SECTION 5 NOISE

A. Introduction

Tetra Tech performed a sound analysis of anticipated sound levels associated with the Project in accordance with sound level limits as set forth by the MDEP Site Law Regulations for Control of Noise (ref. 06-096 Code of Maine Rules (CMR) Chapter 375.10), NRPA Title 38 M.S.R. § 480-D (1)[3]. The analysis evaluates sound levels at nearby sensitive locations from construction activities and routine operation of sound-producing Project components, including inverters and step-up transformers. The complete Sound Analysis for the Project is attached as Exhibit 5-1.

B. Regulatory Standards

Environmental noise limits have been established by the MDEP Site Location of Development Regulations for Control of Noise (ref. 06-096 CMR 375.10). Sound level limits are established for both daytime and nighttime hours. The specific sound level limits are based on zoning, proximity of protected locations, and existing sound levels in the environment.

Although Site Law regulations specify a 75 dBA (A-weighted decibels) limit for a facility property line, the most restrictive limits apply to noise sensitive land uses that meet the definition of a "protected location", as set forth in in 06-096 CMR Chapter 375.10.C(2). The Project is required to meet the noise requirements detailed in 06-096 CMR Chapter 375.10.C.I of Site Law Regulations.

As stated in 06-096 CMR 375.10(C)(1)(a)(ii), at any protected location in an area for which the existing use or use contemplated under a comprehensive plan is not predominantly commercial, transportation, or industrial, the following limits apply:

- 60 decibels (dBA) between 7:00 a.m. and 7:00 p.m. (the "daytime hourly limit"), and
- 50 dBA between 7:00 p.m. and 7:00 a.m. (the "nighttime hourly limit")

As stated in 06-096 CMR 375.10(C)(1)(a)(v), when a proposed development is to be located in an area where the daytime pre-development ambient hourly sound level at a protected location is equal to or less than 45 dBA and/or the nighttime pre-development ambient hourly sound level at a protected location is equal to or less than 35 dBA, the hourly sound levels resulting from routine operation of the development shall not exceed the following limits at the protected location:

- 55 decibels (dBA) between 7:00 a.m. and 7:00 p.m. (the "daytime hourly limit"), and
- 45 dBA between 7:00 p.m. and 7:00 a.m. (the "nighttime hourly limit")

As stated in 06-096 CMR 375.10(C)(1)(d), for the purposes of determining compliance with the mandated sound level limits, 5 dBA shall be added to the observed levels of any tonal sounds that result from routine operation of the development.

The MDEP also provides sound level limits for construction activities, as stated in 06-096 CMR 375.10(C)(2). The sound from construction activities between 7:00 p.m. and 7:00 a.m. is subject to the nighttime sound level limits applicable to normal operation at the site.

[3] MDEP. NRPA. Title 38 M.R.S. §480-D(1). 2009.

C. Predicted Sound Level

In accordance with 06-096 CMR Chapter 375, §10(C) the equivalent noise levels expected to be produced by the sound sources at protected locations located within 1 mile of the proposed Project were modeled. Modelling for the Project was conducted in accordance with the International Organization for Standardization standard 9613-2:1996, "Acoustics-Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation". The model considers source sound power levels, surface reflection and absorption, atmospheric absorption, geometric divergence, meteorological conditions, walls, barriers, berms, and terrain. The acoustical modeling software used was CadnaA, from Datakustik GmbH.

Summaries of the sound propagation model results are presented in Exhibit 5-1 (see Table 6 Acoustic Modeling Results Summary and Figure 2 Operational Received Levels). Acoustic modeling results show that the Project successfully demonstrates compliance with the most stringent 45 dBA MDEP nighttime limit at all identified protected locations and within 500-feet of those protected locations. In fact, the highest predicted sound level at a protected location is 29 dBA, which is inclusive of the 5 dBA be added to the observed levels of any tonal sounds that result from routine operation of the development (06-096 CMR 375.10(C)(1)(d)).

