

EXHIBIT X – Preliminary Application for Site Certificate

NOISE

OAR 345-021-0010(1)(x)

REVIEWER CHECKLIST

(x) Exhibit X. Information about noise generated by construction and operation of the proposed facility, providing evidence to support a finding by the Council that the proposed facility complies with the Oregon Department of Environmental Quality’s noise control standards in OAR 340-035-0035. The applicant shall include:

Rule Sections	Section	✓
(A) Predicted noise levels resulting from construction and operation of the proposed facility.	X.3	
(B) An analysis of the proposed facility's compliance with the applicable noise regulations in OAR 340-035-0035, including a discussion and justification of the methods and assumptions used in the analysis.	X.4	
(C) Any measures the applicant proposes to reduce noise levels or noise impacts or to address public complaints about noise from the facility.	X.5	
(D) Any measures the applicant proposes to monitor noise generated by operation of the facility.	X.6	
(E) A list of the names and addresses of all owners of noise sensitive property, as defined in OAR 340-035-0015, within one mile of the proposed site boundary.	X.7	

EXHIBIT X – Preliminary Application for Site Certificate

NOISE

OAR 345-021-0010(1)(x)

TABLE OF CONTENTS

X.1 INTRODUCTION..... X-1

X.2 BACKGROUND NOISE INFORMATION X-2

X.3 PREDICTED NOISE LEVELS..... X-3

 X.3.1 Construction..... X-3

 X.3.2 Operation..... X-3

X.4 COMPLIANCE WITH NOISE REGULATIONS X-5

 X.4.1 Methods and Assumptions Used in the Analysis..... X-5

 X.4.2 Ambient Noise Monitoring..... X-6

 X.4.3 Compliance X-6

X.5 PROPOSED NOISE REDUCTION MEASURES..... X-9

X.6 MONITORING NOISE DURING OPERATIONS..... X-10

X.7 NOISE-SENSITIVE PROPERTY OWNERS..... X-10

X.8 REFERENCES..... X-11

TABLES

Table X-1 Typical Sound Levels for Common Sources (in A-Weighted Decibels)..... X-2

Table X-2 Typical Construction Noise Levels for Phases of Construction X-3

Table X-3 Predicted Facility Operational Noise Levels at Noise Sensitive Properties X-4

Table X-4 Noise Sources and Reference Noise Levels..... X-5

Table X-5 New Industrial and Commercial Noise Source Standards X-7

Table X-6 Lowest and Average Measured Background Noise Levels X-7

Table X-7 Noise Level Compliance Summary X-8

Table X-8 Noise Sensitive Property Owners X-10

FIGURES

Figure X-1 Noise Sensitive Properties

APPENDICES

Appendix X-1 Noise Study

X.1 INTRODUCTION

Obsidian Solar Center LLC (Applicant) proposes to construct the Obsidian Solar Center (Facility) in Lake County, Oregon, with an alternating current generating capacity of up to 400 megawatts. Please refer to Exhibit B for Facility layout information and Exhibit C for Facility location information.

This exhibit provides the information required by Oregon Administrative Rules (OAR) 345-021-0010(1)(x): *Information about noise generated by construction and operation of the proposed facility, providing evidence to support a finding by the Council that the proposed facility complies with the Oregon Department of Environmental Quality's noise control standards in OAR 340-035-0035.*

As described in Exhibit B, this Application for Site Certificate analyzes the potential impacts from two design scenarios: a stand-alone photovoltaic (PV) solar power generation build-out, and a PV solar power generation plus battery storage build-out. This exhibit analyzes a layout for the inverters, which are the primary source of noise for the Facility, that would be representative of either design scenario.

Executive Summary

The evidence presented in this exhibit demonstrates that Facility construction and operation will comply with the standards provided in OAR 340-035-0035. The results of the noise analysis show that there will be no exceedances of the thresholds provided in the standards. Specifically, noise levels at all nearby residences are predicted to be below the maximum allowable limits for new industrial noise sources, as provided in the Oregon Department of Environmental Quality (DEQ) "Table 8" (DEQ 2018). Predicted noise level increases above existing ambient levels are also below the 10 A-weighted decibel (dBA) maximum allowed by the standards. The noise analysis did not include any additional attenuation for groundcover, topographical conditions, or structural shielding. Furthermore, the noise levels presented were calculated assuming wet conditions and include noise from the 115-kilovolt (kV) transmission lines where applicable. Therefore, the noise levels presented are likely more conservative and higher than what would be expected from the actual installation. Noise levels that will be generated by this Facility—and solar PV facilities in general—are inherently low. However, to further decrease potential noise levels, Applicant will place all inverters—the primary potential sources of noise of this Facility—at least 500 feet from the site boundary in areas within proximity to noise sensitive properties. Applicant proposes this measure as a condition of approval for the Site Certificate.

X.2 BACKGROUND NOISE INFORMATION

Noise is measured in terms of sound pressure level. It is sometimes expressed in decibels (dB), which is a unit describing the amplitude of sound. In general, the dB scale is a logarithmic conversion of absolute air pressure to units that are more convenient and easier to understand.

To better approximate the sensitivity of the human ear to sounds of different frequencies, the A-weighted decibel scale is often used. Because the human ear is less sensitive to higher and lower frequencies, the A-weighted scale reduces the sound level contributions of these frequencies. When the A-weighted scale is used, the decibel levels are denoted as dBA. All noise levels referred to in this exhibit are stated as sound pressure levels in terms of dBA. The A-weighted scale is used in most ordinances and standards, including the applicable noise standards (OAR 340-035-0035) for this Facility.

To account for the time-varying nature of noise, the statistical noise descriptor Lxx is used in the OAR. The sound level descriptor Lxx is defined as the sound level exceeded “XX” percent of the time. For example, the L50 is the sound level exceeded 50 percent of the time. Therefore, during a 1-hour measurement, an L50 of 55 dBA means the sound level was 55 dBA or louder for 30 minutes of the hour.

Table X-1 provides typical noise levels for common noise sources. More detailed information on noise, including sample noise levels of typical sources and activities, is provided in Appendix X-1.

Table X-1 Typical Sound Levels for Common Sources (in A-Weighted Decibels)

Source/Location	Sound Level (dBA)
Threshold of Hearing	0
Motion Picture Studio—Ambient	20
Library	35
Chicago Suburbs—Nighttime Minimum	40
Wind in Deciduous Trees (2–14 mph)	3–61
Falling Rain (Variable Rainfall Rates)	41–63
Tomato Field on California Farm	44
Small Town/Quiet Suburb	47–53
Private Business Office	50
Light Traffic at 100 feet Away	50
Average Residence	50
Large Retail Store	60
Average Traffic on Street Corner	75
Inside Sports Car (50 mph)	80
Los Angeles - 0.75 Miles from Jet Landing	86

Table X-1 Typical Sound Levels for Common Sources (in A-Weighted Decibels)

Source/Location	Sound Level (dBA)
Inside New York Subway Train	95
Loud Automobile Horn (at 1 meter)	115

Source: EPA 1974; IEEE 1974; Miller 1978

Key:

dBA = A-weighted decibels

mph = miles per hour

X.3 PREDICTED NOISE LEVELS

OAR 345-021-0010(1)(x)(A) *Predicted noise levels resulting from construction and operation of the proposed facility.*

Response:

X.3.1 Construction

Construction activity is exempt under OAR 340-035-0035(5)(g); therefore, this exhibit does not provide construction noise level predictions. However, to aid in the understanding of Facility construction, an analysis of construction noise is provided in Appendix X-1, and a summary of typical values is presented in Table X-2.

Table X-2 Typical Construction Noise Levels for Phases of Construction

Construction Phase	Loudest Equipment	Maximum Noise Levels at 50 Feet	Maximum Noise Levels at 500 Feet
Clearing and Earthwork	Dozer, Grader, Backhoe, Haul Trucks	88 to 90 dBA	67 to 69 dBA
Installation of System	Crane, Backhoe, Haul Trucks, Air Compressor, Pneumatic Tools	83 to 85 dBA	62 to 64 dBA

Note: Calculated noise levels from the FHWA (2006) Roadway Construction Noise Model (refer to Appendix X-1)

Key:

dBA = A-weighted decibels

X.3.2 Operation

Residential structures within approximately 1 mile of the site boundary were identified as noise sensitive properties. Sixteen noise sensitive properties occur within 1 mile of the site boundary and one additional noise sensitive property (R-7) is about 1.1 miles from the site boundary (refer to Figure X-1). Applicant included R-7 in the analysis, even though it was outside of the 1-mile

distance, because it was the closest residence at the southwest end of the site boundary. All noise sensitive properties are residences that appear to be occupied.

Table X-3 reports the predicted noise levels of Facility equipment during operation at the noise sensitive properties. Section X.4 includes a discussion and justification of the methods and assumptions used in the analysis, including a description of on-site field monitoring for existing background noise levels used to help determine compliance with the OAR 340-035-0035 standard.

Table X-3 Predicted Facility Operational Noise Levels at Noise Sensitive Properties

Noise Sensitive Properties	Noise Levels Contributions by Facility Equipment at Noise Sensitive Properties			
	Inverter Noise (dBA) ^(a)	Transformer Noise (dBA) ^(b)	Transmission Line Noise (dBA) ^(c)	Total Noise of Facility Equipment (dBA) ^(d)
R-1	14	31	18	31
R-2	17	24	10	25
R-3	23	27	8	28
R-4	21	28	7	29
R-5	21	29	7	30
R-6	19	26	7	27
R-7	17	20	4	21
R-8	22	> 3 dBA	Not measureable	22
R-9	24	> 3 dBA	Not measureable	24
R-10	28	> 3 dBA	Not measureable	28
R-11	26	> 3 dBA	Not measureable	26
R-12	22	> 3 dBA	Not measureable	22
R-13	22	> 3 dBA	Not measureable	22
R-14	20	> 3 dBA	Not measureable	20
R-15	26	> 3 dBA	Not measureable	26
R-16	26	> 3 dBA	Not measureable	26
R-17	26	> 3 dBA	Not measureable	26

Note:

- (a) Total noise from the nearest inverters at the noise sensitive property. Per OAR 340-35-0035(3)(b), the prediction site is 25 feet from the building toward the noise source, or at a point on the noise sensitive property line that is nearest the noise source, whichever is greater.
- (b) Noise from the transformers at the noise sensitive property, predicted per OAR 340-35-0035(3)(b)
- (c) Noise from the 115- kV transmission line at the noise sensitive property, assuming wet conditions, predicted per OAR 340-35-0035(3)(b)
- (d) Total noise, predicted by logarithmically summing the inverter noise, transformer noise, and transmission line noise for the total noise from operations

Key:

dBA = A-weighted decibels

X.4 COMPLIANCE WITH NOISE REGULATIONS

OAR 345-021-0010(1)(x)(B) *An analysis of the proposed facility's compliance with the applicable noise regulations in OAR 340-035-0035, including a discussion and justification of the methods and assumptions used in the analysis.*

Response:

X.4.1 Methods and Assumptions Used in the Analysis

To verify compliance with the OAR 340-035-0035 standard, noise levels were predicted for the 17 representative noise sensitive properties depicted in Figure X-1 using standard acoustical engineering methods and calculations and the expected operational noise levels of noise producing equipment. Noise levels that will be generated by this Facility during operation—and by solar PV generating facilities in general—are inherently low. Much of the equipment that will be installed for the Facility will not produce any noise at all; however, some equipment, such as inverters and transformers, can produce increased noise levels at nearby locations.

