3.11 Noise

This section describes the environmental setting and regulatory setting for noise. It also describes the noise impacts, if any, that would result from implementation of the program and two individual projects. Where applicable, mitigation measures are described that would reduce these impacts.

3.11.1 Existing Conditions

Background Information on Noise

Noise for the purposes of environmental analysis under CEQA is commonly defined as sound that annoys or disturbs people and potentially causes an adverse psychological or physiological effect on human health. Because noise is an environmental pollutant that can interfere with human activities, evaluation of noise is necessary when considering the environmental impacts of a proposed project.

Sound is mechanical energy (vibration) transmitted by pressure waves over a medium such as air or water. Sound is characterized by various parameters that include the rate of oscillation of sound waves (frequency), the speed of propagation, and the pressure level or energy content (amplitude). In particular, the sound pressure level is the most common descriptor used to characterize the loudness of an ambient (existing) sound level. Although the decibel (dB) scale, a logarithmic scale, is used to quantify sound intensity, it does not accurately describe how sound intensity is perceived by human hearing. The human ear is not equally sensitive to all frequencies in the entire spectrum, so noise measurements are weighted more heavily for frequencies to which humans are sensitive in a process called *A-weighting*, written as *dBA* and referred to as *A-weighted decibels*. Table 3.11-1 defines sound measurements and other terminology used in this chapter, and Table 3.11-2 summarizes typical A-weighted sound levels for different noise sources.

In general, human sound perception is such that a change in sound level of 1 dB cannot typically be perceived by the human ear, a change of 3 dB is barely noticeable, a change of 5 dB is clearly noticeable, and a change of 10 dB is perceived as doubling or halving the sound level.

Different types of measurements are used to characterize the time-varying nature of sound. These measurements include the equivalent sound level (L_{eq}), the minimum and maximum sound levels (L_{min} and L_{max}), percentile-exceeded sound levels (such as L_{10}, L_{20}), the day-night sound level (L_{dn}), and the community noise equivalent level (CNEL). L_{dn} and CNEL values differ by less than 1 dB. As a matter of practice, L_{dn} and CNEL values are considered to be equivalent and are treated as such in this assessment.

For a point source such as a stationary compressor or construction equipment, sound attenuates based on geometry at rate of 6 dB per doubling of distance. For a line source such as free flowing traffic on a freeway, sound attenuates at a rate of 3 dB per doubling of distance (California Department of Transportation 2009). Atmospheric conditions including wind, temperature gradients, and humidity can change how sound propagates over distance and can affect the level of sound received at a given location. The degree to which the ground surface absorbs acoustical energy also affects sound propagation. Sound that travels over an acoustically absorptive surface such as grass attenuates at a greater rate than sound that travels over a hard surface such as pavement. The increased attenuation is typically in the range of 1 to 2 dB per doubling of distance.

Barriers such as buildings and topography that block the line of sight between a source and receiver also increase the attenuation of sound over distance.

Table 3.11-1. Definition of Sound Measurements

Sound Measurements	Definition
Decibel (dB)	A unitless measure of sound on a logarithmic scale, which indicates the squared ratio of sound pressure amplitude to a reference sound pressure amplitude. The reference pressure is 20 micro-pascals.
A-Weighted Decibel (dBA)	An overall frequency-weighted sound level in decibels that approximates the frequency response of the human ear.
C-Weighted Decibel (dBC)	The sound pressure level in decibels as measured using the C-weighting filter network. The C-weighting is very close to an unweighted or "flat" response. C-weighting is only used in special cases when low-frequency noise is of particular importance. A comparison of measured A and C weighted level gives an indication of low frequency content.
Maximum Sound Level (L_{max})	The maximum sound level measured during the measurement period.
Minimum Sound Level (L_{min})	The minimum sound level measured during the measurement period.
Equivalent Sound Level (L_{eq})	Leq represents an average of the sound energy occurring over a specified period. In effect, Leq is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The 1-hour A weighted equivalent sound level (Leq[h]) is the energy average of A-weighted sound levels occurring during a 1-hour period.
Percentile-Exceeded Sound Level (L_{xx})	The sound level exceeded "xx" percent of a specific time period. L_{10} is the sound level exceeded 10 percent of the time. L_{90} is the sound level exceeded 90 percent of the time. L_{90} is often considered to be representative of the background noise level in a given area.
Day-Night Level (L_{dn})	The energy average of the A-weighted sound levels occurring during a 24-hour period, with 10 dB added to the A-weighted sound levels occurring during the period from 10:00 p.m. to 7:00 a.m.
Community Noise Equivalent Level (CNEL)	The energy average of the A-weighted sound levels occurring during a 24-hour period with 5 dB added to the A-weighted sound levels occurring during the period from 7:00 p.m. to 10:00 p.m. and 10 dB added to the A-weighted sound levels occurring during the period from 10:00 p.m. to 7:00 a.m.
Peak Particle Velocity (Peak Velocity or PPV)	A measurement of ground vibration defined as the maximum speed (measured in inches per second) at which a particle in the ground is moving relative to its inactive state. PPV is usually expressed in inches/sec.
Frequency: Hertz (Hz)	The number of complete pressure fluctuations per second above and below atmospheric pressure.