Exhibits

- Exhibit 5-1 Acoustic Assessment Report

EXHIBIT 5-1 ACOUSTIC ASSESSMENT REPORT

Final Acoustic Assessment Report

Hartland Solar Project

October 2023

Prepared for

Hartland Solar Facility, LLC
500 Union Street
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Prepared by

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Acronyms and Abbreviations

µPa	microPascal
CadnaA	Computer-Aided Noise Abatement
CMP	Central Maine Power
dB	decibel
dBA	A-weighted decibel
dBL	linear decibel
DEP	Department of Environmental Protection
EPA	U.S. Environmental Protection Agency
Hartland	Hartland Solar Facility, LLC
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
L_N	statistical sound level
LP	sound pressure level
L_w	sound power level
MW	megawatt
NSR	noise sensitive receptor
Project	Hartland Solar Energy Project
PV	photovoltaic
PCS	power conversion system
SDR	short duration repetitive
Teichos	Teichos Energy, LLC
Tetra Tech	Tetra Tech, Inc.

1.0 INTRODUCTION

Teichos Energy, LLC (Teichos) and Hartland Solar Facility, LLC (Hartland) proposes development of the Hartland Solar Energy Project (Project) on up to approximately 1,031 acres in the Town of Hartland, Somerset County, Maine. The Project will consist of a 140-megawatt (MW) solar photovoltaic energy generation system, a 34.5-kilovolt (kV) collection system, and supporting infrastructure, including photovoltaic (PV) inverters with collocated transformers. In addition, the Project will include supporting electrical infrastructure such as collection lines and substation with transformer, tracking motors, and internal access roads.

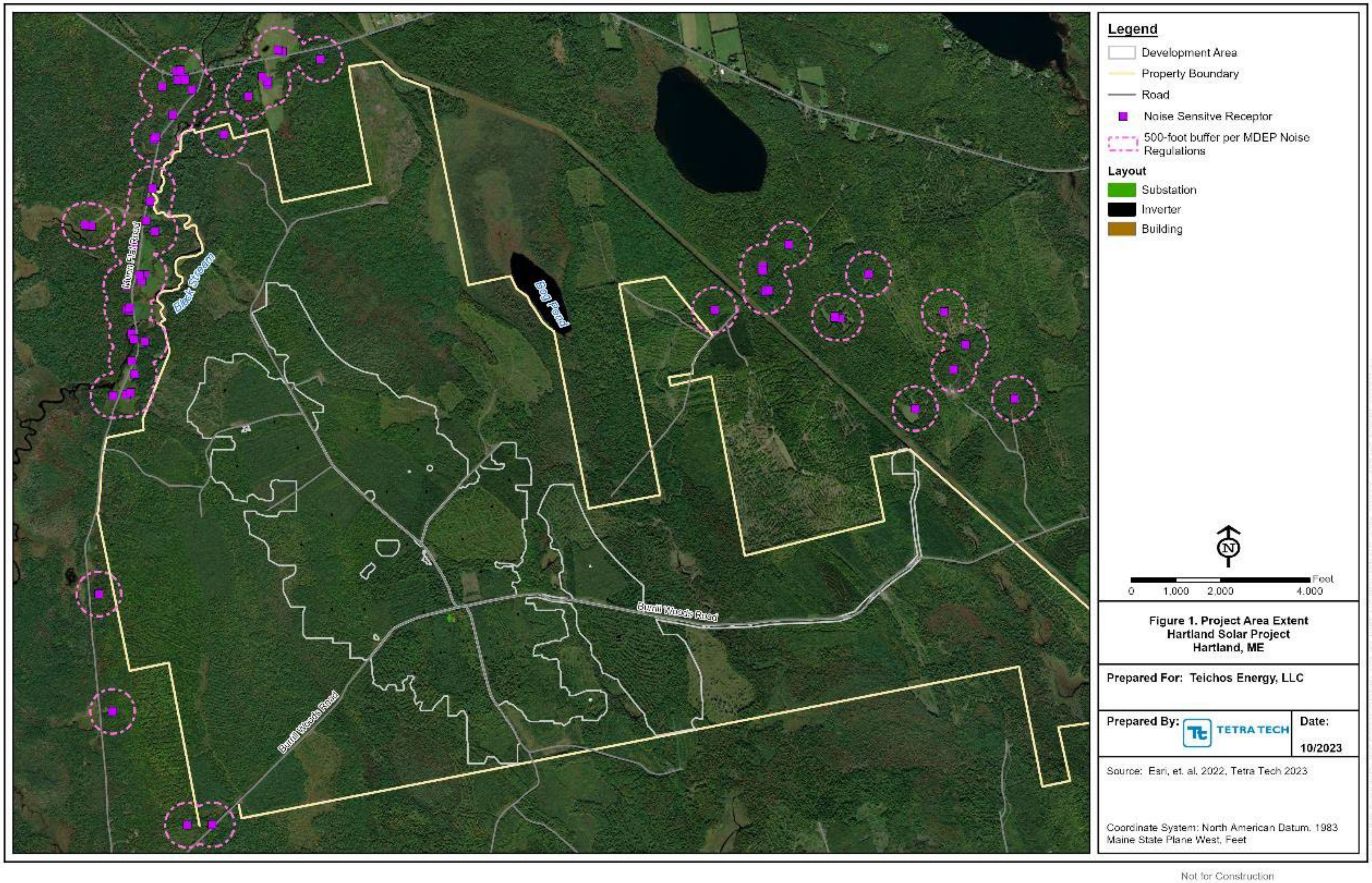
Tetra Tech, Inc. (Tetra Tech) prepared an acoustic assessment for the Project to evaluate potential sound impacts relative to the applicable noise regulations prescribed in the Maine Department of Environmental Protection (DEP) Site Location of Development regulations for Control of Noise (ref. 06-096 CMR c. 375.10). An acoustic modeling analysis was conducted by simulating sound produced during both construction and operation. Operational sound sources consisted primarily of the inverters and step-up transformers. Modeled sound levels from Project operation were evaluated against the Maine DEP noise regulations. 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 Facility will be located in the Town of Hartland, encompassing an area of approximately 1,031 acres within an 8,000-acre privately-owned working forest south of Route 51. The Project will be accessed along the privately-owned Burrill Woods Road. Power from the Project will be transmitted to a new Central Maine Power (CMP) interconnection substation/point of interconnection (POI) located east of the Project and adjacent to an existing CMP 115 kV transmission line.