Operational noise levels for the inverters and transformers were obtained from potential manufactures specifications. In addition, the 115-kV generation-tie (gen-tie) transmission line will potentially produce some corona noise, which can occur from electronic ionization of the air surrounding transmission lines. The level of corona noise produced is dependent on many factors, and for most small lines, like the 115-kV lines proposed, noise only occurs when there is a high level of moisture in the air. To maintain a conservative analysis and ensure that all potential impacts are identified, the analysis was performed assuming wet conditions that would result in corona noise production. Table X-4 lists the main equipment and the reference noise levels at 50 and 500 feet that were used in this analysis. Appendix X-1 provides complete details on the equipment proposed for the site and reference noise levels.

Table X-4 Noise Sources and Reference Noise Levels

Equipment^(a)	Sound Pressure Level at 50 Ft.	Sound Pressure Level at 500 Ft.
Inverter	55 dBA ^(a)	35 dBA ^(a)
Transformer	64 dBA ^(b)	44 dBA ^(b)
115-kV Transmission Line	0 dBA (dry) 15 dBA (wet)	Not measureable

Notes:

- (a) Based on Power Electronics HEMK 600V/FS3000K Specification of < 79 dBA at 3 feet (Power Electronics 2018).
- (b) Based on typical sound power levels for a 115-kV transformer of 97 dBA.
- (c) Based on corona audible noise calculations provided in Appendix AA-1 of Exhibit AA of this Application for Site Certificate.

Key:

dBA = A-weighted decibels

Ft. = feet

kV = kilovolt

Distances from the noise sources to each of the 17 representative noise sensitive properties were measured using computer-aided drafting (CAD) software with calibrated aerial photo overlays. All noise sensitive properties are further than 1,100 feet from the site boundary of Area A, which will house the inverters, and more than 250 feet from the 115-kV gen-tie transmission line corridor (refer to Figure X-1). Refer to Figure 1 in Appendix X-1 for the representative location of inverters use for the predicted noise calculations.

The noise analysis (prediction calculations) was performed using standard acoustical formulas and the reference noise levels provided in Table X-4. Sound propagation factors assumed normal atmospheric absorption. No additional attenuation was assumed for groundcover, topographical shielding, or shielding from battery storage containers or the solar array systems. In addition, the noise levels presented were calculated assuming wet conditions and include noise from the 115-kV transmission lines where applicable. Therefore, the noise levels presented are likely slightly higher than what would be expected from the actual installation. The results of the predicted noise calculations for Facility equipment are provided in Table X-3 and Table X-7 (refer to the “Total Noise of Facility Equipment” columns).

X.4.2 Ambient Noise Monitoring

To verify that the noise level increases at noise sensitive properties will comply with the standard, it was necessary to obtain existing ambient noise levels in the area surrounding the Facility site. Ambient noise refers to the existing background composite of noise from all sources near and far, as measured at a given location. To accomplish this, on-site noise monitoring was performed at two representative sites (see Figure X-1). The noise monitoring was performed on July 5 through July 7, 2018, using two noise monitoring systems and measuring at both sites simultaneously. Measurements were taken for at least 48 hours at each site. Weather was clear, and there was no precipitation during the measurement period. Site M-1 is near a cluster of residences located just west of the solar array in Area A, and was used to represent noise sensitive properties R-1 through R-7. Site M-2 is north of the solar array in Area A, and was used to represent noise sensitive properties R-8 through R-17. Monitoring site M-2 is in an area with fewer residences and lower traffic volumes than monitoring site M-1. All measurement procedures complied with the procedures adopted and set forth in the *Sound Measurement Procedures Manual (NPCS-1)* (DEQ 1983). Table X-5 provides the minimum hourly L10 and L50 for each site over the 48 hour measurement period. Refer to Appendix X-1 for further details regarding methods and results of the ambient noise monitoring.

X.4.3 Compliance

Compliance with the OAR 340-035-0035 standard was determined using two criteria. The standard requires that no new industrial or commercial operational noise source located on a previously unused industrial or commercial site may:

- Exceed the levels specified in Table 8 (DEQ 2018), as measured at an appropriate measurement point, or
- Increase the ambient statistical noise levels, L10 or L50, by more than 10 dBA in any one hour, as measured at an appropriate measurement point.

The first step in determining compliance with the standard was to compare the predicted noise levels of Facility operational equipment at noise sensitive properties (Tables X-3 and X-7) with the maximum allowable noise levels for New Industrial and Commercial Noise Source in DEQ’s “Table 8,” which are reported here in Table X-5.

The most stringent noise level thresholds in the standard are L50 levels of 55 dBA for daytime hours and 50 dBA for nighttime hours (Table X-6). The predicted noise levels at the noise sensitive properties are all well below the thresholds, and range from 18 to 31 dBA (Tables X-4 and X-8). Therefore, Facility operation will comply with this portion of the standard.

Table X-5 New Industrial and Commercial Noise Source Standards

Statistical Descriptor	Daytime (7 am to 10 pm) (dBA)	Night (10 pm to 7 am) (dBA)
L10	60	55
L50	55	50

Source: OAR 340-035-0035 Table 8.

Key:

dBA = A-weighted decibels

L10 = L10 = sound level exceeded 10 percent of the time

L50 = L50 = sound level exceeded 50 percent of the time

The second step in determining compliance with the standard was to verify compliance with the maximum allowable increase of 10 dBA above ambient statistical noise level criterion for the L10 and L50 noise level descriptors. A summary of on-site measurements of ambient noise are summarized in Table X-6. The levels presented are the lowest and average hourly L10 and L50 measured during the 48-hour period. Refer to Appendix X-1 for further details on recorded noise levels.

Table X-6 Lowest and Average Measured Background Noise Levels

Monitoring Site	L10 (Lowest/Average)	L50 (Lowest/Average)
M-1	30/42	28/37
M-2	22/34	20/28

Note: Additional details for measured noise levels, see Appendix X-1

Key:

L10 = sound level exceeded 10 percent of the time

L50 = sound level exceeded 50 percent of the time

Table X-7 was prepared using the L50 ambient measured noise levels reported in Table X-6, and the Facility equipment noise level predictions from Table X-3, to summarize compliance with the 10 dBA maximum increase above ambient levels portion of the standard. This table provides the logarithmical sums of the measured minimum L50 noise levels (the “Existing Background L50” column) and the predicted noise levels from operational equipment (see the “Total Noise of Facility Equipment” column) to arrive at the predicted total future noise levels (see the “Combined Noise” column).

To determine the potential change in noise levels above the existing ambient noise levels, the “Existing Background” values are subtracted from the “Combined Noise” values. Note that the L50 thresholds were selected for this analysis because they are the most stringent and most likely to result in non-compliance with the standard. As shown in Table X-7, predicted noise levels at all noise sensitive properties have L50 increases of 8 dBA or less; therefore, the future level are within the allowable 10 dBA increase from OAR 345-035-0035. Facility operations will comply with this portion of the standard.

Given the relatively flat topography within the site boundary and the surrounding areas, it is reasonable to presume that noise levels at properties farther away from the site boundary than the noise sensitive properties that were evaluated will also meet the OAR standard for operational noise.

Table X-7 Noise Level Compliance Summary

Noise Sensitive Property	Existing Background (ambient) L50 (dBA)^(a)	Total Noise of Facility Equipment (dBA)^(b)	Combined Noise (Background + Total Noise of Facility Equipment, dBA)^(c)	Total Change in L50 Noise (dBA)^(d)	Compliance with OAR 340-035-0035 Standard
R-1	28	31	33	+5	Yes
R-2	28	25	30	+2	Yes
R-3	28	28	31	+3	Yes
R-4	28	29	32	+4	Yes
R-5	28	30	32	+4	Yes
R-6	28	27	30	+2	Yes
R-7	28	21	29	+1	Yes
R-8	20	22	24	+4	Yes
R-9	20	24	26	+6	Yes
R-10	20	28	28	+8	Yes
R-11	20	26	27	+7	Yes
R-12	20	22	24	+4	Yes
R-13	20	22	24	+4	Yes
R-14	20	20	23	+3	Yes

Table X-7 Noise Level Compliance Summary

Noise Sensitive Property	Existing Background (ambient) L50 (dBA) ^(a)	Total Noise of Facility Equipment (dBA) ^(b)	Combined Noise (Background + Total Noise of Facility Equipment, dBA) ^(c)	Total Change in L50 Noise (dBA) ^(d)	Compliance with OAR 340-035-0035 Standard
R-15	20	26	27	+7	Yes
R-16	20	26	27	+7	Yes
R-17	20	26	27	+7	Yes

Notes:

(a) Background measured noise level: L50, using minimum M-1 for R-1 through R-7 and M-3 for R-8 through R-17.

(b) Total Noise from Facility operation equipment at noise sensitive properties, as reported in Table X-4.

(c) Total noise, background and Facility operations, predicted by logarithmically summing the background noise and operational noise.

(d) Change in total noise at noise sensitive properties.

Key:

dBA = A-weighted decibels

L50 = sound level exceeded 50 percent of the time

OAR = Oregon Administrative Rules

X.5 PROPOSED NOISE REDUCTION MEASURES

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

Response:

Applicant’s noise analysis demonstrates that operation of the Facility will comply with all applicable regulatory requirements of the OAR 345-035-0035 standard. Primarily, this is due to the inherently low noise levels associated with solar PV technology. In addition, Applicant is proposing the following measure designed specifically to further reduce noise produced by the Facility operation:

- Inverter set-back: inverters will be placed at least 500 feet from the site boundary in areas in proximity to noise sensitive properties to increase the distance between the noise source and noise sensitive properties resulting in lower overall noise levels outside of the site boundary.

As stated earlier, it is also important to note that this analysis was performed with no additional attenuation for groundcover, topographical shielding, or shielding from battery storage containers or the solar array systems. Furthermore, the noise predictions included the wet conditions for corona noise from the 115-kV gen-tie transmission line. Based on these factors, the predicted noise levels presented in this exhibit are likely more conservative and higher than

what will occur during the actual Facility operation. Therefore, no additional noise reduction measures are necessary for operation of the Facility.

X.6 MONITORING NOISE DURING OPERATIONS

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

Response:

Given the low noise level predictions, on-site noise monitoring for compliance of the noise standard should not be required. The predicted noise levels of Facility operational equipment at the nearest noise sensitive properties range from 20 to 31 dBA. Noise levels of this magnitude are extremely low, and they are not expected to increase the existing ambient L50 by more than +1 to +8 dBA, with typical maximum operational noise levels of 20 to 31 dBA. Noise levels of 20 to 31 dBA are typically only found in very rural areas with little or no traffic, quiet libraries, and recording studios (see Table X-2).

X.7 NOISE-SENSITIVE PROPERTY OWNERS

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

Response: Table X-8 provides property information for all owners of noise sensitive properties within 1 mile of the site boundary along with R-7, located 1.1 miles from the site boundary.