Table 3.11-2. Typical A-weighted Sound Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	—110—	Rock band
Jet flyover at 1,000 feet		
	—100—	
Gas lawnmower at 3 feet		
	—90—	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	—80—	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawnmower, 100 feet	—70—	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	—60—	
		Large business office
Quiet urban daytime	—50—	Dishwasher in next room
Quiet urban nighttime	—40—	Theater, large conference room (background)
Quiet suburban nighttime		
	—30—	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	—20—	
		Broadcast/recording studio
	—10—	
	—0—	

Source: California Department of Transportation 2009.

Other Factors Related to Wind Turbines

Operating wind turbines can generate two types of sound: mechanical sound from components such as gearboxes, generators, yaw drives, and cooling fans; and aerodynamic sound from the flow of air over and past the rotor blades. Modern wind turbine design has greatly reduced mechanical sound, which is generally unnoticeable in comparison with the aerodynamic sound, which is often described as a “swishing” or “whooshing” sound. The International Standard IEC 61400-11 for wind turbine noise assessment provides a requirement for evaluating tonality. Tones are then divided into categories of prominent tone, audible tone, or no tone. (Illingworth & Rodkin 2006.)

Compared with other, primarily older wind turbines, the modern wind turbines that would be installed through the repowering program have several characteristics that reduce aerodynamic sound levels. The modern turbines typically are *upwind* turbines, meaning each turbine faces into the wind, so the wind encounters the rotor blades before the tower and nacelle, making for quieter operations than a downwind turbine. Additionally, the modern turbines have relatively low rotational speeds and pitch control on the rotors, both of which reduce sound levels.

Wind turbines produce a broadband sound (i.e., the sound occurs over a wide range of frequencies, including low frequencies). Low-frequency sounds are in the range of 20–100 Hz, and infrasonic sound (or *infrasound*) is low-frequency sound of less than 20 hertz. Compared with higher frequency sound, low-frequency sound propagates over longer distances, is transmitted through buildings more readily, and can excite structural vibrations (e.g., rattling windows or doors). The threshold of perception, in decibels, also increases as the frequency decreases. For example, in the frequency range where humans hear best (in the low kilohertz), the threshold of hearing is at about 0 dB, but at a frequency of only 10 Hz, the threshold of hearing is at about 100 dB (Rogers et al. 2006a).

Older wind turbines—particularly those in which the blades were on the downwind side of the tower—produced more low-frequency sound because their towers blocked wind flow, causing the blades to pass through more turbulent air. Modern, upwind turbines produce a broadband sound that includes low-frequency sounds, but not at significant levels. A primary cause for low-frequency sounds in modern turbines is the blade passing through the change in air flow at the front of the tower, and this can be aggravated by unusually turbulent wind conditions. This effect is generally referred to as blade amplitude modulation because the aerodynamic noise generated by the blades (the "swishing" sound) is modulated as the turbine blades pass through uneven air velocities. The uneven air that causes this effect may be due to interaction of other turbines, excessive wind shear, or topography (Bowdler 2008).

The University of Massachusetts at Amherst reported on noise measurements made at four different wind turbines ranging from 450 kilowatts to 2 megawatts (Rogers et al. 2006b). The results indicated that at distances of no more than 118 meters (387 feet) from the turbines, all infrasound levels were below human perception levels. The report further states that there is "no reliable evidence that infrasound below the hearing threshold produces physiological or psychological effects." This lack of effects at levels below the hearing threshold was supported by a scientific advisory panel composed of medical doctors, audiologists, and acoustical professionals established by the American and Canadian Wind Energy Associations to review wind turbine sound and health effects (Colby et al. 2009). It was also supported by Canadian and Australian government reviews of available scientific literature (Australia National Health and Medical Research Council 2010; Ontario Chief Medical Officer of Health 2010).

Additional recent studies conducted on a 2.3 MW Siemens SWT-2.3-93 turbine (O'Neal et al. 2010) are a useful point of reference with the regard to low frequency noise generated by a modern wind turbine generator. These studies concluded that the Siemens SWT-2.3-93 wind turbine at maximum noise at a distance of about 305 meters (1,000 feet) from the nearest residence does not pose a low frequency noise or infrasound problem. At this distance the turbine satisfies the following objectives.

- Meets American National Standards Institute/American Standards Association [ANSI/ASA] S12.2 indoor levels for low frequency sound for bedrooms, classrooms, and hospitals.
- Meets ANSI/ASA S12.2 indoor levels for moderately perceptible vibrations in lightweight walls and ceilings.
- Meets ANSI S12.9 Part 4 thresholds for annoyance and beginning of rattles.
- Produces no audible infrasound capable of detection by the most sensitive listeners.