All Facility parcels are located within the privately-owned working forest. The area primarily consists of mixed (coniferous and deciduous) forest managed for commercial timber production. **Figure 1** provides an overview of the Project Area and the Noise Sensitive Receptors (NSR) modeled as part of this Project. A list of NSRs that were modeled is outlined in Section 3.3 of this report.

Figure 1. Project Area Extent



1.2 Acoustic Metrics and Terminology

All sounds originate from 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. 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 using 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), which measures 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 Maine. Estimates of noise sources and outdoor acoustic environments and the comparison of relative loudness are listed 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
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	

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

Noise Source or Activity	Sound Level (dBA)	Subjective Impression
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

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

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 noise 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.
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 Maine Department of Environmental Protection State Regulations

Environmental noise limits have been established by the Maine DEP Site Location of Development Regulations for Control of Noise (ref. 06-096 CMR 375.10). Sound level limits are established for both daytime and nighttime hours and enforced by the Maine DEP. The specific sound level limits are based on zoning, proximity of protected locations, and existing sound levels in the environment.

Although Site Law regulations specify a 75 dBA (A-weighted decibels) limit for a facility property line, the most restrictive limits apply to noise sensitive land uses that meet the definition of a “protected location”, as set forth in in 06-096 CMR Chapter 375.10.C(2). However, when a development is located in a municipality that has duly enacted a quantifiable noise standard that (1) contains limits that are not higher than the DEP limits by more than 5 dBA, and (2) limits or addresses the types of sounds regulated by the DEP, then the DEP is to apply the local standard rather than the DEP standard. In addition, when noise produced by a facility is received in another municipality, the quantifiable noise standard of the other municipality must be taken into consideration (ref. 06-096 CMR Chapter 375.10.B.1).

At protected locations where the existing zoning or the existing use is predominantly commercial, transportation, or industrial, the Project sound levels are limited to 70 dBA during the day (7:00 AM to 7:00 PM) and 60 dBA at night (7:00 PM to 7:00 AM), measured at the property line of the receiver. For protected locations where the zoning or the existing use is not predominantly commercial, transportation, or industrial, the Project sound levels are limited to 60 dBA during the day and 50 dBA at night. Further, if the existing all-encompassing ambient levels (Leq) are at or below 45 dBA during the day or 35 dBA at night, then the area would be considered a quiet area. Assuming that sound levels at nearby protected locations meet the criteria for quiet areas, the Project is required to meet the following sound level limits as detailed in Chapter 375.10.C(2) of Site Location of Development Law Regulations:

- 75 dBA at any time of day at any property line of the development or contiguous property owned or controlled by the project developer; and
- 55 dBA between 7:00 a.m. and 7:00 p.m., and 45 dBA between 7:00 p.m. and 7:00 a.m. at any protected location.