Table X-8 Noise Sensitive Property Owners

Noise Sensitive Property Number (as shown on Figure X-1)	Map and Tax Lot	Owner Name	Owner Address	City	State	ZIP
R-1	26S15E000003200	Fine Troy D & Roberta K	83394 Connley Lane	Silver Lake	OR	97638
R-2	26S16E000005500	Forman Shane & Jacey	83136 Connley Lane	Silver Lake	OR	97638
R-3, R-4	26S16E000005300	Fine Harold L & Judy	83391 Connley Ln	Silver Lake	OR	97638
R-5	26S16E000005700	Fine Troy D & Roberta K	83394 Connley Lane	Silver Lake	OR	97638
R-6	26S16E000005601	Forman Shane & Jacey	83136 Connley Lane	Silver Lake	OR	97638

Table X-8 Noise Sensitive Property Owners

Noise Sensitive Property Number (as shown on Figure X-1)	Map and Tax Lot	Owner Name	Owner Address	City	State	ZIP
R-7	26S16E00007400	G & J Hanson Farms LLC	PO Box 69	Fort Rock	OR	97735
R-8	26S16E000001300	Runels Scott L & Margie B	PO Box 39	Fort Rock	OR	97735
R-9	26S16E000000900	Runels Scott L & Margie B	PO Box 39	Fort Rock	OR	97735
R-10	26S16E000001801	Stevenson John B & Joyce	PO Box 437	Christmas Valley	OR	97641
R-11	26S16E000002707	Runels Scott L & Margie B	PO Box 39	Fort Rock	OR	97735
R-12	26S16E000003400	Mauney Dennis & Pamela	PO Box 1031	Ferndale	CA	95536
R-13	26S16E000003500	Mauney Dennis & Pamela	PO Box 1031	Ferndale	CA	95536
R-14	26S16E000003800	Beasley Jesse Lee	2422 Lara CT.	Medford	OR	97504
R-15	26S16E000004401	Horton Leeroy & Nancy B	PO Box 784	Christmas Valley	OR	97641
R-16	26S16E000004400	Hogan David L & Rita F	2614 1ST St.	Tillamook	OR	97141
R-17	26S16E000002705	Horton Trust	PO Box 784	Christmas Valley	OR	97641

X.8 REFERENCES

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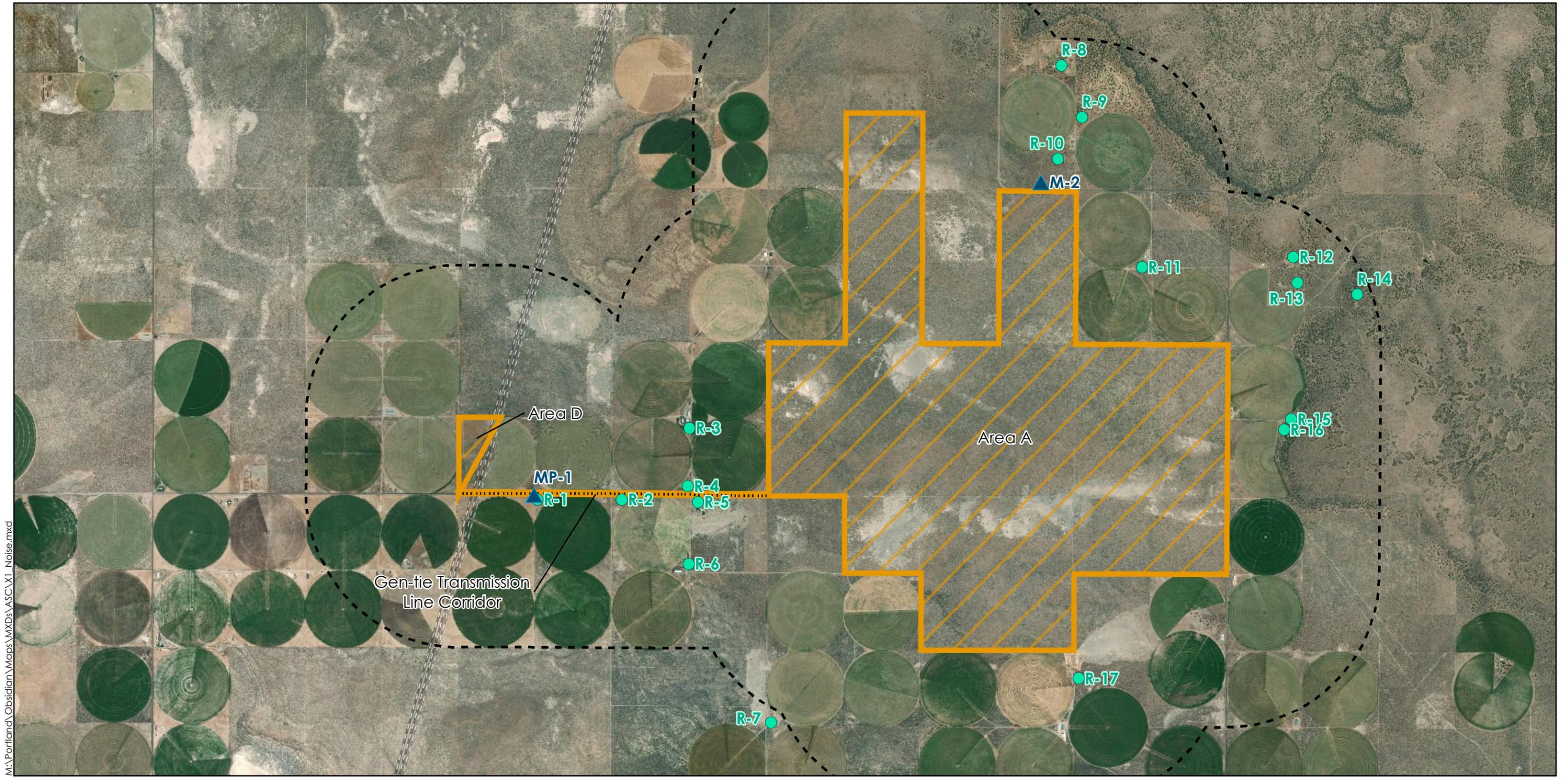
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- Noise Sensitive Property (residence)
- ▲ Noise Monitoring Locations
- Gen-tie Transmission Line
- Site Boundary
- 1-Mile Buffer
- ==== Bonneville Power Administration Transmission Line (500kV)
- ==== PGE Transmission Line (500kV)

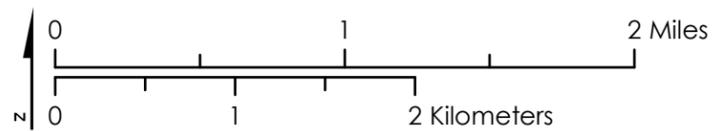


Figure X-1
Noise Sensitive Properties

Obsidian Solar Center

September 2018

Obsidian Solar Center LLC

Sources: Esri 2018

Appendix X-1

Noise Study

Noise Analysis

Obsidian Solar Center

September 2018

Prepared by:

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Portland, Oregon

Contents

1. Introduction.....	1
1.1. Project Description.....	1
1.2. Introduction to Noise	1
1.3. Noise Level Descriptors.....	3
1.4. Decibel Mathematics	4
2. Regulations	5
3. Existing Conditions.....	7
3.1. Existing Ambient Noise Levels	7
4. Facility Equipment and Analysis Methods.....	12
4.1. Noise Emitting Facility Equipment	12
4.2. Analysis Methods.....	13
5. Noise Modeling.....	14
5.1. Modeling Results	14
6. Compliance Analysis	17
6.1. Maximum Allowable Noise Level Criteria.....	17
6.2. Maximum Allowable Noise Increase Criteria	18
6.3. Properties outside Study Area.....	18
7. Noise Mitigation Analysis	19
8. Construction Noise Analysis.....	20
8.1. Method of Analysis.....	20
8.2. Construction Methods and Equipment.....	20
8.3. Construction Noise Levels	21
8.4. Construction Mitigation Measures.....	23

Tables

Table 1. Sound Levels and Relative Loudness of Typical Noise Sources.....	3
Table 2. DEQ New Industrial and Commercial Noise Source Standards.....	5
Table 3. DEQ Median Octave Band Standards for Industrial and Commercial Noise Sources	6
Table 4. Summary of Measured Minimum Background Noise Levels	11
Table 5. Noise Sources and Reference Noise Levels	12
Table 6. Predicted Facility Operational Noise Levels at Noise Sensitive Properties	16
Table 7. Noise Level Compliance Summary	17
Table 8: Construction Equipment List, Use, and Maximum Noise Levels	21
Table 9: Estimated Peak Hour Construction Noise Levels.....	22

Figures

Figure 1. Facility Location and Overview	2
Figure 2. Facility Layout, Residences and Noise Monitoring Locations	8
Figure 3. Photos of Monitoring Site M-1.....	9
Figure 4. Photos of Monitoring Site M-2.....	10
Figure 5. Plot of Measured Noise Levels.....	11
Figure 6. Noise Modeling Locations	15
Figure 7. Expected Construction Noise Levels versus Distance	23

Attachments

References.....	A-1
Power Electronics FS3000M Specifications.....	B-1
Table of Field Measurements.....	C-1

1. Introduction

This noise analysis was prepared at the request of Obsidian Solar Center LLC and its environmental consultant, Ecology and Environment, Inc. Obsidian Solar Center LLC proposes to construct the Obsidian Solar Center (the facility) in Lake County, Oregon. This report was prepared to demonstrate compliance with the Oregon Department of Environmental Quality (DEQ) noise regulations in OAR 340-035-0035. This report provides an analysis of noise emissions from the proposed facility during operation and compares them to the allowable limits in OAR 340-035-0035 to determine compliance.

1.1. Project Description

Obsidian Solar Center LLC proposes a photovoltaic (PV) solar power generation facility and related or supporting facilities located in Lake County, Oregon. The facility will consist of up to approximately 4,000 acres and provide a nominal alternating current generating capacity of up to 400 megawatts. This analysis is for the proposed full build-out of the PV modules and battery storage layout option (with battery enclosures dispersed across the facility).

Figure 1 provides a facility location overview. More information on facility operations, locations of noise producing equipment, and locations of noise sensitive properties are provided in the following sections.

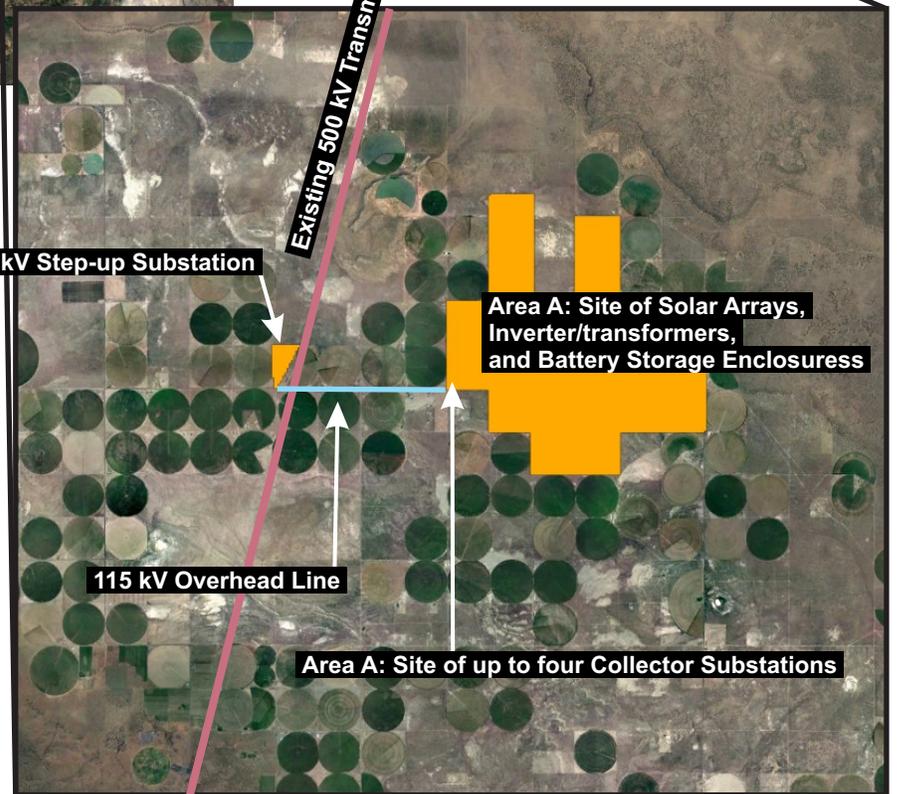
1.2. Introduction to Noise

The human response to sound is subjective and can vary greatly from person to person. Factors that can influence individual response include the loudness, frequency, amount of background noise present, and nature of the work or activity (e.g., sleeping) and time. When sounds become unpleasant, or are unwanted, we tend to classify them as noise.