Wind generates sound when it interacts with structures and vegetation on the ground. The amount of sound generated can vary widely depending primarily on the amount of vegetation in the area and the speed of the wind. For a given wind speed, the sound level in a desert with no trees or vegetation will be different than in a highly vegetated area. When trees are in full leaf, wind in the trees rustles the leaves and high frequency sound is produced (Hoover and Keith 2000). The amount of sound generated depends on wind speed, the distance from the observed position to the trees or foliage, and the approximate frontal area of the trees or foliage as seen from the observed position. Sound levels generated by wind can range from about 20 dBA to 60 dBA for wind speeds in the range of 2 to 20 miles per hour (Hoover and Keith 2000).

Regulatory Setting

Federal

Federal, state, and local agencies regulate different aspects of environmental noise. Generally, the federal government sets noise standards for transportation-related noise sources closely linked to interstate commerce. These include aircraft, locomotives, and trucks. The state government sets noise standards for transportation noise sources such as automobiles, light trucks, and motorcycles. Noise sources associated with industrial, commercial, and construction activities are generally subject to local control through noise ordinances and general plan policies. Local general plans identify general principles intended to guide and influence development plans.

State

Part 2, Title 24 of the California Code of Regulations "California Noise Insulation Standards" establishes minimum noise insulation standards to protect persons within new hotels, motels, dormitories, long-term care facilities, apartment houses, and dwellings other than single-family residences. Under this regulation, interior noise levels attributable to exterior noise sources cannot exceed 45 L_{dn} in any habitable room. Where such residences are located in an environment where exterior noise is 60 L_{dn} or greater, an acoustical analysis is required to ensure that interior levels do not exceed the 45 L_{dn} interior standard.

The *State of California General Plan Guidelines* (Governor's Office of Planning and Research 2003) identifies guidelines for the noise elements of local general plans, including a sound level/land use compatibility chart that categorizes, by land use, outdoor L_{dn} ranges in up to four categories (normally acceptable, conditionally acceptable, normally unacceptable, and clearly unacceptable). For many land uses, the chart shows overlapping L_{dn} ranges for two or more compatibility categories.

The noise element guideline chart identifies the normally acceptable range of L_{dn} values for low-density residential uses as less than 60 dB and the conditionally acceptable range as 55–70 dB. The normally acceptable range for high-density residential uses is identified as L_{dn} values of less than 65 dB, and the conditionally acceptable range is identified as 60–70 dB. For educational and medical facilities, L_{dn} values of less than 70 dB are considered normally acceptable, and L_{dn} values of 60–70 dB are considered conditionally acceptable. For office and commercial land uses, L_{dn} values of less than 70 dB are considered normally acceptable, and L_{dn} values of 67.5–77.5 are categorized as conditionally acceptable. When noise levels are in the conditionally acceptable range new construction should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation requirements are included in the design.

These overlapping L_{dn} ranges are intended to indicate that local conditions (existing sound levels and community attitudes toward dominant sound sources) should be considered in evaluating land use compatibility at specific locations.

Local

General Plan Noise Element

The Alameda County General Plan Noise Element (Alameda County 1976) contains goals, objectives, and implementation programs for the entire county to provide its residents with an environment that is free from excessive noise and that promotes compatibility of land uses with respect to noise. The Countywide Noise Element does not explicitly define the acceptable outdoor noise level for the backyards of single-family homes or common outdoor spaces of multi-family housing projects, but it recognizes the Federal Environmental Protection Agency (EPA) noise level standards for residential land uses. These standards are an exterior L_{dn} of 55 dBA and an interior L_{dn} of 45 dBA. (The L_{dn} measurement, which also includes a 10dB weighting for night-time sound, is approximately equal to the CNEL for most environmental settings.) The Noise Element also references noise and land use compatibility standards developed by an Association of Bay Area Governments (ABAG)-sponsored study.

East County Area Plan

Alameda County's ECAP (Alameda County 2000) contains the following goal, policies and implementation programs related to community noise and windfarms.

Goal: To minimize East County residents' and workers' exposure to excessive noise.

Policies

Policy 170: The County shall protect nearby existing uses from potential traffic, noise, dust, visual, and other impacts generated by the construction and operation of windfarm facilities.

Policy 288: The County shall endeavor to maintain acceptable noise levels throughout East County.

Policy 289: The County shall limit or appropriately mitigate new noise sensitive development in areas exposed to projected noise levels exceeding 60 dB based on the California Office of Noise Control Land Use Compatibility Guidelines.

Policy 290: The County shall require noise studies as part of development review for projects located in areas exposed to high noise levels and in areas adjacent to existing residential or other sensitive land uses. Where noise studies show that noise levels in areas of existing housing will exceed "normally acceptable" standards (as defined by the California Office of Noise Control Land Use Compatibility Guidelines), major development projects shall contribute their pro-rated share to the cost of noise mitigation measures such as those described in Program 104.

Implementation Programs

Program 74: The County shall amend the Zoning Ordinance to incorporate siting and design standards for wind turbines to mitigate biological, visual, noise, and other impacts generated by windfarm operations.

Program 104: The County shall require the use of noise reduction techniques (such as buffers, building design modifications, lot orientation, sound walls, earth berms, landscaping, building setbacks, and real estate disclosure notices) to mitigate noise impacts generated by transportation-related and stationary sources as specified in the California Office of Noise Control Land Use Compatibility Guidelines.