The quiet nighttime limit of 45 dBA applies on portions of a protected location within 500 feet of a dwelling (or other sleeping quarters), or at the lot line of the protected location, whichever is closer to the dwelling. At portions of the protected location greater than 500 feet from the residence or sleeping quarters, the 55 dBA daytime limit applies 24 hours a day. Sound from regular and routine maintenance of the Project is subject to the same sound level limits as routine operation. The DEP requires a 5-dBA penalty be added to the measured total sound level when pure tones are observed, as defined by the standard. If a tone is measured at the protected area, 5 dBA would be added to the measured overall sound level when compared to the limits.

As stated in 06-096 CMR 375.10(C)(1)(a)(ii), at any protected location in an area for which the existing use or use contemplated under a comprehensive plan is not predominantly commercial, transportation, or industrial, the following limits apply:

- 60 decibels (dBA) between 7:00 a.m. and 7:00 p.m. (the “daytime hourly limit”), and
- 50 dBA between 7:00 p.m. and 7:00 a.m. (the “nighttime hourly limit”)

As stated in 06-096 CMR 375.10(C)(1)(a)(v), when a proposed development is to be located in an area where the daytime pre-development ambient hourly sound level at a protected location is equal to or less than 45 dBA and/or the nighttime pre-development ambient hourly sound level at a protected location is equal to or less than 35 dBA, the hourly sound levels resulting from routine operation of the development shall not exceed the following limits at the protected location:

- 55 decibels (dBA) between 7:00 a.m. and 7:00 p.m. (the "daytime hourly limit"), and
- 45 dBA between 7:00 p.m. and 7:00 a.m. (the "nighttime hourly limit")

As stated in 06-096 CMR 375.10(C)(1)(d), for the purposes of determining compliance with the mandated sound level limits, 5 dBA shall be added to the observed levels of any tonal sounds that result from routine operation of the development.

The Maine DEP also provides sound level limits for construction activities, as stated in 06-096 CMR 375.10(C)(2). The sound from construction activities between 7:00 p.m. and 7:00 a.m. is subject to the nighttime sound level limits applicable to normal operation at the site. Sound from construction activities between7:00 a.m. and 7:00 p.m. shall not exceed the limits specified in **Table 3** for any protected location. Construction noise is further discussed in Section 2.0 of this report.

Table 3. Construction Activity Sound Limits

Duration of Activity	Hourly Sound Level Limit
12 hours	87 dBA
8 hours	90 dBA
6 hours	92 dBA
4 hours	95 dBA
3 hours	97 dBA
2 hours	100 dBA
1 hour or less	105 dBA

1.3.2.1 Tonal and Short Duration Repetitive Sounds

Maine DEP Chapter 375.10 requires that 5 dBA be added to tonal and short duration repetitive (SDR) sounds when determining compliance with hourly sound level limits.

A tonal sound from the Project exists at a protected location, if the 10-minute equivalent one-third octave band sound level in the band containing the tonal sound exceeds the arithmetic average of the sound pressure levels of the two contiguous one-third octave bands as follows:

- by 5 dB for center frequencies at or between 500 Hz and 10,000 Hz
- by 8 dB for center frequencies at or between 160 and 400 Hz, and
- by 15 dB for center frequencies at or between 25 Hz and 125 Hz.

When a tonal sound occurs from routine operation of the Project, 5 dBA is added to the hourly equivalent sound level of the tonal sound for purposes of demonstrating compliance with the applicable daytime and nighttime sound level limits (ref. Maine DEP 375.10.C.1(d)).

An SDR sound is a sequence of repetitive sounds clearly discernible as an event resulting from the development and causing an increase in the sound level of 6 dBA or greater on the fast meter response above the sound level observed immediately before and after the event. When routine operation of a development produces SDR sounds, a 5 dBA penalty is to the SDR sound levels to calculate the resulting hourly Leq (ref. Maine DEP 375.10. C.1(d).

1.3.3 Somerset County Code

Somerset County does not provide numerical decibel limits for the regulation of noise which would be applicable to the Project.

