Noise and Ground Vibration Technical Report

Lancaster Solar R&D Project, Los Angeles County, California

NOVEMBER 2022

PREPARED FOR

Heliogen, INC.

PREPARED BY

SWCA Environmental Consultants

NOISE AND GROUND VIBRATION TECHNICAL REPORT
LANCASTER SOLAR R&D PROJECT
LOS ANGELES COUNTY, CALIFORNIA

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November 2022

CONTENTS

1 Introduction 1

2 Project and Study Description 1

3 Sound Fundamentals – Background 3

3.1 Definition of Acoustical Terms 4
3.2 Sound Levels of Representative Sounds and Noises 4
3.3 Ground-borne Vibration Fundamentals 5
3.3.1 Ground Vibration Terms 6
3.3.2 Ground Vibration and Structure Damage 7
3.3.3 Ground Vibration and Human Perception 7

4 Existing Conditions 7

4.1 Climate and Topography 7
4.2 Existing Sound Conditions 8
4.2.1 Measurement Locations 8
4.2.2 Instrument Description 9
4.2.3 Calibration Checks 9
4.2.4 Meteorological Data 10
4.2.5 Existing Sound Levels 10
4.2.1 Nearest Receptor Sites 11

5 Regulatory Setting 13

5.1 Applicable Noise Standards 13
5.1.1 Federal 13
5.1.2 State 13
5.1.3 Local 13
5.2 Applicable Ground-Borne Vibration Standards 16
5.2.1 Federal 16
5.2.2 State 16
5.2.3 Local 16

6 Thresholds of Significance and Methodology 16

6.1 Thresholds of Significance 16
6.1.1 Short-term Construction Noise Criteria 17
6.1.2 Short-Term Construction Vibration Criteria 17
6.1.3 Long-Term Operational Noise Criteria 18
6.2 Methodology 18
6.2.1 Noise Assessment Components 18
6.2.2 On-Site Construction Noise 19
6.2.3 On-Site Operational Noise 20
6.2.4 Vibration Assessment Components 21
6.2.5 Construction Ground-Borne Vibration 22

7 Impacts and Mitigation Measures 22

7.1 Construction Noise 22
7.2 Operational Noise 24
7.2.1 Operational Activities 24
7.2.2 Noise Profile 24
7.3 *Construction Vibration* 24

7.3.1 On-Site Construction Ground-Borne Vibration 24
8 Literature Cited 27

Appendices

Appendix A: Long-Term Monitoring Location Photographs
Appendix B: Project Operation Isopleths

Figures

Figure 1. Vicinity map. 2
Figure 2. Project site plan. ..... **Error! Bookmark not defined.**
Figure 3. Monitoring Sites. 12
Figure 4. Land use compatibility for exterior community noise exposure. 14

Tables

Table 1. Sound Levels of Representative Sounds and Noises 4
Table 2. Average Human Ability to Perceive Changes in Sound Levels 5
Table 3. Human Response to Ground Vibration 7
Table 4. Climatological Conditions Near Lancaster, California 8
Table 5. Monitoring Locations 8
Table 6. Instrumentation 9
Table 7. Pre- and Post-Instrument Response Checks 9
Table 8. Weather Conditions for September 8 through September 15, 2022 10
Table 9. Summary of Ambient Sound Measurements 10
Table 10. Noise Compatible Land Use Objectives 15
Table 11. Construction Vibration Impact Criteria for Building Damage 16
Table 12. Noise Levels for Common Construction Equipment 19
Table 13: Construction Anticipated Equipment 22
Table 14. Predicted Construction Noise Levels 23
Table 15. Equipment Sound Power Levels 24
Table 16. Construction Vibration Impacts – Building Damage 25
Table 17. Construction Vibration Impacts – Human Annoyance 25

1 INTRODUCTION

Heliogen, Inc. (Applicant), retained SWCA Environmental Consultants (SWCA) to prepare this noise and ground vibration technical report in support of the proposed Lancaster Solar R&D Project (project) in the City of Lancaster (Lancaster or City), Los Angeles County, California (county). The purpose of this report is to explain the methodologies used to evaluate the effects of a research, development, and demonstration of Concentrating Solar Power (CSP) technology on the existing soundscape.

This report presents the analysis and noise impact estimates for the construction and operation of the project at noise sensitive areas (NSAs) to demonstrate that the proposed activities associated with this project will not result in a substantial permanent increase in ambient noise levels in the vicinity of the project.

2 PROJECT AND STUDY DESCRIPTION

The approximate 20-acre project site is located at 431 East Avenue K-4, Lancaster, CA 93535, which is the site of the currently abandoned Lancaster Golf Center in Los Angeles County (Figure 1). The purpose of this project is to perform research, development, and demonstration of technology to use CSP to produce green hydrogen through solar thermochemical water splitting. The project includes a heliostat field for collecting and concentrating sunlight, and tower-mounted heliostat control equipment and solar flux measurement devices. In addition to the concentrated solar equipment, there will be an office building, maintenance and storage building, photovoltaic panels, and equipment to support hydrogen production at the project site.

The project will include the heliostat field and control system (Figure 2). This phase will demonstrate Heliogen's heliostat technology, verifying that it meets the performance requirements necessary for thermochemical water splitting. The project is planned for approximately 3 to 5 years during which solar research and technology development will occur.

The heliostat field will consist of approximately 500 heliostats, or sun-tracking mirrors, that collect solar energy by tracking the sun throughout the day. Each heliostat is controlled by computers to direct its reflected beam of sunlight toward the solar receiver. In this way, the field collects solar energy and concentrates it at a single location. The project will also consist of approximately 400 photovoltaic panels to provide power to the site.

During construction, the heliostat field will be mowed and rolled, but will not be graded and the heliostats will be installed by driven pile conforming to the previous grading of the site. The new solar receiver tower will be constructed at a height of approximately 46 feet, with equipment mounted to the tower adding an additional 9 feet (total of approximately 55 feet tall). Gravel access roads will be placed around the perimeters of the field and the tower. Predicted construction-generated noise levels at nearby NSAs were calculated using the Federal Highway Administration (FHWA) Roadway Construction Noise Model (RCNM). The RCNM is FHWA's national model for the prediction of construction noise.

Among project components, the sources with potential to impact ambient noise levels are the heliostat and photovoltaic trackers, blowers and a Hydrogen Storage and Dispensing system. The noise impact evaluation for the operation of the project, provided herein, consists of computer noise modeling using SoundPLAN Essential Version 5.1 and assessment of the outputs as they pertain to the sound (noise) standards and nearest NSAs (i.e., nearest residences).

Figure 1. Vicinity map.

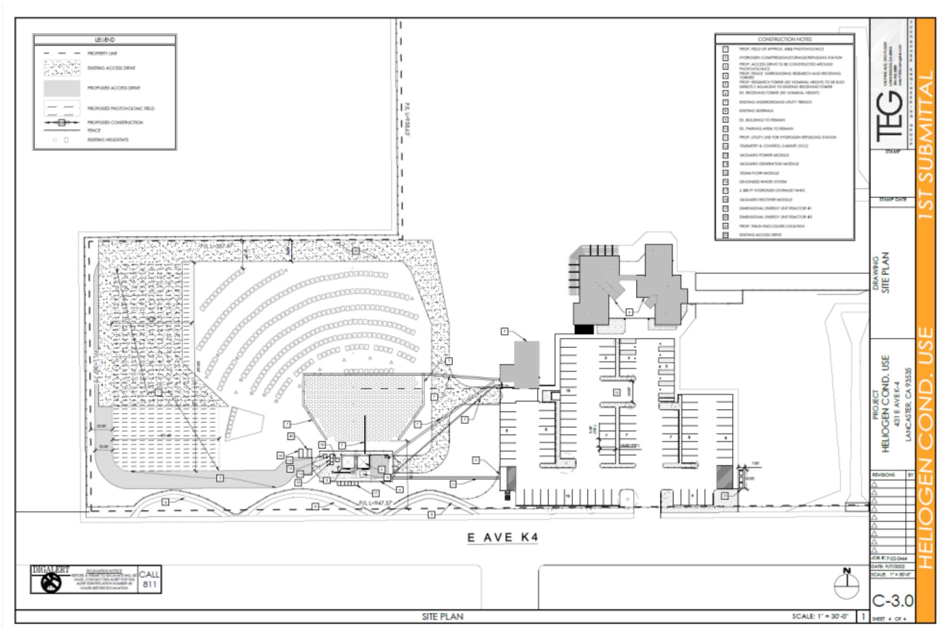


Figure 2. Conceptual Project Layout.

3 SOUND FUNDAMENTALS – BACKGROUND

Sound is defined as a form of energy that is transmitted by pressure variations, which the animal or human ear can detect. Noise can be defined as any unpleasant or unwanted sound that is unintentionally added to a desired sound or environment. The noise effects in humans include interference with communication, learning, rest, or sleep and physiological health effects. There are two main properties of sound: the amplitude and the frequency. Amplitude refers to the level of energy that reaches the ear (how loud we perceive the sound), while frequency is the number of cycles or oscillations per unit of time completed by the source. Frequency is normally expressed in hertz (Hz).