Noise Ordinance

Alameda County's noise ordinance (County General Code, Chapter 6.60) allows higher noise exposure levels for commercial properties than for residential uses, schools, hospitals, churches, or libraries. These standards augment the state-mandated requirements of the Alameda County Building Code, which establishes standards for interior noise levels consistent with the noise insulation standards in the California State Building Code. Table 3.11-3 shows the number of cumulative minutes that a particular external noise level is permitted, as well as the maximum noise allowed under the Alameda County General Code.

Table 3.11-3. Alameda County Exterior Noise Standards

Cumulative Number of Minutes in Any 1-Hour Time Period Daytime	Daytime (7 a.m. to 10 p.m.)	Nighttime (10 p.m. to 7 a.m.)
Residential uses, schools, hospitals, churches, and libraries		
30	50 dBA	45 dBA
15	55 dBA	50 dBA
5	60 dBA	55 dBA
1	65 dBA	60 dBA
Maximum	70 dBA	65 dBA
Commercial uses		
30	65 dBA	60 dBA
15	70 dBA	65 dBA
5	75 dBA	70 dBA
1	80 dBA	75 dBA
Maximum	85 dBA	80 dBA

Source: Alameda County General Code, Chapter 6.60.

The County Zoning Ordinance (County General Code, Chapter 17) restricts noise from commercial activities by prohibiting any use that would generate a noise or vibration that is discernible without instruments beyond the property line. This performance standard does not apply to transportation activities or temporary construction work.

The provisions of the ordinance do not apply to noise sources associated with construction, provided the activities do not take place before 7 a.m. or after 7 p.m. on any day except Saturday or Sunday, or before 8 a.m. or after 5 p.m. on Saturday or Sunday.

Conditional Use Permits

The County's CUPs for the continued operation of the windfarms after 2005, regulated by Resolution Number R-2005-463, identified the following specific condition regarding noise levels.

> Noise Standards: Wind turbines shall be operated so as to not exceed the County's noise standard of 55 dBA (L_{dn}) or 70 dBC (L_{dn}) as measured in both cases at the exterior of any dwelling unit. If the dwelling unit is on land under lease from the Permittee, the applicable standard shall be 65 dBA (L_{dn}) and 70 dBC (L_{dn}).

The Resolution approving the CUPs for windfarm operations included a finding that as a land use, the wind energy use "is properly related to other land uses and transportation and service facilities in the vicinity, in that… d) Although some residents may object to the visual, noise, or other effects of the turbines, the County has determined that the wind energy projects are in compliance with the conditions of approval and are an acceptable use in the area."

Environmental Setting

Existing Land Uses

The program area is the Alameda County portion of the HCP-revised APWRA. The area is designated as Large Parcel Agriculture under the County Zoning Ordinance and the ECAP. General agriculture, single-family residences, grazing, and riding or hiking trails are allowed uses. Conditional uses that may be allowed through a CUP granted by the County include outdoor recreation facilities, transmission facilities, solid waste landfills, and windfarms. CUPs are developed to be consistent with general plan policies and other land uses permitted by the County's general plan.

Program Area

Scattered single-family rural residences are located within the program boundary, including homes on both very large parcels (more than 100 acres) and comparatively small lots (less than 5 acres). Single-family rural residences are mostly located along the west and northeast sides of the program area. Within the program boundary, several residences along Altamont Pass Road are located as close as about 600 feet from existing turbines. Two residences along Flynn Road are located about 800 feet from existing turbines. Several residences located along Dyer Road are within about 1,100 feet of existing turbines. No other residences are located within 1,500 feet of the existing turbines in the program boundary.

Golden Hill Project Area

Two residences located along Flynn Road are about 800 feet from the nearest turbines within the project boundary. No other residences are located within 1,500 feet of the existing turbines within the project boundary.

Patterson Pass Project Area

The closest residence is located off Patterson Pass Road about 2,200 feet away of the nearest turbines within the project boundary.

Existing Noise Conditions

Traffic on I-580 and wind turbine operations are the predominant sources of noise in the program area. Based on traffic noise projections for 2010, the 60 L_{dn} contour for traffic traveling on I-580 extends about 1,800 feet from the freeway (Alameda County 2000).

The following is a summary of ambient noise measurements conducted at seven positions in the Altamont Pass area on May 17, 2013 (ICF International 2013). These measurements are generally representative of noise levels in the program area where first generation wind turbines are currently operating.

- Position M1. Altamont Pass Road 1.2 miles west of West Grant Line Road. 300 feet from the nearest operating turbine.

- Position M2. Altamont Pass Road 1.1 miles west of West Grant Line Road. 380 feet from the nearest operating turbine.
- Position M3. Altamont Pass Road 0.7 miles west of West Grant Line Road. 750 feet from the nearest operating turbine.
- Position M4. Mountain House Road. 1.4 miles north of West Grant Line Road. 590 feet from the nearest operating turbine.
- Position M5. Mountain House Road. 500 feet north of West Grant Line Road. 1,200 feet from the nearest operating turbine.
- Position M6. North Midway Road. 0.9 miles south of I-205. 315 feet from the nearest operating turbine.
- Position M7. North Midway Road. 0.6 miles south of I-205. 1,710 feet from the nearest operating turbine.