Noise is measured in terms of sound pressure level. It is expressed in decibels (dB), which are defined as $10 \log P^2/P_{\text{ref}}^2$, where P is the root-mean-square (RMS) sound pressure and P_{ref} is the reference RMS sound pressure of 2×10^{-5} Newton per square meter. In general, the dB scale is a logarithmic conversion of absolute air pressure to units that are more convenient and easier to understand.

To better approximate the sensitivity of the human ear to sounds of different frequencies, the A-weighted decibel scale was developed. Because the human ear is less sensitive to higher and lower frequencies, the A-weighted scale reduces the sound level contributions of these frequencies. When the A-weighted scale is used, the decibel levels are denoted as dBA.

All noise levels referred to in this report are stated as sound pressure levels in terms of decibels on the A-scale (dBA). The A-scale is used in most ordinances and standards, including the applicable standards for this facility.



Area D: Site of 115/500 kV Step-up Substation

Area A: Site of Solar Arrays, Inverter/transformers, and Battery Storage Enclosures

115 kV Overhead Line

Area A: Site of up to four Collector Substations



Facility Areas



Facility Power Lines



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Figure 1. Facility Location and Overview Obsidian Solar Center

A 10-dBA increase in noise levels is judged by most people as a doubling of sound level. The smallest change in noise level that a human ear can perceive is about 3 dBA, and increases of 5 dBA or more are clearly noticeable. Normal conversation ranges between 44 and 65 dBA when speakers are 3 to 6 feet apart. Noise levels in a quiet rural area at night are typically between 30 and 35 dBA. Quiet urban nighttime noise levels range from 40 to 50 dBA. 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 and then painful, while levels higher than 80 dBA over continuous periods can result in hearing loss. Table 1 provides a scale of common noise sources and typical public responses.

Table 1. Sound Levels and Relative Loudness of Typical Noise Sources			
Noise Source or Activity	Sound Level (dBA)	Subjective Impression	Relative Loudness (human judgment of different sound levels)
Jet aircraft takeoff from carrier (50 feet)	140	Threshold of pain	64 times as loud
50-hp siren (100 feet)	130		32 times as loud
Loud rock concert near stage, Jet takeoff (200 feet)	120	Uncomfortably loud	16 times as loud
Float plane takeoff (100 feet)	110		8 times as loud
Jet takeoff (2,000 feet)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 feet)	90		2 times as loud
Garbage disposal, food blender (2 feet), Pneumatic drill (50 feet)	80	Moderately loud	Reference loudness
Vacuum cleaner (10 feet), Passenger car at 65 mph (25 feet)	70		1/2 as loud
Large store air-conditioning unit (20 feet)	60		1/4 as loud
Light auto traffic (100 feet)	50	Quiet	1/8 as loud
Bedroom or quiet living room, Bird calls	40		1/16 as loud
Quiet library, soft whisper (15 feet)	30	Very quiet	
High quality recording studio	20		
Acoustic Test Chamber	10	Just audible	
	0	Threshold of hearing	
<i>Sources: Beranek (1988) and EPA (1971)</i>			

1.3. Noise Level Descriptors

To account for the time-varying nature of noise, several noise metrics are useful. Commonly used noise descriptors include the L_{max}, L_{min}, L_{eq}, and L_{xx}. The L_{max} and L_{min} are the greatest and smallest RMS (root-mean square) sound levels, in dBA, measured during a specified measurement period. The equivalent sound pressure level (L_{eq}) is defined as the average noise level, on an energy basis, for a stated time period (for example, hourly).

The sound level descriptor L_{xx} is defined as the sound level exceeded “XX” percent of the time. This description is one of the main noise level descriptors applicable to this facility, and is used in the DEQ noise regulations.

Three common examples of the L_{xx} include:

- L01: The sound level exceeded 1 percent of the time. This is a measure of the loudest sound levels during the measurement period. Example: During a 1-hour measurement, an L1 of 75 dBA means the sound level was 75 dBA or louder for 0.6 minutes, or 36 seconds.
- L10: The sound level exceeded 10 percent of the time. This is a measure of the louder sound levels during the measurement period. Example: During a 1-hour measurement, an L10 of 60 dBA means the sound level was 60 dBA or louder for 6 minutes.
- L50: The sound level exceeded 50 percent of the time. Example: During a 1-hour measurement, an L50 of 55 dBA means the sound level was 55 dBA or louder for 30 minutes.

1.4. Decibel Mathematics

An important factor to recognize is that noise is measured on a decibel scale, and combining two noises is not achieved by simple addition. For example, combining two 60 dB noises does not give 120 dB (which is near the pain threshold), but yields 63 dB which is lower than the volume at which most people listen to their televisions. For reference, if two noise sources are 10 dB apart, for example 50 dB and 60 dB, the sum of the two noise levels will simply be the louder of the two, in this case 60 dB. This is to say that for similar noise sources that are 10 dB apart in magnitude, a person would only be able to hear the louder of the two sources.

Examples of simplified decibel addition, based on the difference between the two levels, are provided below for reference, as they will aid in the understanding of the facility noise impact analysis.

Difference between the two noise sources	Amount added to the higher of the two noise levels
0 to 1 dB	3 dB
2 to 3 dB	2 dB
4 to 9 dB	1 dB
10 dB or more	0 dB

2. Regulations

Regulations applicable to the operation of the proposed facility are taken from the OAR Noise Control Regulations, Chapter 340, Division 35. The regulations are applicable at noise sensitive properties. OAR 340-35-0015(38) defines a noise-sensitive property as property normally used for sleeping (e.g., residences) and also includes properties used for schools, churches, hospitals, or public libraries. Industrial or agricultural property use is not considered noise sensitive unless it includes one or more of the noise sensitive buildings described above.

The regulations are applicable at appropriate measurement locations. The appropriate measurements location on a noise sensitive property is defined in OAR 340-35-0035(3)(b), and is the farthest of the following two points:

1. Twenty-five feet toward the noise source from that point on the noise sensitive building that is nearest to the noise source; or
2. The point on the noise sensitive property line that is nearest the noise source.

The primary applicable noise regulation used for this analysis are taken from OAR 340-035-0035(1)(b)(B)(i), which states: *No person owning or controlling a new industrial or commercial noise source located on a previously unused industrial or commercial site shall cause or permit the operation of that noise source if the noise levels generated or indirectly caused by that noise source increase the ambient statistical noise levels, L10 or L50, by more than 10 dBA in any one hour, or exceed the levels specified below in Table 8, as measured at an appropriate measurement point, as specified in subsection (3)(b) of this rule .* The appropriate measuring points are defined above. Table 2 provides the levels specified in DEQ’s “Table 8.”

Statistical Descriptor	New Noise Source (dBA)	
	7 am – 10 pm	10 pm – 7 am
L1	75	60
L10	60	55
L50	55	50

Source: OAR 340-035-0035, Table 8.

OAR 340-035-0035 further limits existing industrial noise sources that can be described as impact or impulse noise (e.g., blasting) as well as audible discrete tones or tonal noise. Impulse sounds are limited to 100 dB, peak response, between the hours of 7 am and 10 pm and 80 dB, peak response, between the hours of 10 pm and 7 am Tonal noise limits are established based on allowable octave band sound pressure levels in the range of frequencies between 31.5 and 8,000 hertz (Hz) as shown in Table 3.

Table 3. DEQ Median Octave Band Standards for Industrial and Commercial Noise Sources		
Octave Band Center Frequency, hertz (Hz)	Allowable Octave Band Sound Pressure Levels (dB)	
	7 am – 10 pm	10 pm – 7 am
31.5	68	65
63	65	62
125	61	56
250	55	50
500	52	46
1000	49	43
2000	46	40
4000	43	37
8000	40	34

Source: OAR 340-035-0035, Table 10.

Warning devices are exempt from OAR 340-035-0035 if not continuously operated for more than 5 minutes.

Noise from construction sites and sounds created during construction or maintenance of capital equipment are also exempt from the OAR noise regulations.

3. Existing Conditions

The land use in the area is mainly undeveloped and farm lands. The facility area was investigated using aerial photos and on-site inspections, and 17 residential structures were identified within approximately 1 mile of the facility. Some residences identified are located on farm lands and are associated with farm operations. Per OAR 340-035-0015(38), these are evaluated as noise sensitive properties.

There are few existing noise sources in this area. Some of the major noise sources include farming activities, including tractors, irrigation and general maintenance, infrequent traffic along the area roadways, wildlife, and wind. Due to the close proximity of some noise sensitive properties to the proposed facility, existing ambient noise monitoring was conducted to establish the existing noise environment, with the purpose of demonstrating compliance with the allowable increase criteria provided in OAR 340-035-0035(1)(b)(B)(i).

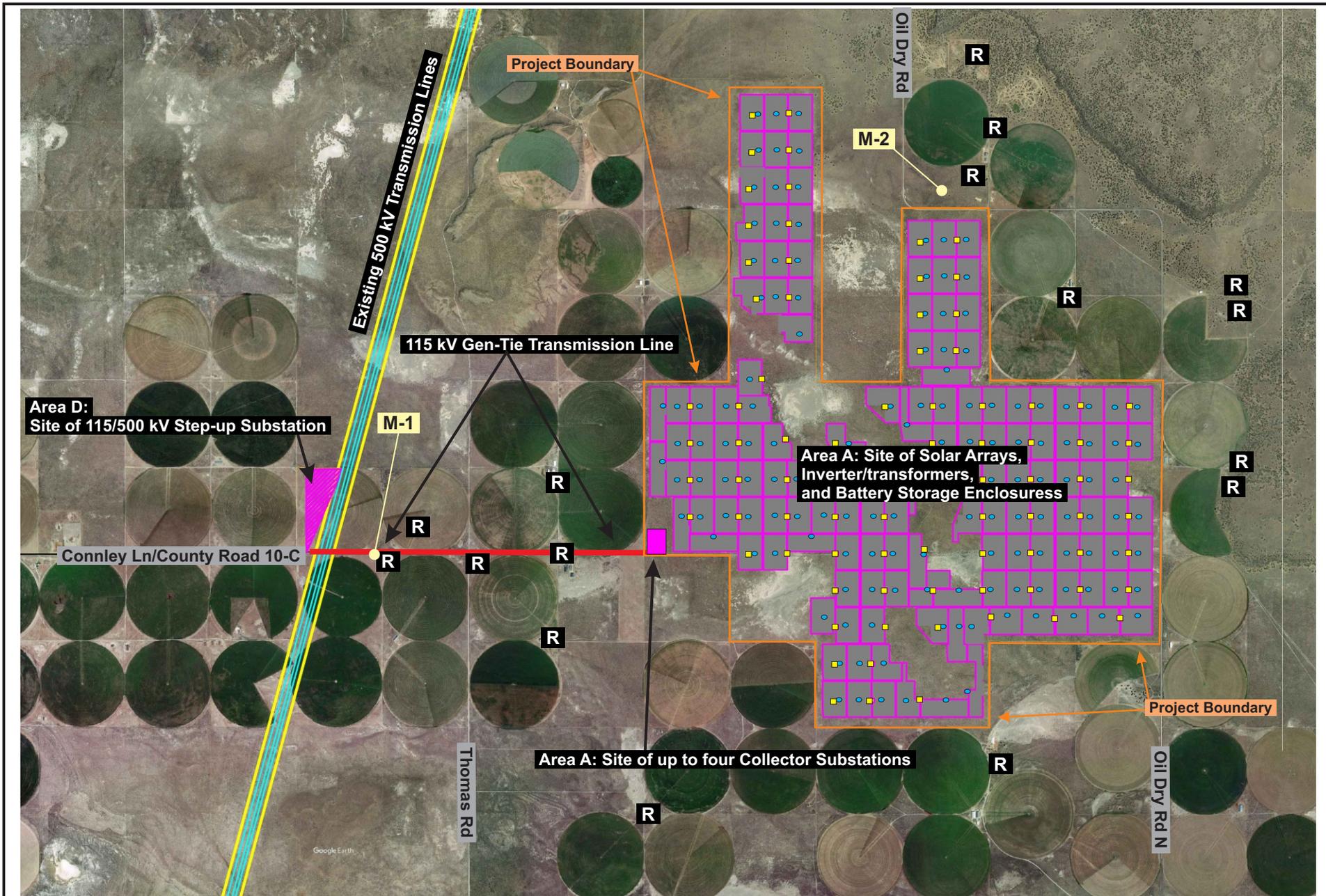
3.1. Existing Ambient Noise Levels

Monitoring was conducted to establish the existing ambient noise levels in the study area to assure compliance with the allowable 10 dB increase in the L10 and L50 criteria. Previous studies for similar solar facilities have rarely identified non-compliances with the DEQ standards due to the inherently low noise levels from typical solar PV system operation. For this analysis, the study area included the areas up to 1.1 miles from the facility boundary, which includes all noise sensitive properties within 1 mile, and also the nearest noise sensitive properties southwest of the site boundary (1.1 miles away).