Sound power is defined as the measurement of the ability of a source to make sound. It is independent of the acoustic environment in which is located. The sound power level (L_{pw}) of a source is the amount of energy it produces relative to a reference value and is normally expressed in decibels. The decibel is a logarithmic scale to describe the sound pressure ratio.

Humans perceive a frequency range of about 20 Hz to about 20,000 Hz. An internationally standardized frequency weighting, the A-weighting scale, was designed to approximate the audible range of frequencies of a healthy human ear. The A-weighting scale corresponds to the fact that the human ear is not as sensitive to sound at the lower frequencies as it is at the higher frequencies.

3.1 Definition of Acoustical Terms

Several different descriptors of time-averaged sound levels are used to account for fluctuations of sound intensity over time. The sound descriptors calculated by the sound meters and used in this report to describe environmental sound are defined below.

- Ambient sound level is defined as the composite of noise from all sources near and far, the normal or existing level of environmental noise at a given location.
- Decibel (dB) is the physical unit commonly used to measure sound levels. Technically, a dB is a unit of measurement that describes the amplitude of sound equal to 20 times the base 10 logarithm of the ratio of the reference pressure to the sound of pressure, which is 20 micropascals (μPa).
- Equivalent noise level (L_{eq}) is the energy average A-weighted noise level during the measurement period.
- The root-mean-squared maximum noise level (L_{max}) characterizes the maximum noise level as defined by the loudest single noise event over the measurement period.
- Day-night sound level (L_{dn}) is the A-weighted equivalent sound level for a 24-hour period with an additional 10 dB weighting imposed on the equivalent sound levels occurring during night-time hours (10 p.m. [22:00] to 7 a.m. [07:00]).
- Daytime Sound Level (L_d) is defined as the equivalent sound level for a 15-hour period between 7 a.m. (07:00) and 10 p.m. (22:00).
- Nighttime Sound Level (L_n) is defined as the equivalent sound level for a 9-hour period between 10 p.m. (22:00) and 7 a.m. (07:00).
- Community Noise Equivalent Level (CNEL) represents the average of 24-hourly readings of equivalent levels, with upward adjustments added to account for increased noise sensitivity in the evening and night periods. These adjustments are 5 dBA for the evening, 7:00 p.m. to 10:00 p.m., and 10 dBA for the night, 10:00 p.m. to 7:00 a.m.
- Residual sound level (L_{90}) is the level that is exceeded 90% of the time over a specified period. The residual sound level excludes intruding sound from sporadic anthropogenic noises, wildlife, and wind gusts that raise the average and maximum levels over a measurement period.

3.2 Sound Levels of Representative Sounds and Noises

The U.S. Environmental Protection Agency (EPA) has developed an index to assess noise impacts from a variety of sources using residential receptors. If L_{dn} values exceed 65 dBA, residential development is not recommended (EPA 1979). Noise levels in a quiet rural area at night are typically between 32 and 35 dBA. Quiet urban night-time noise levels range from 40 to 50 dBA. Levels above 70 dBA tend to be associated with task interference. Levels between 50 and 55 dBA are associated with raised voices in a normal conversation. Noise levels during the day in a noisy urban area are frequently as high as 70 to 80 dBA. Noise levels above 110 dBA become intolerable. Table 1 presents sound levels for some common noise sources and the human response to those decibel levels.

Table 1. Sound Levels of Representative Sounds and Noises

Source and Distance	Sound Level (dBA)	Human Response
Jet takeoff (nearby)	150	

Jet takeoff (15 m/50 feet)	140	
50-hp siren (30 m/100 feet)	130	
Loud rock concert (near stage)	120	Pain threshold
Construction noise (3 m/10 feet)	110	Intolerable
Jet takeoff (610 m/2,000 feet)	100	
Heavy truck (8 m/25 feet)	90	
Garbage disposal (0.6 m/2 feet)	80	Constant exposure endangers hearing
Busy traffic	70	
Normal conversation	60	
Light traffic (30 m/100 feet)	50	Quiet
Library	40	
Soft whisper (4.5 m/15 feet)	30	Very quiet
Rustling leaves	20	
Normal breathing	10	Barely audible
Threshold of hearing	0	

Source: Beranek (1988).

Table 2 provides criteria that have been used to estimate an individual's perception of increases in sound. In general, an average person perceives an increase of 3 dBA or less as barely perceptible. An increase of 10 dBA is perceived as a doubling of the sound.

Table 2. Average Human Ability to Perceive Changes in Sound Levels

Increase in Sound Level (dBA)	Human Perception of Sound
2–3	Barely perceptible
5	Readily noticeable
10	Doubling of the sound
20	Dramatic change

Source: Bolt Beranek and Newman, Inc. (1973).

3.3 Ground-borne Vibration Fundamentals

This chapter describes basic concepts related to ground-borne vibration. Ground-borne vibration is a small, rapidly fluctuating motion transmitted through the ground. When seismic waves are perceptible, when they can be felt, they are called "ground vibrations." Seismic waves are divided into two classes: body waves and surface waves.

1. Body waves travel across the mass of the rock, penetrating down into the interior of the rock mass. There are two forms of body waves: compressional waves and shear waves. The compressional wave (P-wave) is a push-pull type wave that produces alternating compression and dilatation in the direction of wave travel. The shear wave (S-wave) is produced when the medium particles oscillate perpendicular to the propagation direction.

2. Surface waves (L-waves) travel over the surface of rock mass but do not travel through it. Surface waves are generated by body waves that are constrained by physical and geometrical conditions from traveling into the rock mass. Surface waves are the large energy carriers and account for the largest ground motions. There are two fundamental types of surface waves: the Raleigh, and the Love waves (Q-wave). Raleigh and Love waves represent the energy measured by a seismograph and are the main component of vibration when examining ground vibration from blasting activities.

The ground vibration from surface waves is measured as the velocity of motion, or how many inches per second (in/sec) the ground is moving. The motion of the ground particles (vibration) happens in three dimensions: radial, transverse, and vertical. During vibration, each particle has a velocity, and the maximum velocity is referred to as the peak particle velocity (PPV). The resulting vector of all three components (i.e., radial, transverse, and vertical) combined is referred to as peak vector sum (PVS).

The industry standard is to use the readings of the PPV as the metric to measure the intensity of the ground vibration. In reporting, the maximum measurement of any of the three components is used rather than the resulting PVS.

3.3.1 *Ground Vibration Terms*

Ground vibration is described using the following terms:

- Acceleration—The rate at which particle velocity changes.
- Crest factor—The ratio of peak particle velocity to maximum root mean square amplitude in an oscillating signal.
- Displacement—The farthest distance that the ground moves before returning to its original position.
- Frequency—The number of oscillations per second that a particle makes when under the influence of seismic waves.
- Hertz (Hz)—The unit of acoustic or vibration frequency representing cycles per second.
- Peak particle velocity (PPV)—The greatest particle velocity associated with an event.
- Peak vector sum (PVS)—The square root of the sum of the squares of the individual PPV values in all three vector directions.
- Particle velocity—The velocity at which the ground moves.
- Propagation velocity—The speed at which a seismic wave travels away from the blast.
- Root Mean Square (RMS)—The square root of the mean-square value of an oscillating waveform, where the mean-square value is obtained by squaring the value of amplitudes at each instant of time and then averaging these values over the sample time.
- Vibration Velocity Level (LV)—Ten times the common logarithm of the ratio of the square of the amplitude of the RMS vibration velocity to the square of the amplitude of the reference RMS vibration velocity.

3.3.2 *Ground Vibration and Structure Damage*

Ground vibrations can produce permanent changes in the relative positions of "particles" that constitute structures. Because these permanent changes are unwanted, they are colloquially referred to as "damage". The larger the vibration (i.e., the higher the ground movement speed), the greater is the potential for these permanent shifts in particle positions in structures.

While structural damage associated with ground vibration can occur, noticeable vibration damage is often seen as cracks in drywall or plaster and exterior surfaces such as grout and stucco. This may, or may not, be a sign of structural damage. Since such cosmetic damage can also be caused by settling, temperature changes, and normal aging, a few hairline cracks found in a house does not necessarily indicate a vibrational cause.

3.3.3 *Ground Vibration and Human Perception*

In addition to concerns about structural damage, under specific conditions, humans can be startled or annoyed by ground vibration. Human response to vibration is hard to evaluate due to differences in individual perception. Humans can detect lower levels of ground vibration than those levels discussed in Section 5.2.2 that could adversely impact structures. The human body can distinctively perceive ground vibration as low as 0.1 inch per second, with some people being able to perceive even lower levels.

The reason the public may perceive ground vibration as annoying is because it is an A-Cultural Vibration—that is, something that occurs that people are not used to experiencing. For example, vibration produced by a blast is unique and one does not expect it; therefore, an individual may report on the vibration to a much larger extent (Konya 2019). Additionally, the rattling of objects in the immediate surroundings influences the occupants to look for cracks in their residences. Dowding (1996) sees this as human sensitivity being triggered by vibrations that give rise to their inquiring minds. Table 3 indicates the average human response to vibration that may be anticipated when the person is at rest, situated in a quiet surrounding.

