 1 Munich, Germany.

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

EPA. 1971b. Technical Document NTID300.1, Noise from Construction Equipment and Operations, US Building Equipment, and Home Appliances. Prepared by Bolt Beranek and Newman for USEPA Office of Noise Abatement and Control, Washington, DC. December 1971.

EPA. 1980. Construction Noise Control Technology Initiatives. Technical Report No. 1789. Prepared by ORI, Inc. Prepared for USEPA, Office of Noise Abatement and Control. September 1980. Available at: http://www.nonoise.org/epa/Roll5/roll5doc22.pdf.

FHWA (Federal Highway Administration). 2006. FHWA Roadway Construction Noise Model User's Guide, FHWA-HEP-05-054, January.

HSE (Health and Safety Executive). Typical Noise Levels. Available online at: https://www.hse.gov.uk/agriculture/topics/noise.htm#_Typical_noise_levels

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

U.S. Census Bureau. 2020. Decennial Census of Population and Housing Datasets. Retrieved from https://www.census.gov/quickfacts/prossercitywashington