Table 3.11-4. Summary of Noise Measurements in the APWRA

Position	Start Time	Duration	L_{eq}	L_{max}	L_{min}	L_{10}	L_{33}	L_{50}	L_{90}
M1	10:17 a.m.	5 min	58.4	67.9	54.7	60.4	58.3	57.5	55.9
M2	10:38 a.m.	5 min	56.1	62.6	53.6	57.6	56.0	55.5	54.3
M3	10:38 a.m.	5 min	53.3	67.2	49.1	54.5	62.9	52.3	50.5
M4	11:24 a.m.	5 min	56.7	73.6	51.2	57.4	56.1	55.6	53.8
M5	11:43 a.m.	5 min	47.0	60.3	40.8	50.0	46.6	45.6	43.1
M6	12:18 p.m.	5 min	50.0	55.0	44.6	52.1	50.5	49.6	47.1
M7	12:36 p.m.	5 min	56.8	65.4	50.9	59.1	56.9	55.6	52.6

Although sound from existing operating turbines is audible adjacent to them, there is no documented evidence that noise standards of the existing CUPs, as defined above in the *Conditional Use Permits* section, have been exceeded.

3.11.2 Environmental Impacts

This section describes the impact analysis relating to noise for the proposed program and the Golden Hills and Patterson Pass projects. It describes the methods used to determine the impacts of the program and projects and lists the thresholds used to conclude whether an impact would be significant. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany the impact discussion.

Methods for Analysis

Wind Turbine Noise

The proposed program would replace the existing turbines (first- and second-generation turbines) with fewer and larger current-generation turbines. Section 2.3 of this Program EIR, *Wind Turbine Technology*, provides a description and comparison of existing and proposed turbines. The specific types or sound data of current generation wind turbines to be used in the program area are not known and, therefore, the levels of noise produced by the installation of new turbines cannot be specifically determined. However, noise produced by current generation turbines such as the REpower MM 92 turbine and the Vestas V90 turbine are known to produce a sound level of about 44 dBA at 1,000 feet (Solano County 2011). Continuous operation over a 24-hour period would result in about 50 dBA (L_{dn}) at 1,000 feet. At any given receptor location, the received noise level from turbine operation could be potentially influenced by several turbines, depending on the geometric relationship between the turbines and the receptor. Table 3.11-5 provides an indication of potential received noise levels expressed in dBA (L_{dn}) based on the distance to a receiver and the number of turbines influencing noise received at the receptor. The table also highlights (using shading) the distances within which the County standard of 55 dBA (L_{dn}) would be exceeded. Under the assumption that up to 10 turbines could affect the received noise level at a receptor, the results in Table 3.11-5 indicate that the County noise standard of 55 dBA (L_{dn}) could be exceeded within about 1,750 feet of a receptor.

Table 3.11-5. Turbine Noise Level, dBA (L_{dn}), as a Function of Distance and Number of Turbines

	Number of Turbines Influencing the Received Noise Level						
Distance (feet)	1	2	3	4	5	7	10
500	56	59	61	62	63	64	66
550	55	58	60	61	62	63	65
750	52	55	57	58	59	60	62
1,000	50	53	55	56	57	58	60
1,150	49	52	54	55	56	57	59
1,250	48	51	53	54	55	56	58
1,400	47	50	52	53	54	55	57
1,500	46	49	51	52	53	54	56
1,750	45	48	50	51	52	53	55
2,000	44	47	49	50	51	52	54
2,500	42	45	47	48	49	50	52
3,000	40	43	45	46	47	48	50

Note: Based on simple geometric attenuation of 6 dB per doubling of distance.

C-weighted sound levels provide a measure of low frequency sound energy associated with operation of a wind turbine. C-weighted sound levels for the REpower MM 92 turbine and the Vestas V90 are about 10 dB higher than A-weighted sound levels. The C-weighted county standard for wind turbines is 70 dBC (L_{dn}).

Table 3.11-6 provides an indication of potential received noise levels expressed in dBC (L_{dn}) based on the distance to a receiver and the number of turbines influencing noise received at the receptor. The table also highlights distances within which the County standard of 70 dBC (L_{dn}) would be exceeded. Under the assumption that up to 10 turbines could affect the received noise level at a receptor, the results in Table 3.11-6 indicate that the County noise standard of 70 dBC(L_{dn}) could be exceeded within about 1,000 feet of a receptor.

Table 3.11-6. Turbine Noise Level, dBC (L_{dn}), as a Function of Distance and Number of Turbines

	Number of Turbines Influencing the Received Noise Level						
Distance (feet)	1	2	3	4	5	7	10
500	66	69	71	72	73	74	76
550	65	68	70	71	72	73	75
650	64	67	69	70	71	72	74
700	63	66	68	69	70	71	73
800	62	65	67	68	69	70	72
1,000	60	63	65	66	67	68	70
2,500	52	55	57	58	59	60	62
3,000	50	53	55	56	57	58	60

Construction Noise

Construction activities would involve the use of heavy equipment. To assess noise impacts associated with these activities, construction equipment is identified and noise is evaluated using methods recommended by the Federal Highway Administration (Federal Highway Administration 2006). Noise impacts associated with increased construction traffic is evaluated using methods for the FHWA traffic noise model (TNM).