Table 3. Human Response to Ground Vibration

Average Human Response	PPV (in/sec)
Barely to distinctly perceptible	0.020–0.10
Distinctly to strongly perceptible	0.10–0.50
Strongly perceptible to mildly unpleasant	0.50–1.00
Mildly to distinctly unpleasant	1.00–2.00
Distinctly unpleasant to intolerable	2.00–10.00

Source: California Department of Transportation (2013)

4 EXISTING CONDITIONS

4.1 Climate and Topography

The Lancaster meteorological station outside of Lancaster, California, was selected as having representative historical climatic conditions for the project area. The meteorological station is located approximately 7 miles northwest of the project area.

The climate in this area is characterized by hot summers and generally mild to cool winters. Temperatures range from an average low of 43.8 degrees Fahrenheit (°F) in December to an average high of 82.3°F in July (Table 4). Lancaster meteorological station has an average annual precipitation of 7.4 inches with most of the rain falling in the winter. According to the NCDC, there was an average of 16 days per year when rainfall exceeded 0.1 inch during the 1981 through 2010 period. Snow is a negligible form of precipitation in the project region; many years passed with no measurable snow. Lancaster meteorological station has an average annual snowfall of 2.3 inches, all occurring from December through March.

Table 4. Climatological Conditions Near Lancaster, California

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Normal daily maximum temperature (°F)	58.7	61.7	67.1	73.2	82.3	90.0	97.8	97.5	90.7	79.4	66.9	57.9	77.0
Normal daily minimum temperature (°F)	31.1	34.9	39.3	44.9	54.0	61.3	66.8	64.3	56.6	45.9	35.9	29.7	47.1
Normal daily mean temperature (°F)	44.9	48.3	53.2	59.1	68.1	76.1	82.3	80.9	73.7	62.6	51.4	43.8	62.0
Average precipitation (inches)	1.50	1.78	1.14	0.35	0.09	0.05	0.09	0.10	0.15	0.44	0.54	1.15	N/A
Average no. days with ≥ 0.10-inch precipitation	3.2	3.4	2.5	1.0	0.3	0.1	0.2	0.2	0.4	1.0	1.4	2.4	N/A
Average snowfall (inches)	0.4	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	N/A

Source: Data are 30-year averages (1981–2010) from National Climatic Data Center (NCDC) Local Climatological Data Monthly Climate Normals for Lancaster, CA (USW00003159; NOAA 2022).

4.2 Existing Sound Conditions

4.2.1 *Measurement Locations*

SWCA performed an ambient noise survey from September 8 through September 15, 2022. The purpose of the survey was to characterize the noise environment in the vicinity of the project. Monitoring locations are listed below in Table 5. Figure 3 shows the location of the 7 noise measurement locations. Appendix A provides photographs of the monitoring location.

Table 5. Monitoring Locations

Monitor	Monitor Location		Elevation (feet amsl)
	Latitude	Longitude	
LT-1	34.67233	-118.123306	2,429
ST-1	34.671238	-118.12146	2,431
ST-2	34.6721775	-118.124486	2,432
ST-3	34.6715176	-118.1236069	2,432
ST-4	34.672127	-118.121206	2;432
ST-5	34.673208	-118.121161	2;433

ST-6	34.672869	-118.1233726	2;431

4.2.2 *Instrument Description*

Noise measurements were collected using one (1) Larson Davis Precision Integrating Sound Level Meter Model 831C meeting the requirements of the American National Standards Institute (ANSI 2013), one (1) PCB PRM831 preamplifiers, and one (1) PCB 377B02 free-field microphones as described in Table 6.

The microphone was fitted with an environmental windscreen and bird spikes and set up on a tripod at a height of 5 feet (1.5 m) above ground and placed as far from the influence of vertical reflective sources as possible. All cables were secured to prevent any sounds due to wire movement. All clocks associated with the sound measurement were synchronized using the Larson Davis G4 LD Utility software.

Table 6. Instrumentation

Monitoring Location	Sound Level Meter	Preamplifier	0.5-inch free-field microphone
LT-1	Larson Davis 831C (S/N 0010737)	PRM831 (S/N 58504)	377B02 (S/N 311602)

Note: S/N = Serial Number.

4.2.3 *Calibration Checks*

The sound level meters were calibrated at the beginning and end of the measurement period using a Larson Davis Model CAL200 Precision Acoustic Calibrator. The Larson Davis CAL200 emits a 1-kHz tone at 114 dB against which the response can be checked.

The calibrator has been designed for both field and laboratory use, and the accuracy has been calibrated to a reference traceable to the National Institute of Standards and Technology. The Larson Davis 831C showed a response of less than the normal error of 0.50 dBA. The results for the calibrations are shown in Table 7.

Table 7. Pre- and Post-Instrument Response Checks

Monitor Location Name	Test Date	Sound Level	Response (dB)	Error [1] (dB)
LT1	Pre-Test 9/14/2022	114 dB	114.03	0.03
	Post-Test 9/15/2022	114 dB	114.13	0.13
ST1	Pre-Test 9/9/2022	114 dB	114.03	0.03
	Post-Test 9/9/2022	114 dB	113.94	-0.06
ST2	Pre-Test 9/8/2022	114 dB	113.98	-0.02
	Post-Test 9/8/2022	114 dB	113.86	-0.14
ST3	Pre-Test 9/8/2022	114 dB	113.94	-0.06
	Post-Test 9/8/2022	114 dB	113.89	-0.11
ST4	Pre-Test 9/9/2022	114 dB	114.07	0.07
	Post-Test 9/9/2022	114 dB	113.89	-0.11
ST5	Pre-Test 9/9/2022	114 dB	114.09	0.09
	Post-Test 9/9/2022	114 dB	114.01	0.01
ST6	Pre-Test 9/8/2022	114 dB	114.07	0.07
	Post-Test 9/8/2022	114 dB	114.26	0.26

[1] Calibration error indicates the difference between the values measured by the instrument and the tone emitted by the acoustic calibrator.

4.2.4 *Meteorological Data*

Approximately 25 hours of noise data were collected during the survey and validated against weather data from the Desert Wind Station (KCALANCA126) located approximately 0.7 miles southeast of the project. Survey weather conditions are presented in Table 8.

Table 8. Weather Conditions for September 8 through September 15, 2022

Weather Station	Monitoring Start	Monitoring End	Wind Speed (mph)		Temperature (°F)		Humidity (% relative humidity)	
			Range	Avg.	Range	Avg.	Range	Avg.
Desert Wind	9/8/2022	9/15/2022	0–7	1.6	57–101	78.8	18–85	45

Note: mph = miles per hour; avg. = average.

The American Society for Testing and Materials (ASTM) Standard Guide for Measurement of Outdoor A-Weighted Sound Levels (ASTM 2012) specifies that data should not be used when steady wind speeds exceed 20 km per hour (12.4 miles per hour). No data points were removed from the long-term or short-term sound data sets due to high-wind events.

4.2.5 *Existing Sound Levels*

To determine the baseline or ambient sound levels experienced near the project area and at the closest noise-sensitive areas, ambient sound surveys were performed of the area. Long-term and short-term sound monitoring was conducted from September 8 to 15, 2022, to document the acoustic environment in the area surrounding the proposed project. Table 9 summarizes the measured A-weighted L_{eq}, L_{90}, CNEL and L_{dn} (calculated from the measured L_{eq}) for each of the monitoring locations.

Table 9. Summary of Ambient Sound Measurements

Monitoring Location	Monitoring Start	Monitoring End	Elapsed Time	Measured Sound Levels					
				L_{eq}	L_{90}	L_{dn}	CNEL	L_d	L_n
LT-1 *	9/14/2022 15:04	9/15/2022 16:00	24:55	59.4	40.7	61.0	61.1	61.1	50.7
ST-1	9/9/2022 12:29	9/9/2022 12:49	0:20	61.7	51.6	-	-	61.7	-
ST-2	9/8/2022 12:58	9/8/2022 13:14	0:15	49.5	46.0	-	-	49.5	-
ST-3	9/8/2022 14:25	9/8/2022 14:42	0:17	49.9	43.9	-	-	49.9	-
ST-4	9/9/2022 13:00	9/9/2022 13:15	0:15	66.1	50.2	-	-	66.1	-
ST-5	9/9/2022 13:25	9/9/2022 13:42	0:17	73.2	62.0	-	-	73.2	-
ST-6	9/8/2022 13:33	9/8/2022 14:01	0:27	49.6	43.9	-	-	49.6	-

* Data derived from the average 1-hour L_{eq} calculated by logarithmic averaging the number of sound measurements taken at each specific hour.

Measurement duration was sufficient to ensure natural variation in sound levels and meteorological conditions were covered. Observed sources of background sound that contributed to the existing sound level at the monitoring locations included road traffic, birds, insects, dogs, and airplanes.

4.2.1 *Nearest Receptor Sites*

Noise-sensitive receptors generally are defined as locations where people reside or where the presence of unwanted sound may adversely affect the existing land use. A noise sensitive receptor is usually defined as a location where a state of quietness is a basis for use or where excessive noise interferes with the normal use of the location. Typical receptors include residential areas, monuments, schools, hospitals, churches, and libraries. The closest receptor is an apartment complex 65 feet north of the nearest project boundary.