Two sites were selected for ambient noise monitoring: sites M-1 and M-2. Site M-1 is near a cluster of residences located just east of the solar array and west of the existing 500-kilovolt (kV) transmission line. Due to the limited number of residences, and very low volumes of traffic, site M-1 is representative of all residences in this immediate area. Site M-2 is to the north of the solar array, in an area with even fewer residences and lower traffic volumes than the area of M-1. This monitoring site was used to represent residences in the north and east sections of the study area.

Equipment used for the noise measurements were Bruel & Kjaer Type 2238 sound level meters. The sound level meters meet or exceed American National Standards Institute (ANSI) S1.4-1983 for Type 1 Sound Measurement Devices. All measurement procedures complied with those procedures adopted by the Commission and set forth in Sound Measurement Procedures Manual (NPCS-1) from the DEQ, and more recent methods from the ANSI procedures for community noise measurements. System calibration was performed before and after each measurement session with a Bruel & Kjaer Type 4231 sound level calibrator. The meters are calibrated by an accredited laboratory on an annual basis. The noise monitoring was performed on July 5 through July 7, 2018 using three systems, and performing monitoring at all three sites simultaneously. Weather was clear, and there was no precipitation during the measurement period.

Figure 2 provides an overview of the facility showing the locations of facility related equipment, noise sensitive properties (residences), and the two noise monitoring sites. Figures 3 and 4 provide photos of the monitoring equipment placement.



- Monitoring Site
- Solar Array
- Substation/Building
- R** Residence(s)
- Inverter
- Battery Storage

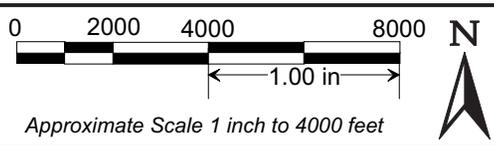


Figure 2. Facility Layout, Residences and Noise Monitoring Locations Obsidian Solar Center

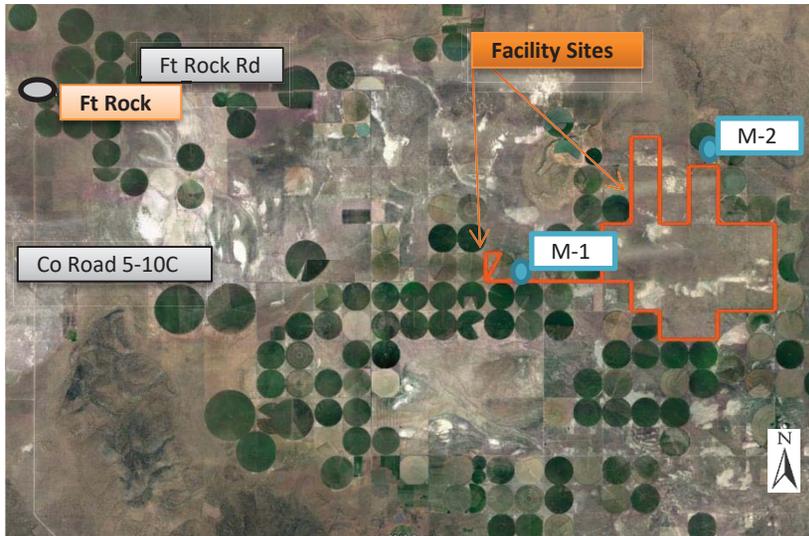


Photo 1: Aerial View



Photo 2: Looking East



Photo 3: Looking West



Photo 4: Looking South East

Monitoring Location M-1
 County Road 5-10C;
 1300 feet from County Rd 5-10 Intersection



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**Figure 3. Photos of Monitoring Site M-1
 Obsidian Solar Center**

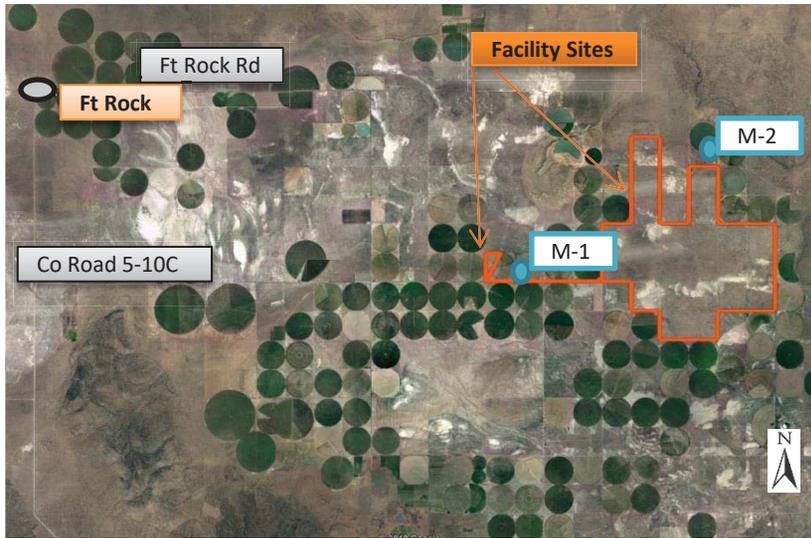


Photo 1: Aerial View



Photo 2: Looking North West

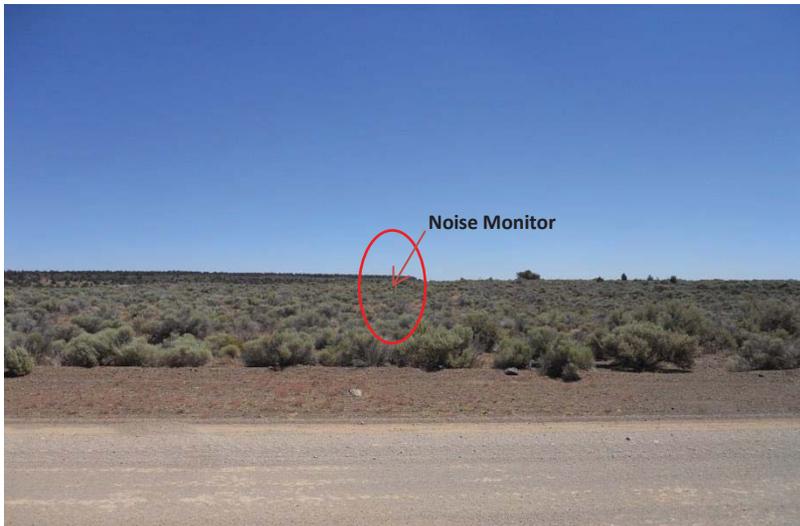


Photo 3: Looking North (from roadway)

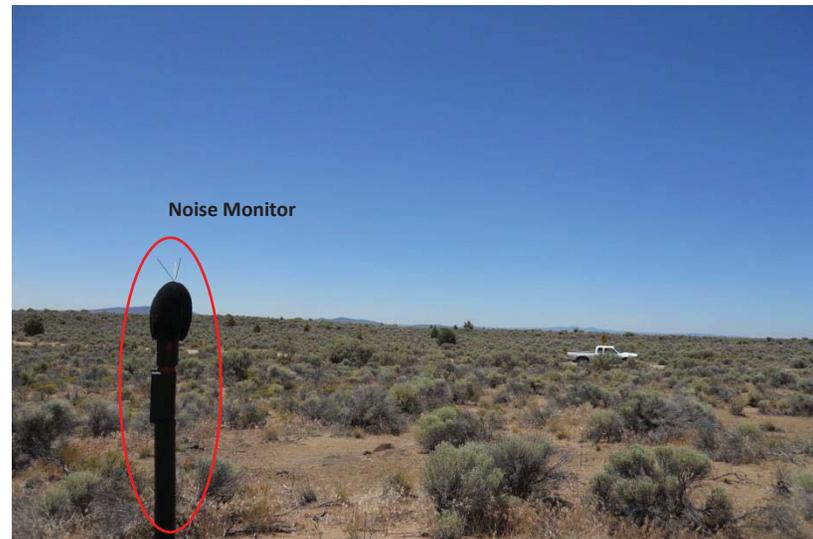


Photo 4: Looking South

Monitoring Location M-2
Oil Dry Rn N at County Road 5-12



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**Figure 4. Photos of Monitoring Site M-2
Obsidian Solar Center**

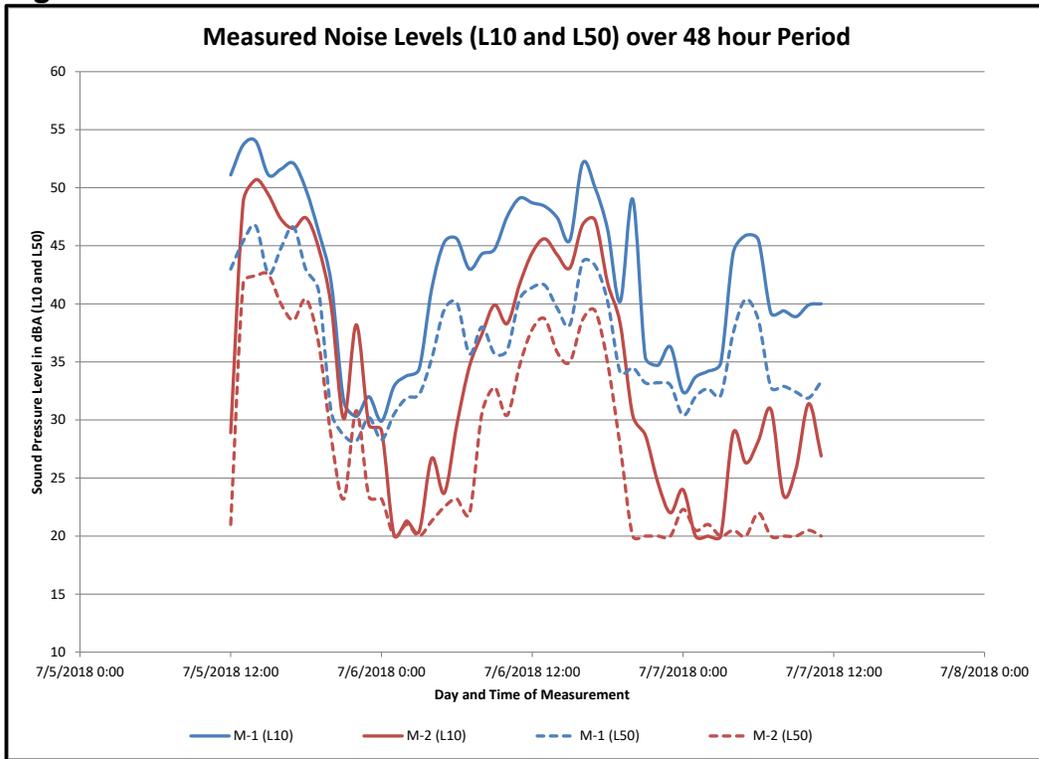
The overall measured L10 from both sites ranged 20 to 54 dBA, while the L50 ranged from 20 to 47 dBA. The average measured L10 was 38 dBA and the average L50 was 32 dBA. These are very low noise levels, and are found only in very rural areas far away from any arterial roadways, highways or other main transportation noise source, commercial or industrial land use.