The County uses a noise standard for wind turbines in the program area of 55 dBA (L_{dn}) or 70 dBC (L_{dn}) at dwelling units, with the exception that dwelling units on the same parcel being leased for windfarm use may be exposed to up to 65 dBA (L_{dn}). Noise impacts associated with the proposed program are evaluated based on how the project would change the daily noise level associated with wind turbine operations. The threshold of 5 dB is used because it is generally considered to be the lowest sound level change clearly noticeable by the human ear.

Determination of Significance

In accordance with Appendix G of the State CEQA Guidelines and the County conditions of approval for the existing turbine operations, program Alternative 1, program Alternative 2, the Golden Hills project, or the Patterson Pass project would be considered to have a significant effect if it would result in any of the conditions listed below.

- Exposure of residences to noise from new wind turbines in excess of 55 dBA (L_{dn}) where wind turbine noise is currently less than 55 dBA (L_{dn}). In the situation where the dwelling unit is on the same parcel being leased for windfarm, 65 dBA (L_{dn}) is used as the threshold.
- Exposure of residences to noise from new wind turbines in excess of 70 dBC (L_{dn}) where wind turbine noise is currently less than 70 dBC (L_{dn}).
- Exposure of residences to a daily noise increase in L_{dn} value of more than 5 dB from the addition of new wind turbines where the existing noise level is in excess of 55 dBA (L_{dn}). In the situation where the dwelling unit is on the same parcel being leased for windfarm, 65 dBA (L_{dn}) is used as the threshold.

- Exposure of residences to equipment noise associated with construction activities that exceed Alameda County noise ordinance standards (Table 3.11-3) during nonexempt hours (7 p.m. to 7 a.m. on weekdays and 5 p.m. to 8 a.m. on Saturday and Sunday).

Impacts and Mitigation Measures

Impact NOI-1a-1: Exposure of residences to noise from new wind turbines—program Alternative 1: 417 MW (less than significant with mitigation)

Program Alternative 1 would replace the existing turbines (first- and second-generation turbines) with fewer and larger current-generation turbines. The location and types of turbines to be used would be determined as projects are proposed. Section 2.5.2 discusses County siting requirements and technical siting requirements for the proposed turbines; updated setback requirements are presented in Table 2-2.

As discussed above, there are no documented instances of wind turbines causing exceedance of noise standards in the existing CUPs. In addition, current-generation turbines expected to be installed through the repowering program have several characteristics that reduce aerodynamic sound levels. The modern turbines typically are *upwind* turbines, meaning each turbine faces into the wind, so the wind encounters the rotor blades before the tower and nacelle, making for quieter operations than a downwind turbine. Additionally, the modern turbines have relatively low rotational speeds and pitch control on the rotors, both of which reduce sound levels.

The noise prediction results in Table 3.11-5, however, indicate that residences located within about 1,500 feet of a group of turbines could be exposed to noise that exceeds 55 dBA (L_{dn}). The noise prediction results in Table 3.11-6 also indicates that residences located within about 800 feet of a group of turbines could be exposed to noise that exceeds 70 dBC (L_{dn}). Because of the possibility that implementation of program Alternative 1 could result in daily L_{dn} values caused by wind turbines to increase by more than 5 dB at locations where noise currently exceeds 55 dBA (L_{dn}), expose residences to noise in excess of 55 dBA (L_{dn}) where noise is currently less than 55 dBA (L_{dn}), or expose residence to noise in excess of 70 dBC (L_{dn}) this impact is considered to be significant. Implementation of Mitigation Measure NOI-1 would reduce this impact to a less-than-significant level.

Mitigation Measure NOI-1: Perform project-specific noise studies and implement measures to comply with County noise standards

The applicant for any proposed repowering project will retain a qualified acoustic consultant to prepare a report that evaluates noise impacts associated with operation of the proposed wind turbines. This evaluation will include a noise monitoring survey to quantify existing noise conditions at noise sensitive receptors located within 2,000 feet of any proposed turbine location. This survey will include measurement of the daily A-weighted and C-weighed L_{dn} values over a 1-week period and concurrent logging of wind speeds at the nearest meteorological station. The study will include a site-specific evaluation of predicted operational noise levels at nearby noise sensitive uses. If operation of the project is predicted to result in noise in excess of 55 dBA (L_{dn}) where noise is currently less than 55 dBA (L_{dn}), result in a 5 dB increase where noise is currently greater than 55 dBA(L_{dn}), or result in noise that exceeds 70 dBC (L_{dn}), the applicant will modify the project, including selecting new specific installation sites within the program area, to ensure that these performance standards will not be exceeded.