Figure 3. Monitoring Sites.

5 REGULATORY SETTING

Federal, state, and local agencies have set noise and ground-borne vibration regulations and policies to protect the health and welfare of the public, as described below.

5.1 Applicable Noise Standards

5.1.1 *Federal*

There are no federal noise standards or regulations that directly regulate environmental noise related to the construction or operation of the proposed project.

5.1.2 *State*

5.1.2.1 CALIFORNIA NOISE CONTROL ACT

The State, recognizing the effects of noise upon people's health and wellbeing, required that local jurisdictions prepare statements of policy indicating their intentions regarding noise and noise sources, establish desired maximum noise levels according to land use categories, set standards for noise emission from transportation facilities and fixed-point sources, and prepare a program for implementation of noise control measures. The California Noise Control Act declares that the State of California has the responsibility to protect the health and welfare of its citizens by the control, prevention, and abatement of noise. The Office of Noise Control in the Department of Health Services aids local communities developing local noise control programs and works with the Governor's Office of Planning and Research to provide guidance for the preparation of the required noise elements in city and county general plans, pursuant to Section 65302(f) of the California Government Code.

5.1.2.2 STATE OF CALIFORNIA GENERAL PLAN

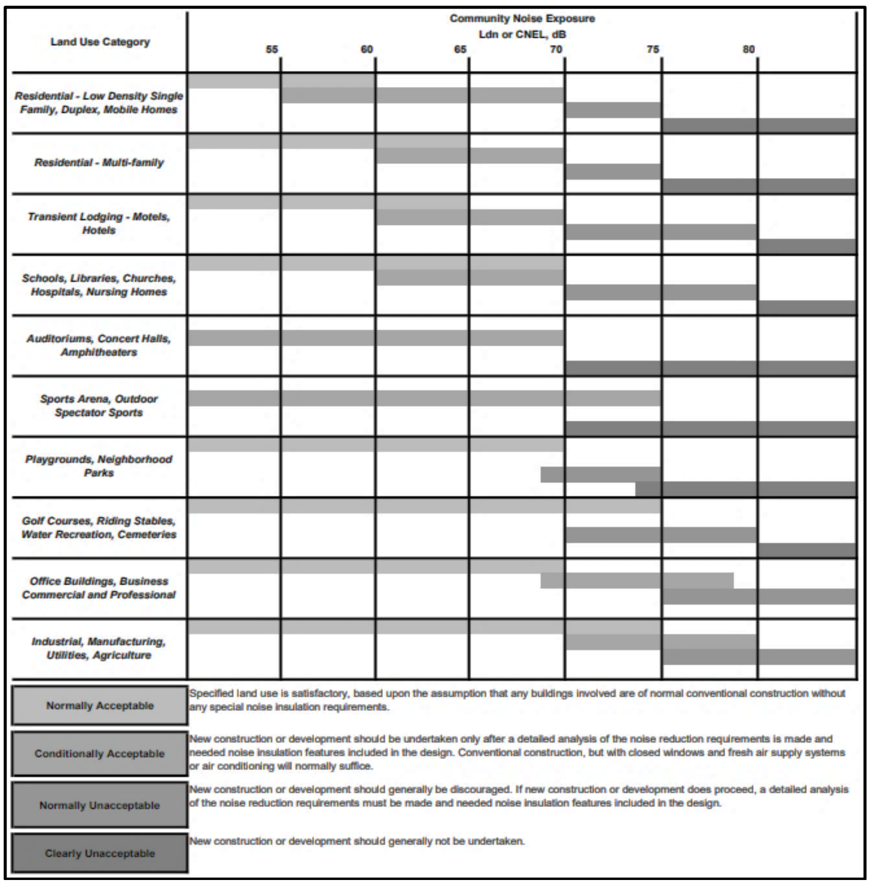
The State of California has not adopted statewide regulations or standards for noise. However, the *State of California General Plan Guidelines*, published and updated by the Governor's Office of Planning and Research (OPR), provides standards and the acceptable noise categories for different land uses (OPR 2017). Figure 4 provides the exterior noise standards associated with the different land uses evaluated by the State.

California also requires each local government entity to perform noise studies and implement a noise element as part of its general plan. The purpose of the noise element is to limit the exposure of the community to excessive noise levels; the noise element must be used to guide decisions concerning land use.

5.1.3 *Local*

5.1.3.1 CITY OF LANCASTER GENERAL PLAN PUBLIC HEALTH AND SAFETY ELEMENT

The City of Lancaster has adopted a Noise section of the Public Health and Safety Element of the General Plan to define ″quiet" and set standards that will ensure an appropriately quiet environment for the Lancaster various land uses proposed within the General Plan study area, recognizing the varying noise-sensitivity of these uses.



Source: OPR (2017:Appendix D, Figure 2)

Figure 4. Land use compatibility for exterior community noise exposure.

To protect City of Lancaster residents from excessive noise, the Noise section contains the following objective related to the Project:

Objective 4.3 *Promote noise-compatible land use relationships by implementing the noise standards identified in Table 4-3 to be utilized for design purposes in new development and establishing a program to attenuate the existing noise problem.*

To ensure noise issues are addressed (Objective 4-3), the Noise section identifies the following policies:

4.3.1 Ensure that noise-sensitive land uses and noise generators are located and designed so that city noise objectives will be achieved.

4.3.2 Wherever feasible, manage the generation of single event noise levels (SENL) from motor vehicles, trains, aircraft, commercial, industrial, construction, and other activities such that SENL levels are no greater than 15 dBA above the noise objectives included in the Plan for Public Health and Safety.
4.3.3 Ensure that the provision of noise attenuation does not create significant negative visual impacts. For related policies and specific actions, refer to the Community Design section of the Plan for Physical Development.

Section III, Plan for Public Health and Safety, of the City of Lancaster General Plan, also includes Noise Compatible Land Use Objectives identified in Table 10, Noise-Compatible Land Use Objectives.

Table 10. Noise Compatible Land Use Objectives

Land Use	Maximum Exterior CNEL, dBA	Maximum Interior CNEL, dBA
Rural, Single-Family, Multi-Family Residential	65	45
Schools: Classrooms	65	45
Playgrounds	70	--
Libraries	--	50
Hospitals/Convalescent Facilities: Living Areas	--	50
Sleeping Areas	--	40
Commercial and Industrial	70	--
Office Areas	--	50

Source: City of Lancaster has adopted a Noise section of the Public Health and Safety Element of the General Plan, Table 4-3: Noise Compatible Land Use Objectives

5.1.3.2 CITY OF LANCASTER MUNICIPAL NOISE STANDARDS

The City of Lancaster adopted provisions in the Lancaster Municipal Code to regulate excessive and offensive noise. According to Chapter 8.24 of the Health and Safety Code, it is the policy of the City to prohibit unnecessary, excessive, and annoying noises from all sources subject to its police power.

Section 8.24.030 (Loud, unnecessary and unusual noises prohibited) states that no person shall make, cause or suffer, or permit to be made upon any premises owned, occupied or controlled by him/her any unnecessary noises or sounds which are physically annoying to persons of ordinary sensitiveness which are so harsh or so prolonged or unnatural or unusual in their use, time, or place as to occasion physical discomfort to the inhabitants of any neighborhood. All animals shall be so maintained.

With respect to construction and building, Section 8.24.040 (Loud, Unnecessary and Unusual Noises Prohibited-Construction and Building) states the following:

Except as otherwise provided in this chapter, a person at any time on Sunday or any day between the hours of eight p.m. and seven a.m. shall not perform any construction or repair work of any kind upon any building or structure or perform any earth excavating, filling or moving where any of the foregoing entails the use of any air compressor, jack hammer, power-driven drill, riveting machine, excavator, diesel-powered truck, tractor or other earth-moving equipment, hard hammers on steel or iron or any other machine tool, device or equipment which makes loud noises within five hundred (500) feet of an occupied dwelling, apartment, hotel, mobile home or other place of residence.

5.2 Applicable Ground-Borne Vibration Standards

5.2.1 *Federal*

There are no federal ground-borne vibration standards or regulations adopted by an agency that are applicable to evaluating vibration impacts from land use development projects such as the proposed project.

5.2.2 *State*

There are no state ground-borne vibration standards that directly apply to the project.

5.2.3 *Local*

Section 12.08.560 of the County Noise Control Ordinance provides a ground-borne vibration limit as to not exceed the vibration human perception threshold of 0.01 inch per second (80 vibration velocity decibels [VdB]).

As noted above, no standards or limits applicable to potential building damage from ground-borne vibration have been adopted by a local, state, or federal agency. Therefore, Federal Transit Administration (FTA) available guidelines are used to assess potential impacts on buildings and structures due to ground-borne vibration. The FTA's *Transit Noise and Vibration Impacts Assessment Manual* provides impact criteria concerning building damage during construction activities (FTA 2018). Table 11 includes the FTA vibration criteria applicable to construction activities.