1.3.4 Hartland Town Code

The Maine Legislature Revised Statues Annotated , Title 17, Chapter 91, Subchapter 3, §2802 partially defines a miscellaneous nuisance as, "causing or suffering any offal, filth or noisome substance to collect or to remain in any place to the prejudice of others." The Hartland Town Code uses this definition in the Building and Property Maintenance Ordinance, dated June 5, 2023, to state, "All grounds or parts thereof shall be maintained to prevent unsafe, unsanitary, and/or nuisance conditions and to avoid any adverse effect on the value of adjoining properties." The Hartland Town Code does not provide numerical decibel limits.

2.0 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 12 to 24 months and would require a variety of equipment and vehicles.

2.1 Projected Noise Levels During Construction

Noise levels resulting from construction activities vary greatly depending on the type of equipment; the specific equipment model; the operations being performed; and the overall condition of the equipment. Construction noise levels have been predicted using a semi-qualitative approach based on equipment sound levels provided in the Noise and Vibration Impact Assessment (Federal Transit Administration [FTA] 2018). Because this equipment is also used on solar projects, the FTA's sound levels are applicable to incorporate in this analysis. Construction activities associated with the Project have the potential for localized sound on a temporary basis, as construction activities progress through certain locations within the Project area. Construction activities at the Project can be generally divided into five phases:

1. Preparation of the site and staging areas, including grading and on-site access roads;
2. Installation of array foundations, conductors, the operations and maintenance building, and the control enclosure;
3. Assembly of solar panels and electrical connection components;
4. Construction of the inverter pad, substation, cabling, terminations, and transmission lines; and
5. 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 PV inverter skids are likely to be completed while respective solar arrays are being constructed; completion of other Project-related elements, such as the O&M building, will occur independently. Sound generated by Project construction is expected to vary depending on the construction phase. Table 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 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

Table 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
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: Beranek 1988; FHWA 2006.
dBA = A-weighted decibel

2.2 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.
- 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, 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.
- Utilize a complaint resolution procedure to address any noise complaints received from residents.

3.0 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, and the results of the noise impact analysis.

3.1 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. The latest Hartland Solar Project site layout, dated September 18, 2023, was modeled using an industry standard CadnaA developed by DataKustik GmbH (2023) 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.

CadnaA is a comprehensive software model that conforms to the International Organization for Standardization (ISO) standard ISO 9613-2, Attenuation of Sound during Propagation Outdoors. The engineering methods specified in this standard consist of full (1/1) octave band algorithms that incorporate several factors, including those listed below. 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 or conditions that are typically considered worst-case. The calculation of sound propagation from source to receiver locations consists of full octave band sound frequency algorithms that 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.

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 ground (G) =0 for acoustically hard, reflective surfaces and G=1 for absorptive surfaces and soft ground. If the ground is hard-packed dirt, typically found in industrial complexes, pavement, bare rock or for sound traveling over bodies of water, the absorption coefficient is defined as G=0 to account for reduced sound attenuation and higher reflectivity. In contrast, ground covered in vegetation, including suburban lawns, livestock and agricultural fields would be acoustically absorptive and aid in sound attenuation, i.e., G=1.0. For the acoustic modeling analysis, a conservative ground absorption rate was selected, accounting for a semi-reflective ground surface off-site with a fully reflective surface assumed onsite due to the coverage of the solar panels. Topographical information was imported into the acoustic model using the official United States Geological Survey (USGS) digital elevation dataset to accurately represent terrain in three dimensions. Sound attenuation through foliage and diffraction around and over existing anthropogenic structures such as buildings were ignored.

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 0.0 for a reflective surface was assumed on site.

3.2 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 sound sources during operations are the cooling fans on the inverters, and transformers, and the electrical components of the inverters. 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 32 inverter skids distributed throughout the solar array areas. Tracking motors are not typically modeled when evaluating solar facility sound levels because the sound levels associated with the trackers are low and would not contribute to offsite sound levels in a material way when compared to other onsite sound sources like inverters. Furthermore, the 115-kV transmission line associated with the Project was not modeled as it is expected to produce low-level sound during both foul and fair-weather conditions.

Reference sound power levels input to CadnaA were provided by the equipment manufacturer, based on information contained in reference documents or developed using empirical methods. The source levels used in the predictive modeling are generally deemed to be conservative. **Table 5** 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 potentially operate at full load during daytime and nighttime hours.

Substations have switching, protection, and control equipment, as well as a main power transformer, which generate the sound generally described as a low humming. Three chief noise sources are 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); 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.