Noise levels measured at site M-1 ranged from 30 to 54 dBA L10, with an average L10 of 42 dBA. The L50 at M-1 ranged from 28 to 47 dBA, with an average of 37 dBA. Noise levels measured at site M-2 ranged from 20 to 51 dBA L10, with an average L10 of 34 dBA. The L50 at M-1 ranged from 20 to 43 dBA, with an average of 28 dBA. Table 4 provides the minimum (lowest) L10 and L50 values taken over the measurement period. Figure 5 is a plot of the L10 and L50 as measured over the 48 hours period. Tables with the complete L10, L50 and Leq measurements are provided in Attachment C for reference.

Monitoring Site	L10 (dBA)	L50 (dBA)
M-1	30	28
M-2	22	20

Note: Measured noise levels are provided in Attachment C.

Figure 5. Plot of Measured Noise Levels



4. Facility Equipment and Analysis Methods

There are many different pieces of equipment used for this type of facility. Much of the equipment will not produce any noise; however, some equipment, including invertors, generators and transmissions lines, have the potential to produce noise that could be notable off site. Table 5 lists the noise-emitting equipment and the reference noise levels at 50 and 500 feet that were used in this analysis. Descriptions of the equipment are provided below.

Table 5. Noise Sources and Reference Noise Levels		
Equipment	Sound Pressure Level (at 50 Feet in dBA)	Sound Pressure Level (at 500 Feet in dBA)
Invertor	55 dBA ^a	35 dBA ^a
Transformer	64 dBA ^b	44 dBA ^b
115 kV Transmission Line	0 dBA (dry) 15 dBA (wet) ^c	Not measureable
<i>Note:</i> a. Based on Power Electronics FS3000M Specification of < 79 dBA at 3 feet. b. Based on typical sound power levels for a 115 kV transformer of 97 dBA c. Based on estimates provided in Appendix AA-1 of Exhibit AA EMF		

4.1. Noise Emitting Facility Equipment

Inverters

The facility will use Power Electronics FS3000M or similar inverters to convert from direct current to alternating current. Specifications for inverters with the required capacity, like the Power Electronics FS3000M, produce 79 dBA at 3 feet from the unit. Specification sheets for the Power Electronics FS3000M are provided in Attachment B.

Transformers

The inverter alternating current output voltage will be stepped up to a higher-voltage (34.5 kV) by pad-mounted transformers designed to integrate with the selected inverter. These medium voltage step-up transformers will be co-located with the inverters. Additionally, for battery storage, the output voltage will be stepped up and stepped down to enable the power to enter and leave the batteries. Typical sound levels from these types of transformers are 63 to 66 dBA at 50 feet.

Transmission Line

At each collector substation, power will be increased to 115 kV through pad-mounted transformers. The power will then run from the collector substation via an overhead 115-kV transmission line to the substation nearest the point of interconnection with the PGE 500 kV transmission line. The 115 kV generation tie (gen-tie) transmission line can, under the right conditions, produce corona noise. Corona noise can occur from electronic ionization of the air surrounding transmission lines. The level of corona noise produced is dependent on many factors, and for most small lines, like the 115-kV lines proposed, noise only occurs when there is a high level of moisture in the air.

4.2. Analysis Methods

Noise levels that will be generated by this facility during operation—and by solar PV generating facilities in general—are inherently low. The primary noise producing equipment includes inverters, transformers, and the transmission lines.

Operational noise levels for the inverters and transformers were obtained from potential manufacturers specifications (see Table 5). In addition, the 115-kV gen-tie transmission line may potentially produce some corona noise, which only occurs when there is a high level of moisture in the air. To maintain a conservative analysis and assure all potential impacts are identified, the analysis was performed assuming wet conditions that would result in corona noise production.

Sound propagation factors assumed normal atmospheric absorption. No additional attenuation was assumed for groundcover, topographical shielding, or shielding from battery storage containers or the solar array systems.

This analysis also assumes the facility will be in constant operation, with power transmission during nighttime hours from the battery storage. This assumption was made because the lowest L50 noise levels were measured during nighttime and very early morning hours, during which time the solar panels will not produce any energy (see Attachment C). By assuming the batteries will discharge during these quiet periods, compliance can be confirmed during those periods with the lowest measured L50 noise levels. Also, because the analysis assumes constant facility operations, the L10 and L50 of noise generated from the site will be the same.

5. Noise Modeling

Potential noise levels were predicted at 17 representative noise sensitive properties, including all that are within 1 mile of the site boundary, and one that is 1.1 miles from the site boundary. Noise sensitive property R-7, located at 1.1 miles from the facility was included because it is the nearest residence on the southwest side of the proposed area of the facility with solar modules. All noise sensitive properties are residences that appear to be occupied.

Distances from the noise sources to each of the 17 representative noise sensitive properties were measured using computer-aided drafting (CAD) software with calibrated aerial photo overlays. The noise sensitive properties are at least 2,000 feet from any inverter, and more than 250 feet from the 115-kV gen-tie transmission line.

The locations of these noise sensitive properties are depicted on Figure 6. The figure also depicts representative locations of the inverters, the gen-tie transmission line, substations, and existing 500 kV transmission lines.

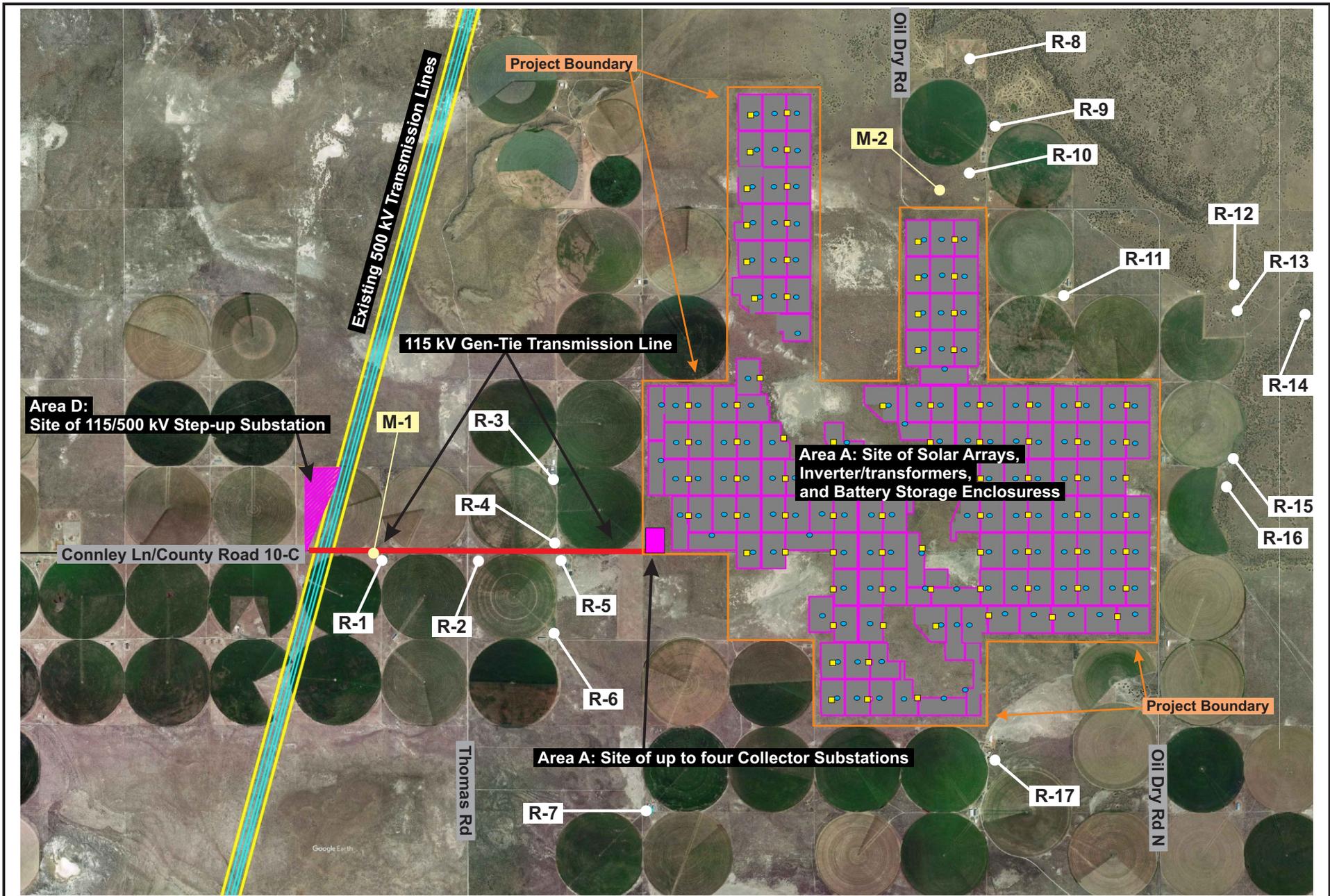
The analysis assumed direct line-of-sight between the noise sources and the noise sensitive properties, and included no additional attenuation from battery storage enclosures, solar arrays, topographic conditions, or ground cover. In addition, it was assumed to be in wet conditions and included corona noise from the transmission lines where applicable. These assumptions result in a conservative analysis, based on the worst-case scenario conditions.

5.1. Modeling Results

Table 6 reports the predicted noise levels of facility equipment during operation at the noise sensitive properties.

Modeled noise levels for residences located to the west of the facility, represented by noise sensitive properties R-1 through R-7, ranged from 21 to 31 dBA. The average noise levels among these seven noise sensitive properties were 27 dBA. Noise sensitive property R-1 has the highest predicted noise levels in this part of the study area due to the close proximity to the 115-kV transformers at the connection to the 500-kV transmission lines. Receiver R-7 has the lowest predicted noise level in this part of the study area, and is also located farthest overall from the solar array, generators, inverters and transmission lines.

Modeled noise levels for residences located to the east of the facility, represented by noise sensitive properties R-8 through R-17, ranged from 20 to 28 dBA. The average noise levels among these ten noise sensitive properties were 24 dBA. The lower noise levels at these noise sensitive properties, when compared to levels at R-1 to R-7, is likely due to the lack of noise associated with the proposed 115-kV and existing 500-kV power lines. As is shown in the Table 6, the transmission lines do not measurably contribute to the total facility noise at R-8 to R-17. For the noise sensitive properties in this part of the study area, R-10 has the highest predicted noise levels due to the close proximity to the inverters in the solar array. The lowest noise levels in this area are at R-14.