Table 11. Construction Vibration Impact Criteria for Building Damage

Building Category	PPV (in/sec)
I. Reinforced-concrete, steel, or timber (no plaster)	0.5
II. Engineered concrete and masonry (no plaster)	0.3
III. Non-engineered timber and masonry buildings	0.2
IV. Buildings extremely susceptible to vibration damage	0.12

Source: FTA (2018)

PPV = peak particle velocity; in/sec = inch(es) per second

6 THRESHOLDS OF SIGNIFICANCE AND METHODOLOGY

6.1 Thresholds of Significance

Based upon criteria presented in the California Environmental Quality Act (CEQA) Appendix G, a project would have a significant noise impact if it would cause any of the following:

a) Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?

b) Generation of excessive groundborne vibration or groundborne noise levels?

c) For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?

Since the project site is not located within an airport land use plan, within 2 miles of a public airport or public use airport, or within the vicinity of a private airstrip, the project would not expose people to airport-related noise. Therefore, impacts related to airport-related noise would not occur.

6.1.1 *Short-term Construction Noise Criteria*

The City of Lancaster General Plan Noise Compatible Land Use Objectives (Table 10) identifies an exterior noise level of 65 dBA for noise-sensitive residential land uses. According to General Plan Policy 4.3.2, construction noise represents a SNEL which shall be limited to no greater than 15 dBA above the noise objectives included in the Plan for Public Health and Safety.

To evaluate the potential impacts due to single-event noise levels, the L_{max} descriptor is used for construction noise levels since it accounts for the maximum level measured over a time interval. Therefore, a maximum project-related construction noise level threshold of 80 dBA L_{max} is used in this analysis to assess the construction noise levels at the nearby sensitive residential land uses.

The noise levels generated by construction activities have been assessed against the following regulations and standards to determine potential noise impacts:

- Construction activities would exceed the project-related construction noise level threshold of 80 dBA L_{max} at at nearby sensitive receiver locations.

6.1.2 *Short-Term Construction Vibration Criteria*

Because there are currently no local regulatory standards for ground-borne vibration that are applicable to the project, then, based on FTA impacts with respect to building damage (see Table 11), ground-borne vibration would be considered significant if

- ground-borne vibration levels from construction activities exceed 0.5 PPV at the nearest off-site reinforced-concrete, steel, or timber building; or
- ground-borne vibration levels from construction activities exceed 0.3 PPV at the nearest off-site engineered concrete building; or
- ground-borne vibration levels from construction activities exceed 0.2 PPV at the nearest off-site non-engineered timber and masonry building; or
- ground-borne vibration levels from construction activities exceed 0.12 PPV at buildings extremely susceptible to vibration damage (e.g., historic buildings).

With respect to human annoyance, Section 12.08.560 of the Los Angeles County Noise Control Ordinance presents a threshold of 0.01 inch per second (80 VdB). Therefore, construction vibration impacts associated with human perception would be significant if

- ground-borne vibration levels from construction activities exceed 80 VdB at the off-site receptor.

6.1.3 *Long-Term Operational Noise Criteria*

The City of Lancaster General Plan, Noise Compatible Land Use Objectives (Table 10) are also used to establish the operational noise level standards for the project. The CNEL noise level standards of the Noise Compatible Land Use Objectives are adapted to analyze the potential impacts from the noise-generating land uses within the project site using an L_{eq} threshold, which represents a steady state sound level containing the same total energy as a time varying signal over a given sample period. This represents a conservative approach, since using an L_{eq} threshold allows for a peak hour analysis with all operational activities occurring at the same time; unlike the CNEL which averages all activities over 24-hours.

The noise levels generated by operational activities have been assessed against the following thresholds:

- If project-related operational noise levels exceed the exterior 65 dBA L_{eq} noise level standard at nearby sensitive receiver locations.

6.2 Methodology

This analysis focuses on the potential change in the existing noise levels due to implementation of the project. Noise and ground-borne vibration would result from both construction and operation of the project.

A combination of existing literature and application of accepted noise and ground-borne vibration prediction and propagation methodologies were used for estimating short-term construction, operation, and long-term non-transportation noise levels, as well as for evaluating ground-borne vibration impacts.

Using the construction and operation assumptions provided for the project, potential noise and vibration levels were estimated using the methods described below.

6.2.1 *Noise Assessment Components*

A noise assessment is based on the following components: a sound-generating source, a medium through which the source transmits, the pathways taken by these sounds, and an evaluation of the proximity to NSAs. Soundscapes are affected by the following factors:

- Source. The sources of sound are any generators of small back-and-forth motions (i.e., motions that transfer their motional energy to the transmission path where it is propagated). The acoustic characteristics of the sources are very important. Sources must generate sound of sufficient strength, approximate pitch, and duration so that the sound may be perceived and can cause adverse effects, compared with the natural ambient sounds.
- Transmission path or medium. The transmission path or medium for sound or noise is most often the atmosphere (i.e., air). For the noise to be transmitted, the transmission path must support the free propagation of the small vibratory motions that make up the sound. Atmospheric conditions (e.g., wind speed and direction, temperature, humidity, precipitation) influence the attenuation of sound. Barriers and/or discontinuities (e.g., existing structures, topography, foliage, ground cover, etc.) that attenuate the flow of sound may compromise the path. For example, sound will travel very well across reflective surfaces such as water and pavement but can attenuate across rough surfaces (e.g., grass, loose soil).
- Proximity to NSAs. An NSA is defined as a location where a state of quietness is a basis for use or where excessive noise interferes with the normal use of the location. Typical NSAs include residential areas, parks, and wilderness areas, but also include passive parks and monuments, schools, hospitals, churches, and libraries.

6.2.2 *On-Site Construction Noise*

The evaluation of potential noise and vibration impacts associated with project construction was based on the construction schedule, phasing, and equipment assumptions provided by the Applicant for the project. Construction of the project, from mobilization to the site to final completion, is expected to occur between January 2023 and March 2023, and would last for approximately 3 months.

Construction-related noise was analyzed using data and modeling methodologies from the FHWA's Roadway Construction Noise Model (FHWA 2011). The Roadway Construction Noise Model is FHWA's national model for the prediction of construction noise. This software is based on actual sound level measurements from various equipment types taken during the Central Artery/Tunnel Project conducted in Boston, Massachusetts, during the early 1990s (FWHA 2011).

Estimates of noise from the construction of the project are based on a roster of the maximum amount of construction equipment used on a given day. Table 12 presents standard construction equipment and the associated noise level at 50 feet. The Roadway Construction Noise Model has noise levels for various types of equipment preprogrammed into the software; that is, the noise level associated with the equipment is typical for the equipment type and not based on any specific make or model.

The approximate noise generated by construction equipment to be used at the project site has been conservatively calculated based on an estimated project construction equipment roster anticipated to be used at the construction site, and not considering further attenuation due to atmospheric interference or intervening structures. The predicted noise from construction activity is presented as a worst-case (highest noise level) scenario, where it is assumed that all equipment is present and operating simultaneously on-site for each stage of construction.

To analyze the project's potential noise impacts, the average 1-hour L_{eq} construction noise level generated during each phase of construction was estimated at each analyzed receptor based on its distance to the construction phase activity.

Table 12. Noise Levels for Common Construction Equipment

Equipment Description	Typical Maximum Noise Levels at 50 Feet (dBA)
Auger drill rig	85
Backhoe	80
Chain saw	85
Compressor (air)	80
Concrete saw	90
Crane	85
Dozer	85
Drill rig truck	84
Drum mixer	80
Dump truck	84
Excavator	85
Flat-bed truck	84

Equipment Description	Typical Maximum Noise Levels at 50 Feet (dBA)
Front-end loader	80
Generator	82
Grader	85
Impact pile driver	95
Jackhammer	85
Man lift	85
Paver	85
Pickup truck	55
Pneumatic tools	85
Pumps	77
Rock drill	85
Roller	85
Scraper	85
Tractor	84
Trencher	82
Vibratory concrete mixer	80
Vibratory pile driver	95
Welder/torch	73

Source: Roadway Construction Noise Model Software, Version 1.1 (FHWA 2011)

6.2.3 *On-Site Operational Noise*

On-site noise levels would be generated by stationary noise sources such as mechanical equipment. Using noise level data from published sources, impacts from these on-site stationary noise sources are evaluated by estimating the noise levels that each noise source would generate at the nearest noise-sensitive receptors. The estimated noise level from each noise source considers the distance from source to receptor. This noise impact evaluation consists of computer noise modeling using SoundPLAN Essential Version 5.1. SoundPLAN estimates noise contours of the overall project in accordance with a variety of standards, primarily International Standards Organization (ISO) 9613-2:1996 Acoustics standards for noise propagation calculations.

All sound propagation losses, such as geometric spreading, air absorption, ground absorption, and barrier shielding, are calculated in accordance with these recognized standards. The model uses industry-accepted propagation algorithms and accepts sound power levels (in decibels) provided by the manufacturer and other sources.