Table 5. 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
Inverter Skid	88	88	92	88	82	80	81	85	77	90
Main Power Transformer	64	83	95	98	103	101	97	92	82	105

3.2.1 Tonal and Short Duration Repetitive Sounds

The Maine DEP noise rule requires that 5 dBA be added to the measured sound level at a protected location if sound from a development generates either 1) a tonal sound or 2) SDR sound events over a one-hour measurement interval.

Both the inverters and transformer have the potential to generate a tonal sound as defined by Maine DEP 375.10. As such, 5 dBA has been added to calculate sound levels at the nearest protected locations to the Project.

The sound sources associated with the Hartland Solar Project operate in a near steady-state mode slowly rising and decaying in response to sun conditions. Therefore, there is virtually no potential for the generation of SDR sounds or the associated sound penalty.

3.3 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. It is expected that all sound-producing equipment would operate during both daytime and nighttime periods. After calculation, the sound energy was then summed to determine the equivalent continuous A-weighted downwind sound pressure level at a point of reception.

Table 6 shows the projected exterior sound levels resulting from full, normal operation of the Project during both daytime and nighttime hours at all nearby protected locations. A sound contour plot displaying broadband (dBA) operational sound levels presented as color-coded isopleths are provided in **Figure 2**. The sound contours are graphical representations of the cumulative sound levels associated with full 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 sound level around some source, or sources, of sound). Furthermore, the contours are independent of the existing acoustic environment and are representative of expected Project sound levels only.

Acoustic modeling results show that the Project successfully demonstrates compliance with the most stringent 45 dBA Maine DEP nighttime limit at all identified protected locations and within 500-feet of those protected locations. In fact, the highest predicted sound level at a protected location is 29 dBA, which is inclusive of the 5 dBA be added to the observed levels of any tonal sounds that result from routine operation of the development (06-096 CMR 375.10(C)(1)(d)).

Table 6. Acoustic Modeling Results Summary

NSR ID	UTM Coordinates (meters) NAD83 UTM Zone 19		Operational Sound Level (dBA)
	Easting	Northing	
35	452009	4971493	19
50	452337	4966807	27
66	451795	4969754	29
91	455818	4970273	25
116	452169	4971955	18
126	452222	4971912	18
128	451822	4970323	24
187	451587	4968394	24
188	451573	4970906	21
214	452021	4971509	19
215	451993	4971158	21
216	451824	4969767	29
253	452168	4966806	24
297	456675	4970205	18
303	451528	4970916	21
326	452893	4972080	17
327	452138	4971657	19
328	451831	4969982	25
347	456168	4970393	20