Methods that can be used to ensure compliance with these performance standards include increasing the distance between proposed turbines and noise sensitive uses and the use of alternative turbine operational modes to reduce noise. Upon completion of the evaluation, the project applicant will submit a report to the County demonstrating how the project will comply with these performance standards. After review and approval of the report by County staff, the applicant will incorporate measures as necessary into the project to ensure compliance with these performance standards.

Impact NOI-1a-2: Exposure of residences to noise from new wind turbines—program Alternative 2: 450 MW (less than significant with mitigation)

Program Alternative 2 would replace the existing turbines (first- and second-generation turbines) with fewer and larger current-generation turbines. The location and types of turbines to be used would be determined as projects are proposed. Section 2.5.2 discusses County siting requirements and technical siting requirements for the proposed turbines; updated setback requirements are presented in Table 2-2.

As discussed above, there are no documented instances of wind turbines causing exceedance of noise standards in the existing CUPs. In addition, current-generation turbines expected to be installed through the repowering program have several characteristics that reduce aerodynamic sound levels. The modern turbines typically are *upwind* turbines, meaning each turbine faces into the wind, so the wind encounters the rotor blades before the tower and nacelle, making for quieter operations than a downwind turbine. Additionally, the modern turbines have relatively low rotational speeds and pitch control on the rotors, both of which reduce sound levels.

The noise prediction results in Table 3.11-5, however, indicate that residences located within about 1,500 feet of a group of turbines could be exposed to noise that exceeds 55 dBA (L_{dn}). The noise prediction results in Table 3.11-6 also indicates that residences located within about 800 feet of a group of turbines could be exposed to noise that exceeds 70 dBC (L_{dn}). Because of the possibility that implementation of program Alternative 2 could result in daily L_{dn} values caused by wind turbines to increase by more than 5 dB at locations where noise currently exceeds 55 dBA (L_{dn}), expose residences to noise in excess of 55 dBA (L_{dn}) where noise is currently less than 55 dBA (L_{dn}), or expose residence to noise in excess of 70 dBC (L_{dn}) this impact is considered to be significant. Implementation of Mitigation Measure NOI-1 would reduce this impact to a less-than-significant level.

Mitigation Measure NOI-1: Perform project-specific noise studies and implement measures to comply with County noise standards

Impact NOI-1b: Exposure of residences to noise from new wind turbines—Golden Hills Project (less than significant with mitigation)

The project would remove the majority of the existing turbines (about 734 turbines) in the project area and install 27 to 48 larger, current-generation turbines. The specific sound data for turbines to be used in the project area are not known. Figure 2-15 shows the layout of proposed turbines in the project area. The new turbines would be installed farther from existing residences than the existing turbines. Two residences located along Flynn Road that are about 800 feet from the existing turbines would be about 1,300 to 1,800 feet from proposed turbines.

As discussed under Impact NOI-1a, there are no documented instances of wind turbines causing exceedance of noise standards in the existing CUPs. In addition, proposed modern turbines have several characteristics that reduce aerodynamic sound levels and make for quieter operations than the existing turbines. The modern turbines have relatively low rotational speeds and pitch control on the rotors, both of which reduce sound levels.

The noise prediction results in Table 3.11-5 however, indicate that residences located within about 1,500 feet of a group of turbines could be exposed to noise that exceeds 55 dBA (L_{dn}) or increases in noise greater than 5 dB. The noise prediction results in Table 3.11-6 also indicate that residences located within about 800 feet of a group of turbines could be exposed to noise that exceeds 70 dBC (L_{dn}). No new turbines are anticipated to be located within 1,000 feet of existing residences. Because of the possibility that daily L_{dn} value caused by wind turbines could increase by more than 5 dB at locations where noise currently exceeds 55 dBA (L_{dn}), expose residences to noise in excess of 55 dBA (L_{dn}) where noise is currently less than 55 dBA (L_{dn}), or expose residences to noise in excess of 70 dBC (L_{dn}) this impact is considered to be significant. Implementation of Mitigation Measure NOI-1, as discussed under Impact NOI-1a, would reduce this impact to a less-than-significant level.

Mitigation Measure NOI-1: Perform project-specific noise studies and implement measures to comply with County noise standards

Impact NOI-1c: Exposure of residences to noise from new wind turbines—Patterson Pass Project (less than significant)

Implementation of the project would remove the existing turbines (about 317 turbines) in the project area and install 8 to 12 larger, current-generation turbines. Figure 2-17 shows the layout of proposed turbines in the project area. The specific type of turbine to be used and turbine-specific noise levels have not yet been determined. The new turbines would be installed farther away from the existing residence. One residence located off Patterson Pass Road is currently located about 2,200 feet from the existing turbines and would be located about 3,300 feet from the nearest proposed new turbines.

As discussed under Impact NOI-1a, there are no documented instances of wind turbines causing exceedance of noise standards in the existing CUPs. In addition, proposed modern turbines have several characteristics that reduce aerodynamic sound levels and make for quieter operations than the existing turbines. The modern turbines have relatively low rotational speeds and pitch control on the rotors, both of which reduce sound levels.