The ISO 9613-2 standard estimates sound pressure levels at a specified distance by subtracting the attenuation factors from the source sound power level for each source in octave frequency bands. Attenuation factors include geometrical divergence, atmospheric attenuation, ground effect, and barrier attenuation; these terms are defined as follows:

- Geometrical divergence occurs as the source sound power is spread out over an increasing surface area (i.e., as the distance from the source increases). The estimated loss rate is the same for all frequencies. This is considered the most significant loss associated with propagation. Attenuation due to geometrical divergence is highly dependent on the distance between the source and the receiver. Direction also affects the noise level: (0°) direct line of sight noise level will be higher than (90°) direction line of sight to a emission point. Therefore, the differences in ground elevation, and receiver height and hub height (source height) are important parameters.

- Ground effect is described according to the parameter Ground Factor (G) which varies between 0 for surfaces with low porosity ("hard" ground) and 1 for "soft" ground (surfaces including loose dirt, grass, crops and other vegetation). This factor describes the effect of sound waves reflected off the ground. Parameters influencing the ground effect are the source height, receiver height, and propagation distance between the source and receiver and the ground conditions.
- Barrier attenuation describes the effect of sound waves refracted around an imperforate element or barrier. A barrier could include man-made objects such as structures, buildings and fences, as well as topographical features. Therefore, the differences in ground elevation, source height, receiver height, dimension, location absorption and reflection coefficients of man-made structures and topographic features are important parameters when estimating barrier attenuation in SoundPLAN.

6.2.4 *Vibration Assessment Components*

Vibration energy extends out as it travels through the ground, causing the vibration level to reduce with respect to the distance from the source. High-frequency vibration decreases much more rapidly than low frequencies, so that low frequencies tend to dominate the spectrum at large distances from the source. The propagation of ground-borne vibration is not simple to model due to geological differences in the medium (ground). Geological factors that may influence the propagation of ground-borne vibration include the following:

- Soil conditions. The type of soil has a strong influence on the propagation of ground-borne vibration. Hard, dense, and compacted soil, stiff clay soil, and hard rock transfer vibration more efficiently than loose, soft soils, sand, or gravel.
- Depth to bedrock. Shallow depth to bedrock provides more efficient propagation of ground-borne vibration. Shallow bedrock concentrates the vibration energy near the surface, reflecting vibration waves back toward the surface that would otherwise continue to propagate farther down into the earth.
- Soil strata. Discontinuities in the soil layering can produce diffractions or channeling effects that impact the propagation of vibration over long distances.
- Frost conditions. Seismic waves typically propagate more efficiently in frozen soils than in unfrozen soils.
- Water conditions. The amount of moisture in the soil has an impact on vibration propagation. The depth of the water table in the path of the propagation also has substantial effects on ground-borne vibration levels.

Specific conditions at the source and receptor locations can also affect the vibration levels. For instance, how the source is connected to the ground (e.g., direct contact or via a structure) or when the source is underground versus on the surface will impact the amount of energy transmitted into the ground. At the receptor, vibration levels can be affected by variables such as the building construction and the foundation type.

6.2.5 *Construction Ground-Borne Vibration*

Construction-related vibration resulting from the project was analyzed using data and modeling methodologies provided by the FTA analytical vibration prediction model (FTA 2018). This guidance manual provides typical vibration source levels for various types of construction equipment, as well as methods for estimating the propagation of ground-borne vibration over distance.

The following equation was used to estimate the change in PPV levels over distance:

$$PPV_{equipment} = PPV_{ref} \times (100/D_{rec})^n$$

Where: $PPV_{equipment}$ is the PPV at a receptor; PPV_{ref} is the reference PPV at 100 feet from the equipment; D_{rec} is the distance from the equipment to the receptor, in feet; and n is the attenuation rate through ground (the default suggested value for n is 1.1). The equation was used to estimate the PPV at each of the closest vibration-sensitive receptors based on the worst-case (closest) distance between each source and receptor.

Vibration emission levels (PPV_{ref}) used are from measurements from several projects, including the Central Artery/Tunnel Project in Boston and from several published sources including the FTA manual (2018) and Dowding (1996).

7 IMPACTS AND MITIGATION MEASURES

7.1 Construction Noise

The noise levels generated by construction equipment vary significantly and depend on several different parameters, such as the type, model, size, and condition of the equipment; the operation schedule; and the condition of the area being worked. Additionally, construction projects are accomplished in several different stages. Each stage has a specific equipment mix, depending on the work to be completed.

The construction duration is assumed to be approximately 3 months. Project construction would consist of different activities which would be undertaken in a single phase, through to the operation of the project. Table 13 presents an estimate of the maximum number of pieces of equipment for the single phase and conservatively assumes equipment will be operating 8 hours per day, 5 days per week for the three-month construction duration.

Table 13: Construction Anticipated Equipment

Phase (Duration)	Equipment Used		
	Type	Number	Hrs/ day
Building Phase	Crane	1	8
	Excavator	1	8
	Forklift	1	8
	Air compressors	1	8
	Cement and mortar mixers	1	8
	Dumpers/Tenders	1	8
	Rubber-tired dozer	1	8

	Rubber-tired loader	1	8
	Concrete/Industrial saws	1	8
	Skid steer loaders	1	8
	Rough terrain forklifts	1	8

Construction noise levels were estimated using the RCNM. Estimates of noise from the construction of the project are based on a roster of the maximum amount of construction equipment used on a given day. Table 12 showed a list of typical construction equipment and the noise level at 50 feet. The RCNM has noise levels for various types of equipment preprogrammed into the software; therefore, the noise level associated with the equipment is typical for the equipment type and not based on any specific make or model.

The RCNM assumes that the maximum sound level for the project (L_{max}) is the maximum sound level for the loudest piece of equipment. The approximate noise generated by the construction equipment used at the facility has been conservatively calculated based on an estimated project construction equipment roster projected to be used at the construction site, and not considering further attenuation due to atmospheric interference or intervening structures. Results of the RCNM construction noise calculations are presented in Table 14.

Table 14. Predicted Construction Noise Levels

Phase	Equipment	Distance (feet)	Construction 1-hr L_{eq} (dBA)	Construction L_{max} [a] (dBA)
Building Phase	Crane Excavator Forklift Air compressors Cement and mortar mixers Dumpers/Tenders Rubber-tired dozer Rubber-tired loader Concrete/Industrial saws Skid steer loaders Rough terrain forklifts	25	93.3	96.0
		50	87.3	90.0
		100	81.3	84.0
		160	77.2	79.9
		250	73.3	76.0
		500	67.3	70.0
		1,000	61.3	64.0
		2,000	55.2	58.0
		4,000	49.2	51.9
		5,000	47.3	50.0

[a] Calculated L_{max} is the loudest individual value.

Construction is transient in nature and noise levels vary depending on the activity in progress. Noise impacts to residents due to the construction of the Project would be temporary and intermittent. Additionally, the noise levels were estimated to present a conservative impact analysis, assuming all pieces of equipment operate simultaneously. Furthermore, the model assumes that construction noise is constant when construction activities are periodic and change throughout the day.

As discussed in Section 6.1.1, the corresponding significance criterion used in this construction noise analysis is the project-related construction noise level threshold of 80 dBA L_{max} at nearby sensitive receiver locations. Estimated noise levels from construction activities at the closest NSA from the center of the construction site were estimated to be approximately 74.1 dBA L_{eq} and 76.8 dBA L_{max}. Therefore, without employing mitigation, noise impacts associated with the construction activities for the project would be less than significant.

7.2 Operational Noise

To determine the potential noise impact from these sources, detailed noise modeling was conducted. The noise levels at the identified NSAs in the vicinity of the project from the operation of the project have been predicted and compared with the relevant noise criteria, including the City of Lancaster General Plan noise restrictions on residential use 65 dBA L_{eq} limit.

7.2.1 *Operational Activities*

The primary noise sources anticipated due to operation of the proposed the heliostat trackers, blowers, and a Choshu Hydrogen Storage and Dispensing system.

7.2.2 *Noise Profile*

The sound power level (L_{pw}) for each equipment noise source is listed in Table 15. All equipment sound levels were estimated based on available data from the equipment manufacturers or obtained from other sources or calculations where manufacturer's data were not available.

Table 15. Equipment Sound Power Levels

Description	Quantity	Modeled Hours of Operation	Sound Power (each) (dBA)
Heliostats	500	15	75.0
10-hp Blowers	5	15	58.6
Photovoltaic Panels	400	15	41.0
Choshu Hydrogen Storage and Dispensing system	1	24	91.0

The calculated noise levels emitted by the project would be below the City of Lancaster General Plan noise restrictions on residential use (65 dBA L_{eq}) at all identified residential NSAs. Noise contributions from the project are low and well below the stated noise limits; therefore, the project noise would remain at or below the specified noise standard. Since noise contribution from the project at the closest NSA was estimated at 49.3 dBA L_{eq}. Thus, the operation of the project's sources would not generate substantial noise level increases at nearby off-site sensitive uses. Therefore, this impact would be less than significant.

Noise contour grid maps were generated by SoundPlan software and are presented in Appendix B. The maps depict the extent of noise propagation from the SoundPlan models that were developed for the noise impact assessment. The noise contour map illustrates the extent of noise associated with the proposed development. It is important to note that the extent of the impacts depicted in these figures does not include the contribution of the existing background noise.