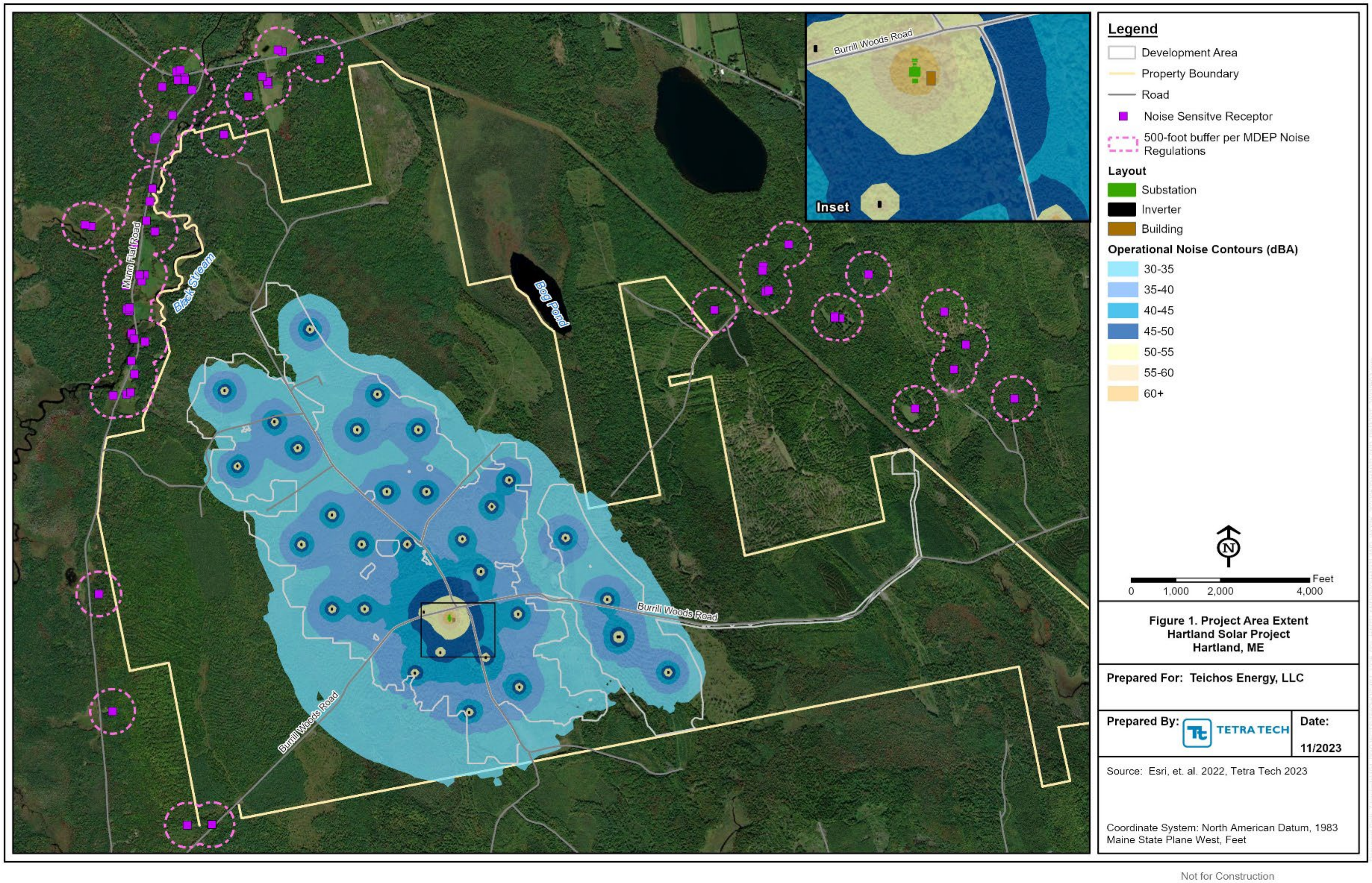
Table 6. Acoustic Modeling Results Summary

NSR ID	UTM Coordinates (meters) NAD83 UTM Zone 19		Operational Sound Level (dBA)
	Easting	Northing	
364	457856	4969638	15
421	452194	4971964	18
423	451864	4970781	22
444	456873	4970501	17
478	451806	4970335	24
501	451704	4969748	25
529	456331	4970713	18
530	453149	4972024	18
545	452178	4971896	18
546	451669	4967590	23
556	451927	4970112	25
598	456154	4970566	19
619	456640	4970219	19
641	456190	4970403	20
643	451802	4970496	23
676	451824	4970345	24
703	452792	4971858	20
704	452656	4971778	20
724	456149	4970537	19
742	452227	4971896	18
753	452070	4971851	19
754	451948	4970938	21
804	452864	4972092	17
821	457386	4970238	16
824	452788	4971877	20

Table 6. Acoustic Modeling Results Summary

NSR ID	UTM Coordinates (meters) NAD83 UTM Zone 19		Operational Sound Level (dBA)
	Easting	Northing	
848	451852	4969892	29
849	452753	4971911	20
850	457178	4969580	18
851	457447	4969844	16
852	457529	4970012	16
853	456636	4970209	19
854	452273	4971827	18
855	451929	4970570	23
856	451910	4970527	23
857	451896	4970569	23
858	452006	4970864	22
859	451974	4971070	21
860	451836	4970170	25
861	451853	4970132	25
862	452486	4971520	21

Figure 2. Operational Received Levels



4.0 CONCLUSION

Tetra Tech completed a detailed acoustic assessment of the proposed Hartland Solar Project, to be constructed in Somerset County, Maine. The assessment included an evaluation of potential Project sound level impacts during construction and operation phases.

The construction noise assessment 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 2.2. Traffic noise generated during construction on site and off site would also add to overall sound levels but would be intermittent and short-term.

Operational sound levels were modeled and evaluated at the nearby NSRs. Anticipated Project sound sources consist of the cooling fans on the inverters, and transformers, and the electrical components of the inverters. Incorporating several conservative assumptions, acoustic modeling results indicate that the Project is well below the Maine DEP 55 dBA daytime limit and 45 dBA nighttime limit. In addition, the Project is predicted to comply with all the applicable Maine DEP regulatory limits at the Project lease boundary. 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.

5.0 REFERENCES

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