<ul style="list-style-type: none"> ○ Modeling Site ■ Solar Array ■ Substation/Building 	<ul style="list-style-type: none"> ● Monitoring Site ● Inverter ■ Battery Storage 	<p>0 2000 4000 8000</p> <p>← 1.00 in →</p> <p>Approximate Scale 1 inch to 4000 feet</p> <p>N</p>	 <p>Michael Minor & Associates Sound, Vibration, Air Portland, Oregon</p>	<p>Figure 6. Noise Modeling Locations Monitoring sites M-1 and M-2 shown for reference Obsidian Solar Center</p>
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Table 6. Predicted Facility Operational Noise Levels at Noise Sensitive Properties

Noise Sensitive Properties ^a	Noise Levels Contributions by Facility Equipment at Noise Sensitive Properties			Total Noise of Facility Equipment (dBA) ^e
	Inverter Noise (dBA) ^b	Transformer Noise (dBA) ^c	Transmission Line Noise (dBA) ^d	
R-1	14	31	18	31
R-2	17	24	10	25
R-3	23	27	8	28
R-4	21	28	7	29
R-5	21	29	7	30
R-6	19	26	7	27
R-7	17	20	4	21
R-8	22	> 3 dBA	Not measureable	22
R-9	24	> 3 dBA	Not measureable	24
R-10	28	> 3 dBA	Not measureable	28
R-11	26	> 3 dBA	Not measureable	26
R-12	22	> 3 dBA	Not measureable	22
R-13	22	> 3 dBA	Not measureable	22
R-14	20	> 3 dBA	Not measureable	20
R-15	26	> 3 dBA	Not measureable	26
R-16	26	> 3 dBA	Not measureable	26
R-17	26	> 3 dBA	Not measureable	26

Note:

- a. As depicted on Figure 6.
- b. Total noise from the nearest inverters at the noise sensitive property. Per OAR 340-35-0035(3)(b), prediction site is 25 feet from the building toward the noise source, or at a point on the noise sensitive property line that is nearest the noise source, whichever is greater.
- c. Noise from the transformers at the noise sensitive property, predicted per OAR 340-35-0035(3)(b)
- d. Noise from the 115- kV transmission line at the noise sensitive property, assuming wet conditions, predicted per OAR 340-35-0035(3)(b)
- e. Total noise, predicted by logarithmically summing the inverter noise, transformer noise and transmission line noise for the total noise from operations.

It is important to note the overall noise levels predicted at the residences of 20 to 31 dBA is very low, and is comparable to the lowest background noise levels in very quiet rural areas. For comparisons, noise levels of 30 to 35 dBA are typical for the interior of a very quiet library, and noise levels of 20 to 30 dBA would typically only be found in a high quality recording studio.

6. Compliance Analysis

To determine facility compliance with the OAR 340-035-0035 standards, two analyses are required. First, the noise levels reported in Table 6 need to be compared to the maximum allowable limits for a new industrial and commercial land use, as reported in Table 2. Second, the expected noise level increases need to be calculated (see Table 7) to determine compliance with the maximum allowable 10 dB increase of the existing L10 and L50 ambient noise levels.

Descriptions of these analyses are provided in Sections 6.1 and 6.2.

Noise Sensitive Property ^a	Existing Background L50 (dBA) ^b	Total Noise of Facility Equipment (dBA) ^c	Combined Noise (Background + Total Noise of Facility Equipment, dBA) ^d	Total Change in L50 Noise (dBA) ^e	Compliance with OAR 340-035-0035 Standard
R-1	28	31	33	+5	Yes
R-2	28	25	30	+2	Yes
R-3	28	28	31	+3	Yes
R-4	28	29	32	+4	Yes
R-5	28	30	32	+4	Yes
R-6	28	27	30	+2	Yes
R-7	28	21	29	+1	Yes
R-8	20	22	24	+4	Yes
R-9	20	24	26	+6	Yes
R-10	20	28	28	+8	Yes
R-11	20	26	27	+7	Yes
R-12	20	22	24	+4	Yes
R-13	20	22	24	+4	Yes
R-14	20	20	23	+3	Yes
R-15	20	26	27	+7	Yes
R-16	20	26	27	+7	Yes
R-17	20	26	27	+7	Yes

Note:

- As depicted on Figure 6.
- Background measured noise level: L50, using minimum M-1 for R-1 through R-7 and M-3 for R-8 through R-17.
- Total Noise from Facility operation equipment at noise sensitive properties, as reported in Table 4.
- Total noise, background and Facility operations, predicted by logarithmically summing the background noise and operational noise.
- Change in total noise at noise sensitive properties, (existing levels to Facility operation).

6.1. Maximum Allowable Noise Level Criteria

The predicted noise levels of facility operations equipment range from 20 to 31 dBA (see Table 6). The most stringent criterion provided in the OAR standard is an L50 of 50 dBA

during nighttime hours (Table 2). Because the worst-case predicted noise levels from facility operations is 31 dBA, the proposed facility will be in compliance with this portion of the OAR standard.

6.2. Maximum Allowable Noise Increase Criteria

In basic terms, to determine compliance with the 10 dBA maximum increase above ambient noise criterion, the predicted noise level data were “logarithmically summed” with the measured background noise level data to arrive at the combined noise levels (decibel mathematics is discussed in Section 1.4 for reference). Specifically, the measured existing background noise levels were subtracted from the combined noise levels to determine the increase above the ambient noise level. To be in compliance, this total must be 10 dBA or less above the measured background data. Table 7 provides the results of these calculations and provides compliance results.

Table 7 was produced using the L50 ambient measured noise levels reported in Table 4. The measured noise levels in Table 4 are for the hour with the lowest L50. Because the measured L50 levels are lower than the L10 levels at both monitoring sites, using the L50 levels is the most conservative method of analysis. Noise sensitive properties R-1 through R-7 used background data from M-2, and noise sensitive properties R-8 through R-17 use background data from M-2. The facility operational noise levels used for these calculations are taken from Table 6.

As shown in Table 7, predicted noise levels at all noise sensitive properties have L50 increases of 8 dBA or less; therefore, the future, combined noise levels are within the allowable 10 dBA increase from OAR 345-035-0035. Therefore, facility operations will also comply with this portion of the OAR standard.

6.3. Properties outside Study Area

Given the relatively flat topography within the site boundary and the surrounding areas, it is reasonable to presume that noise levels at properties farther away from the site boundary than the noise sensitive properties that were evaluated will also meet the OAR standard for operational noise.

7. Noise Mitigation Analysis

The predicted noise levels at the nearest noise sensitive properties range from 20 to 31 dBA. This level is below OAR 340-035-0035 maximum allowable noise level for new industrial and commercial uses (see Table 3). In addition, the total noise at the nearest noise sensitive properties, background + facility noise levels, are not predicted to increase by more than 8 dB, which is also in compliance with the OAR 340-035-0035 allowable increase criteria. Therefore, no noise mitigation measures—beyond that included in the facility design, including a 500-foot setback for inverters from the facility boundary, as feasible—are required or recommended.

It is important to note that noise levels of this magnitude are extremely low, and operational noise levels of this magnitude are typically only found in very rural areas with little or no traffic, or in quiet libraries or recording studios (see Table 1).

Furthermore, as previously stated, the noise analysis was performed assuming a direct line-of-sight between the noise producing equipment and the noise sensitive properties, with no additional shielding from the battery storage systems, solar arrays, topographic conditions, or ground cover. The combined noise reduction if this shielding was included in the analysis would be approximately 2 to 5 dBA, or more, for most noise sensitive properties. Therefore, the noise levels presented are most likely slightly higher than what will be expected from the actual installation.

8. Construction Noise Analysis

Facility construction will take approximately two years to complete, and during this time construction noise may, at times, be noticeable at nearby residences. This section provides an analysis of the potential construction noise levels. Construction noise is exempt from the OAR 340-035-0035 standards. This information is provided for reference purposes, and to disclose potential noise sources from the facility.

8.1. Method of Analysis

Construction noise levels were estimated using the methods described in the Federal Highway Administration Highway Construction Noise: Measurement, Prediction and Mitigation, USDOT, 1997. The FHWA Roadway Construction Noise Model (FHWA RCNM) Version 1.1 was used for this analysis. Although this program was designed for highway noise, the type of equipment and equipment noise levels are the same as will be used for construction of this facility.

8.2. Construction Methods and Equipment

Equipment required to complete the facility includes common construction equipment that is used for typical roadway and infrastructure type activities. Table 8 provides a typical list of the types of equipment expected for this facility, the activities they would be used for, and the corresponding maximum noise level measured at 50 feet under normal use. The equipment listed was derived from information found in the FHWA RCNM.

Equipment	Impact^a	Typical Expected Project Use^b	Lmax^{c, d}
Air Compressors	No	Used for pneumatic tools and general maintenance	70 – 78
Back Hoe	No	Excavation, support holes, and general construction	78 – 82
Concrete Pumps	No	Pump concrete for structure bases	82
Cranes	No	Removal and installation of solar panels, overhead line and equipment placement	81
Dozer	No	Major earth work and leveling	88
Grader	No	Level ground and earthwork	86
Haul Trucks	No	Materials handling, general hauling to and from site	86
Loader	No	Excavation, support holes, and general construction	80
Power Plants	No	General construction use for temporary power	78
Pumps	No	General construction use, water removal	77 – 81
Pneumatic Tools	No	Miscellaneous construction and system assembly	85
Service & Utility Trucks	No	Repair and maintenance of equipment	78
Tractor Trailers	No	Materials delivery and movement	84
Welders	No	General construction, materials modification and repair	74
Notes: <ul style="list-style-type: none"> a. <i>Impact Equipment is equipment that generates impulsive noise. Impulse noise is defined as noise produced by the periodic impact of a mass on a surface, of short duration (generally less than one second), high intensity, abrupt onset and rapid decay, and often rapidly changing spectral composition.</i> b. <i>Typical project uses for construction projects.</i> c. <i>Typical maximum noise level under normal operation measured at 50 feet from the noise source.</i> d. <i>Equipment noise levels taken from the FHWA Construction Noise Model.</i> 			

8.3. Construction Noise Levels

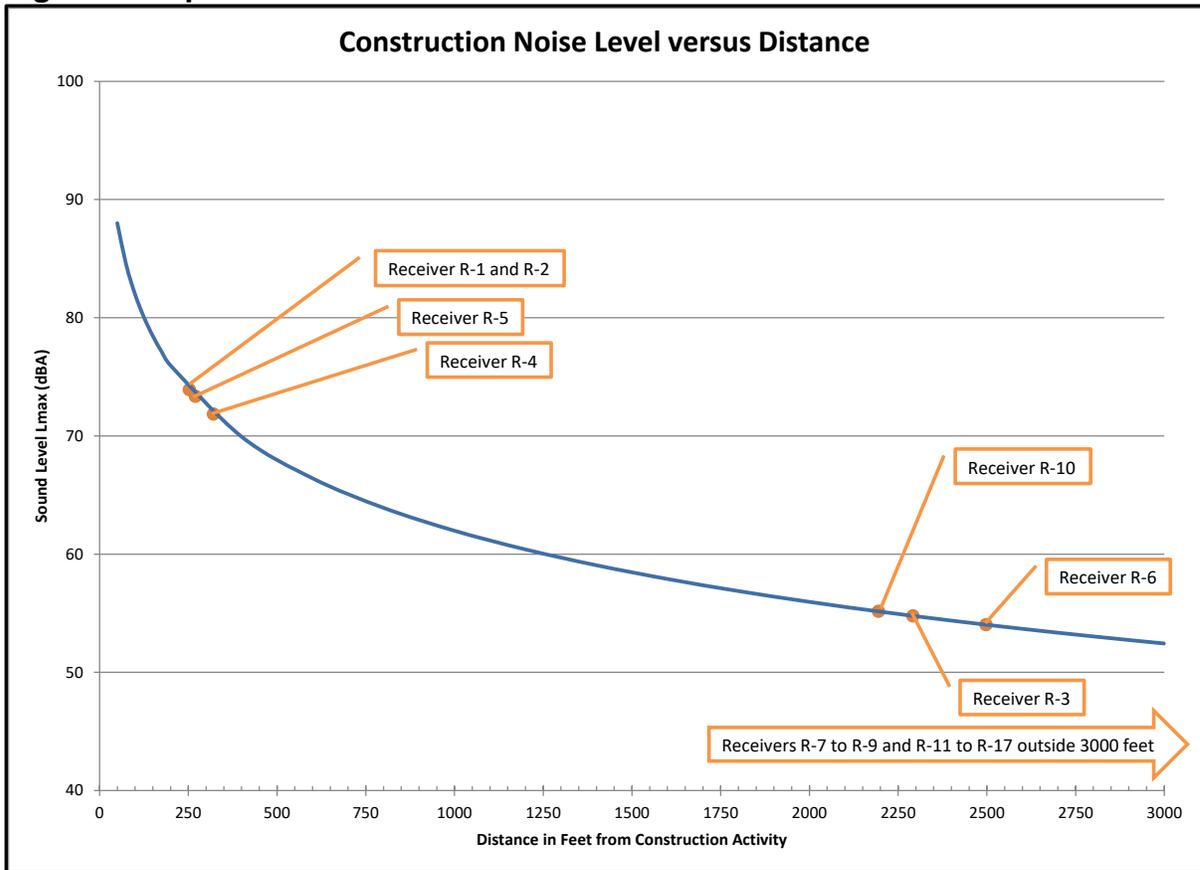
Construction noise would be generated by heavy equipment used during major construction periods. Construction activities could occur as close as 50 feet from some noise sensitive properties along County Road 10-C (see Figure 6). Other noise sensitive properties are approximately 1,000 feet or more from the nearest expected construction activity. Estimates of maximum hourly noise levels at 50 feet for various stages of construction are provided in Table 9.