Commented [JS1]: Please advise what the change in impacts will be to account for 500 heliostats + 400 PV panels

7.3 *Construction Vibration*

The operation of heavy construction equipment at the project site would generate ground-borne vibration that could affect structures immediately adjacent to the project site or could also cause an annoyance to people at those locations.

7.3.1 *On-Site Construction Ground-Borne Vibration*

Ground-borne vibration levels resulting from construction activities occurring within the project site were estimated using data published by the FTA (FTA 2018). Construction activities that would have the potential to generate levels of ground-borne vibration within the project site include mobile equipment activities, among others. Project vibration impacts were estimated using the vibration source level of construction equipment and the construction vibration assessment methodology published by the FTA.

Based on the reference vibration levels for the different pieces of equipment and the distances from the primary project construction activities, construction vibration velocity levels were estimated at the different receptors. The estimated vibration velocities were then compared against the building damage criteria in the FTA's *Transit Noise and Vibration Impacts Assessment Manual* (2018). Table 30 shows the estimated PPVs at the off-site receptors and the estimated vibration impacts on buildings.

Table 16. Construction Vibration Impacts – Building Damage

Off-Site Receptor	Building Category	Distance to Structure	Estimated Vibration Velocity Levels at the Off-Site Receptors Building Phase	Significance Threshold
		ft	in/sec	in/sec
ST1	Engineered concrete and masonry buildings	540	0.0009	0.3
ST2	Non-engineered timber and masonry buildings	228	0.0032	0.2
ST4	Non-engineered timber and masonry buildings	829	0.0005	0.2
ST5	Non-engineered timber and masonry buildings	840	0.0005	0.2
ST6	Non-engineered timber and masonry buildings	375	0.0015	0.2

Table 17 shows the comparison between the estimated ground-vibration levels and the human annoyance threshold.

Table 17. Construction Vibration Impacts – Human Annoyance

Off-Site Receptor	Building Category	Distance to Structure	Estimated Vibration Velocity Levels at the Off-Site Receptors Building Phase	Significance Threshold*
		ft	in/sec	VdB
ST1	Engineered concrete and masonry buildings	540	47	80
ST2	Non-engineered timber and masonry buildings	228	58	80

ST4	Non-engineered timber and masonry buildings	829	41	80
ST5	Non-engineered timber and masonry buildings	840	41	80
ST6	Non-engineered timber and masonry buildings	375	52	80

* FTA ground-borne vibration impact criteria for residences and buildings where people normally sleep for infrequent vibration events (FTA 2018).

As shown in Table 176 and Table 17, vibration levels generated by the construction equipment at the project site during project construction would not exceed the applicable vibration criteria for building damage or human annoyance at the surrounding structures. Therefore, impacts would be less than significant.

8 LITERATURE CITED

American National Standards Institute (ANSI). 2013. *Quantities and Procedures for Description and Measurements with an Observer Present – Part 3: Short-term Measurements with an Observer Present*. ANSI/ASA S12.9-2013/Part 3. Melville, New York: Acoustical Society of America.

American Society for Testing and Materials (ASTM). 2012. *E1014-12, Standard Guide for Measurement of Outdoor A-Weighted Noise Levels*. West Conshohocken, Pennsylvania: American Society for Testing and Materials International.

Association of Environmental Professionals. 2022. *2022 California Environmental Quality Act (CEQA) Statute and Guidelines*. Appendix G – Environmental Checklist Form. Available at: https://www.califaep.org/docs/2022_CEQA_Statue_and_Guidelines.pdf.

Beranek, L.L. (ed.). 1988. *Noise and Vibration Control*. Washington, D.C.: Institute of Noise Control Engineering.

Bolt, Beranek and Newman, Inc. 1973. *Fundamentals and Abatement of Highway Traffic Noise*. Report Number PB-222-703. Prepared for U.S. Department of Transportation, Federal Highway Administration. Cambridge, Massachusetts: Bolt, Beranek and Newman, Inc.

California Department of Transportation (Caltrans). 2013. *Transportation and Construction Vibration Guidance Manual*. Report No. CT-HWANP-RT-13-069.25.3. Sacramento: California Department of Transportation, Division of Environmental Analysis, Environmental Engineering, Hazardous Waste, Air, Noise, & Paleontology Office.

Dowding, C. 1996. *Construction Vibrations*. Upper Saddle River, New Jersey: Prentice Hall.

Federal Highway Administration (FHWA). 1978. Highway Traffic Noise Prediction Model (FHWA-RD-77-108).

———. 2004. Traffic Noise Model, Version 2.5. Washington, D.C.: Office of Environment and Planning.

———. 2011. Roadway Construction Noise Model (RCNM). Software Version 1.1.

Federal Transit Administration (FTA). 2018. *Transit Noise and Vibration Impact Assessment Manual*. FTA Report No. 0123. Washington, D.C.: U.S. Department of Transportation, Federal Transit Administration, Office of Planning and Environment.

Google Earth. 2022. Los Angeles, CA. V 7.3.4.8642 (March 1, 2022). Available at: http://www.earth.google.com. Accessed August 6, 2022.

Governor's Office of Planning and Research (OPR). 2017. *State of California General Plan Guidelines*. Available at: https://www.opr.ca.gov/planning/general-plan/guidelines.html.

Konya, C. 2019. *Environmental Factors of Blasting Report for the Proposed Idaho-Maryland Gold Project Nevada County, CA*. Montville, Ohio: Precision Blasting Services.

NOAA's National Centers for Environmental Information. 2022. Local Climatological Data for Lancaster CA. Available at: https://www.ncdc.noaa.gov/cdo-web/search. Accessed August 2022.

U.S. Environmental Protection Agency (EPA). 1974. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*. 550-74-004. Available at: https://nepis.epa.gov/Exe/ZyPDF.cgi/2000L3LN.PDF?Dockey=2000L3LN.PDF.

Weather Underground. 2022. Desert Wind Station (KCALANCA126). Accessed September 2022.

APPENDIX A

Monitoring Location Photographs

Photo A-1. Monitoring Location LT1.

Photo A-2. Monitoring Location ST1.

Photo A-3. Monitoring Location ST2.

Photo A-4. Monitoring Location ST3.

Photo A-5. Monitoring Location ST4.

Photo A-6. Monitoring Location ST5.

Photo A-7. Monitoring Location ST6.

APPENDIX B

Project Operation Isopleths

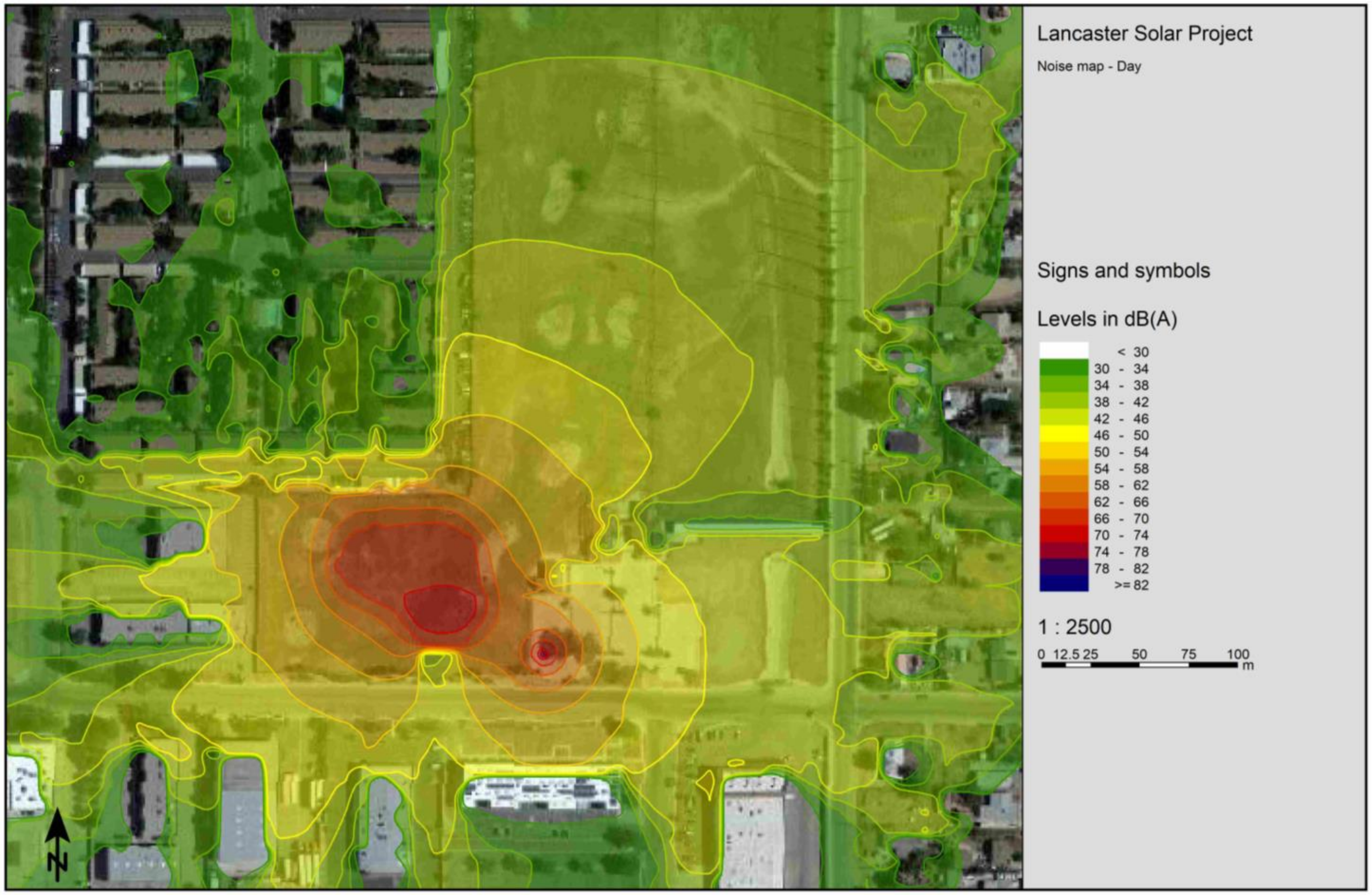


Figure B-1. Project operation noise isopleth - Day

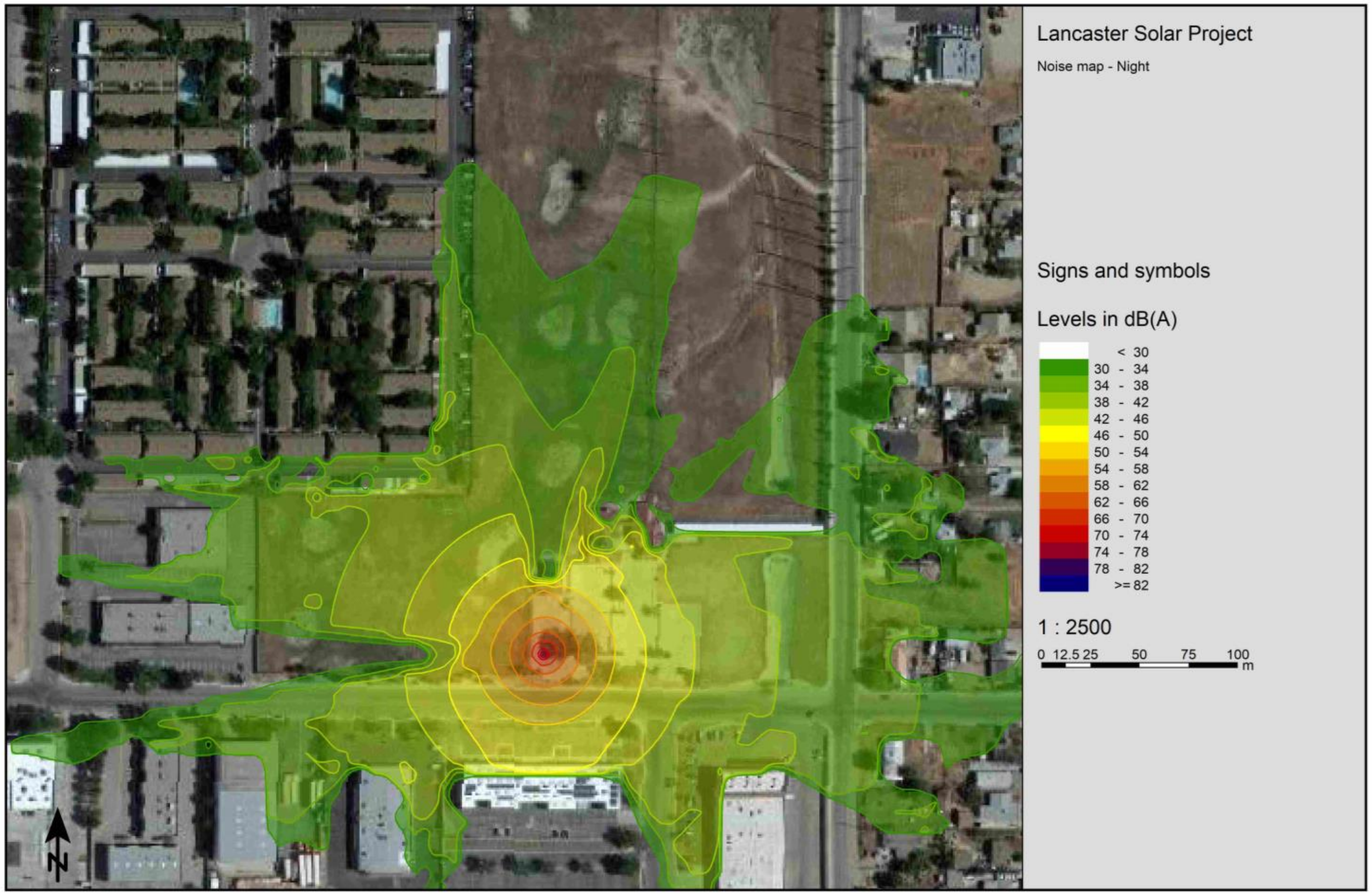


Figure B-2. Project operation noise isopleth – Night

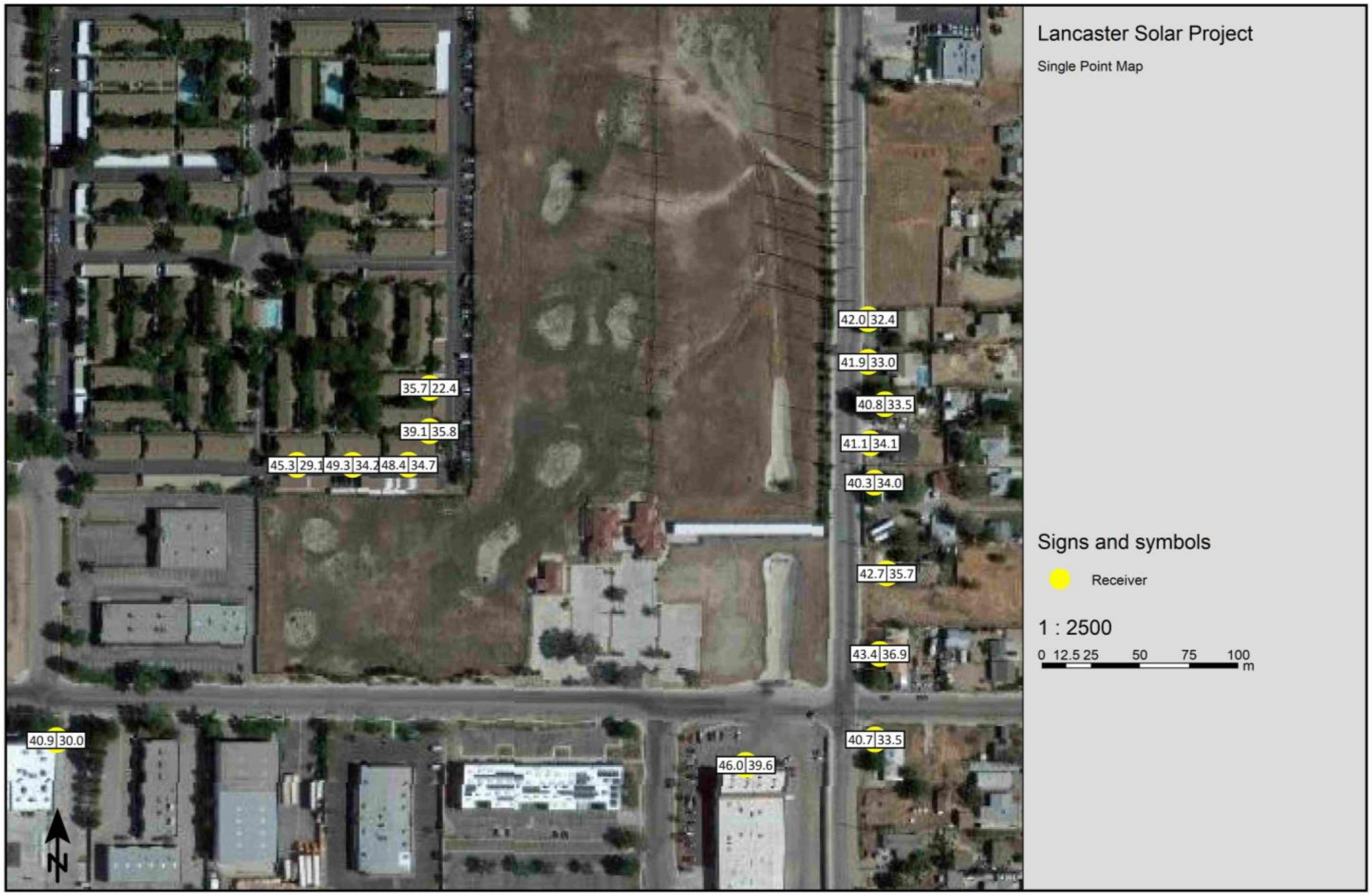


Figure B-3. Project operation noise isopleth – Single Point Map