Table 9: Estimated Peak Hour Construction Noise Levels		
Construction Phase	Loudest Equipment	Maximum Noise Level at 50 feet (dBA L_{max})
Clearing, grubbing and earthwork	Bulldozer, Grader, Backhoe, Haul Trucks	88
Foundation and Base preparation for systems	Backhoe, Loader, Tractor Trailers, Crane	84
Solar Array and Transmission Line Installation	Backhoe, Loader, Tractor Trailers, Crane	84
<i>Source: U.S. Department of Transportation. Highway Construction Noise: Measurement, Prediction, and Mitigation. 1977.</i>		

The noise levels in Table 9 are similar to noise produced by a typical infrastructure project. These noise levels are also similar to the noise produced by some farming equipment already in use in this area. The measured noise levels at monitoring sites M-1 and M-2 included maximum (highest) short term noise levels of 86 dBA and 81 dBA, respectively, and frequently had measured levels above 70 dBA throughout the daytime and some nighttime hours.

Although the noise levels reported in Table 9 are relatively high, the construction phase will be temporary. In addition, the levels reported in Table 9 can be expected only when the equipment is within 50 feet of a receiver. These noise levels will decrease substantially at larger distances (i.e., 1,000 feet or more) that will occur between most noise sensitive properties and construction activities. To provide a better understanding of how construction noise will decrease with distance from the site, Figure 7 shows a reference noise level of 88 dBA at 50 feet away extrapolated to 3000 feet away. The graphics also includes the noise sensitive properties (shown as “receivers”) located within 3000 feet of the work areas.

Figure 7. Expected Construction Noise Levels versus Distance



8.4. Construction Mitigation Measures

Several construction noise abatement methods can be implemented to limit potential impacts from noise. The contractor shall insure that all engine-powered equipment have mufflers installed according to the manufacturer's specifications, and that all equipment complies with pertinent equipment noise standards of the U.S. Environmental Protection Agency.

If specific noise complaints are received during construction, one or more of the following noise mitigation measures, as directed by the project manager, could be considered and implemented:

- Locate stationary engine-powered construction equipment as far from nearby noise sensitive properties as possible.
- Shut off idling equipment.
- Reschedule construction activities to avoid periods of noise annoyance identified in the complaint.
- Notify nearby residents before extremely noisy work occurs.

Attachment A References

- DEQ (Oregon Department of Environmental Quality). 2018. Oregon Administrative Rules, Chapter 340, Division 35 Noise Control Regulations Tables. Accessed August 1, 2018. <https://www.oregon.gov/deq/Rulemaking%20Docs/div35table1-10.pdf>.
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- Esri. 2017. "World Imagery" [basemap]. Scale Not Given. June 2017. <https://www.arcgis.com/home/item.html?id=10df2279f9684e4a9f6a7f08febac2a9>. Accessed August 2, 2018.
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- IEEE (Institute of Electrical and Electronics Engineers). 1974 “Psychoacoustics—Proceedings of a Workshop”, IEEE Power Engineering Society, Publication Number 21 74 CHO 967-0PWR, July 17.
- Miller 1978. “Sound Levels of Rain and Wind in the Trees,” Noise Control Engineering 11(3):101-109, November/December, Miller, L.N.

Attachment B Power Electronics FS3000M Specifications



TECHNICAL CHARACTERISTICS

		MV CENTRAL STRING INVERTER
REFERENCE	FS3000M	
OUTPUT	AC Output Power(kVA/kW) @50°C ^[1]	3000
	AC Output Power(kVA/kW) @25°C ^[1]	3300
	Operating Grid Voltage(VAC) ^[2]	34.5kV / 27.6kV / 24.94kV / 13.8kV / 12.47kV
	Operating Grid Frequency(Hz)	50Hz/60Hz
	Current Harmonic Distortion (THDi)	< 3% per IEEE519
	Power Factor (cosine phi) ^[3]	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night
INPUT	MPPT @full power (VDC)	849V-1310V
	Maximum DC voltage	1500V
	Number of inputs	4 per MPPT
	Number of MPPTs	Up to 6
EFFICIENCY & AUXILIARY SUPPLY	Max. Efficiency PAC, nom (η)	98% (preliminary)
	Max. Power Consumption (KVA)	30
CABINET	Dimensions [WxDxH] [ft]	20 x 6.5 x 7
	Type of ventilation	Forced air cooling
ENVIRONMENT	Degree of protection ^[4]	IP54 / NEMA3R
	Permissible Ambient Temperature	-35°C ^[5] to +60°C / >50°C Active Power derating
	Relative Humidity	4% to 100% non condensing
	Max. Altitude (above sea level)	1000m; >1000m power derating (Max. 4000m)
	Noise level ^[5]	< 79 dBA
CONTROL INTERFACE	Interface	Graphic Display
	Communication protocol	Modbus TCP
	Plant Controller Communication	Optional
	Keyed ON/OFF switch	Standard
PROTECTIONS	Ground Fault Protection	GFDI and Isolation monitoring device
	General AC Protection	MV Switchgear
	General DC Protection	Fuses
	Overvoltage Protection	AC, DC Inverter and auxiliary supply type 2
CERTIFICATIONS	Safety	UL1741, CSA 22.2 No.1071-01, UL62109-1, IEC62109-1, IEC62109-2
	Compliance	NEC 2017
	Utility interconnect	UL 1741SA-Sept. 2016 / IEEE 15471-2005

NOTES [1] Values at 1.00•Vac nom and cos φ=1. Consult Power Electronics for derating curves.
 [2] Consult Power Electronics for other configurations.
 [3] Consult P-Q charts available: $Q(kVAr) = \sqrt{(S(kVA))^2 - P(kW)^2}$.
 [4] IP65 available. Consult Power Electronics.
 [5] Heating resistors kit option below -20°C.
 [5] Readings taken 1 meter from the back of the unit.

Attachment C
Table of Field Measurements

DEQ Day/Night	Date/Time	L10		L50		Leq	
		M-1	M-2	M-1	M-2	M-1	M-2
Daytime Hours	7/5/2018 12:00	51.1	28.9	43	21	52.1	30.9
	7/5/2018 13:00	53.7	48.8	45.4	41.8	53.5	44.9
	7/5/2018 14:00	54	50.7	46.7	42.4	53.7	46.5
	7/5/2018 15:00	51.1	49.4	42.6	42.5	52.4	46.2
	7/5/2018 16:00	51.6	47.3	44.8	40	49.8	43.4
	7/5/2018 17:00	52.1	46.5	46.6	38.6	51.4	43.8
	7/5/2018 18:00	49.8	47.4	42.9	40.4	51	43.6
	7/5/2018 19:00	46.2	44.8	41.1	36.6	50.3	47.3
	7/5/2018 20:00	41.8	39.8	30.7	28.5	49	36.8
	7/5/2018 21:00	31.6	30.1	28.7	23.2	46	30.3
Nighttime Hours	7/5/2018 22:00	30.3	38.2	28.2	30.8	28.6	34.4
	7/5/2018 23:00	32	29.6	30.2	23.4	30.4	26.2
	7/6/2018 0:00	29.9	29.1	28.3	23.2	28.5	26.4
	7/6/2018 1:00	32.9	20.1	30.5	20	31.9	20.5
	7/6/2018 2:00	33.8	21.3	31.9	21	32.2	20.5
	7/6/2018 3:00	34.4	20.4	32.2	20	32.4	20.6
	7/6/2018 4:00	41.3	26.7	35.3	21.3	37.6	25.7
	7/6/2018 5:00	45.3	23.7	39.5	22.5	41.8	25.7
7/6/2018 6:00	45.6	29.6	40.1	23.2	48.2	30.7	
Daytime Hours	7/6/2018 7:00	43	34.6	35.7	21.9	44.5	39.8
	7/6/2018 8:00	44.3	37.4	38	30.6	51.2	36.2
	7/6/2018 9:00	44.7	39.9	35.7	32.8	54.9	39.9
	7/6/2018 10:00	47.5	38.3	36	30.4	51.7	36.5
	7/6/2018 11:00	49.1	41.7	40.4	34.7	54.2	39.4
	7/6/2018 12:00	48.7	44.4	41.4	37.8	52.2	40.9
	7/6/2018 13:00	48.4	45.6	41.6	38.7	51.4	42
	7/6/2018 14:00	47.4	44.2	39.6	35.8	45.7	43.9
	7/6/2018 15:00	45.5	43.1	38.2	35	48.4	41.5
	7/6/2018 16:00	52.1	46.8	43.6	38.6	52.6	43.7
	7/6/2018 17:00	50	47.2	43.3	39.4	49.2	44.3
	7/6/2018 18:00	46.4	41.8	40.2	34.9	49.8	38.2
	7/6/2018 19:00	40.2	38.3	34.1	27.7	46.8	37.5
	7/6/2018 20:00	49	30.4	34.5	20	50.2	32.9
7/6/2018 21:00	35.4	28.7	33.2	20	43.2	35.4	

DEQ Day/Night	Date/Time	L10		L50		Leq			
		M-1	M-2	M-1	M-2	M-1	M-2		
Nighttime Hours	7/6/2018 22:00	34.7	24.6		33.2	20		42.9	28.6
	7/6/2018 23:00	36.3	22		33	20		33.8	21.9
	7/7/2018 0:00	32.4	24		30.4	22.3		30.7	31.7
	7/7/2018 1:00	33.7	20		32	20.5		33	20
	7/7/2018 2:00	34.2	20		32.7	21		32.9	20
	7/7/2018 3:00	34.9	20		32.1	20		32.8	20.8
	7/7/2018 4:00	44.4	28.9		37.5	20.5		40.3	44.8
	7/7/2018 5:00	45.9	26.3		40.4	20		51.1	23.4
	7/7/2018 6:00	45.5	28.2		38.6	22		42.6	34.7
Daytime Hours	7/7/2018 7:00	39.2	30.9		32.8	20		53.4	33.1
	7/7/2018 8:00	39.4	23.5		32.9	20		48.9	25.9
	7/7/2018 9:00	38.9	25.8		32.4	20		51.2	30.3
	7/7/2018 10:00	39.9	31.4		31.9	20.5		51.8	35.3
	7/7/2018 11:00	40	26.9		33.3	20		52.8	31.2
Min		30	20		28	20		29	20
Max		54	51		47	43		55	47
Average		42	34		37	28		45	34