The noise prediction results in Table 3.11-5 indicate that residences located within about 1,750 feet of a group of turbines could be exposed to noise that exceeds 55 dBA (L_{dn}) or increases in noise greater than 5 dB. The noise prediction results in Table 3.11-6 also indicate that residences located within about 1,000 feet of a group of turbines could be exposed to noise that exceeds 70 dBC (L_{dn}). Because the nearest residence would be more than 3,000 feet from the new turbines, operation of the new turbines is not expected to result in noise that exceeds 55 dBA(L_{dn}), 70 dBC(L_{dn}) or result in a 5 dBA increase in noise at residences. The operational noise impact is considered to be less than significant. No mitigation is required.

Impact NOI-2a-1: Exposure of residences to noise during decommissioning and new turbine construction—program Alternative 1: 417 MW (less than significant with mitigation)

Construction Equipment Noise

Program Alternative 1 would generally involve the following construction phases.

- Phase 1—Decommissioning of existing wind turbines and foundation removal
- Phase 2—Construction of laydown areas, substations and switch yards
- Phase 3—Road construction
- Phase 4—Construction of wind turbine generator (WTG) foundations and batch plant
- Phase 5—WTG delivery and installation
- Phase 6—Utility collector line installation
- Phase 7—Cleanup and restoration

Table 3.11-7 lists the construction equipment that is expected to be used for each construction phase, based on the assumptions provided in Appendix D.

Table 3.11-7. Construction Phases and Equipment

Construction Phase	Equipment
1—Decommissioning and foundation removal	Crane, truck and lowboy trailer, excavator, grader, dump truck
2—Laydown areas, substations and switch yards construction	Road grader, track type dozer, drum type compactor, water truck, truck and lowboy trailer, backhoe/front loader
3—Road construction	Road grader, track type dozer, drum type compactor, water truck, truck and lowboy trailer, backhoe/front loader, excavator, rock crusher
4—WTG foundations and batch plant	Road grader, track type dozer, drum type compactor, water truck, truck and lowboy trailer, backhoe/front loader, excavator, rock crusher, cement truck
5—WTG delivery and installation	Crane, truck and lowboy trailer, excavator
6—Utility collector line installation	Water truck, backhoe/front loader, trencher, horizontal directional drilling (HDD) bore machine
7—Cleanup and restoration	Road grader, excavator

Source: Appendix D.

Table 3.11-8 summarizes typical noise levels produced by anticipated construction equipment (Federal Highway Administration 2006). L_{max} sound levels at 50 feet are shown along with the typical acoustical use factors. The acoustical use factor is the percentage of time each piece of construction equipment is assumed to be operating at full power (i.e., its noisiest condition) during construction operation and is used to estimate L_{eq} values from L_{max} values. For example, the L_{eq} value for a piece of equipment that operates at full power 50% of the time (acoustical use factor of 50) is 3 dB less than the L_{max} value.

Table 3.11-8. Typical Construction Equipment Noise Levels

Equipment Type	Typical L_{max} Noise Level at 50 Feet from Source (dBA)	Acoustical Use Factor (%)	L_{eq} Noise Level at 50 Feet from Source (dBA)
Cement truck	79	40	75
Compactor	83	20	76
Crane	81	16	73
Dozer	82	40	78
Dump truck	76	40	72
Excavator	81	40	77
Flat-bed truck	74	40	70
Front-end loader	79	40	75
Grader	85	40	81
HDD bore machine	82	25	76
Rock crusher	85	50	82
Trencher	80	50	77
Water truck	76	40	72

Source: Federal Highway Administration 2006.

Table 3.11-9 summarizes the combined noise level of equipment associated with each construction phase.

Table 3.11-9. Combined Noise Level by Construction Phase

Construction Phase	L_{max} Noise Level at 50 Feet from Source (dBA)	L_{eq} Noise Level at 50 Feet from Source (dBA)
1—Decommissioning and foundation removal	88	83
2—Laydown areas, substations and switch yards construction	89	85
3—Road construction	91	87
4—WTG foundations and batch plant	95	86
5—WTG delivery and installation	84	79
6—Utility collector line installation	86	81
7—Cleanup and restoration	86	82

Based on geometric attenuation of 6 dB per doubling of distance and additional attenuation resulting from ground absorption and atmospheric effects, potential construction noise levels at various distances for each construction phase have been calculated relative to the Alameda County noise ordinance standards. Table 3.11-10 summarizes the results of this analysis and identifies distances within which Alameda County noise standards could be exceeded as a result of the construction activities. The calculations of construction equipment noise levels are included in Appendix D.

Table 3.11-10. Construction Noise Analysis

Construction Phase	Daytime Hours (7 a.m. to 10 p.m.)		Nighttime Hours (10 p.m. to 7 a.m.)	
	Distance (feet) to 70 dBA L_{max}	Distance (feet) to 50 dBA L_{eq}	Distance (feet) to 65 dBA L_{max}	Distance (feet) to 45 dBA L_{eq}
1—Decommissioning and foundation removal	235	820	345	1,105
2—Laydown areas, substations and switch yards construction	260	910	385	1,225
3—Road construction	290	1,130	460	1,520
4—WTG foundations and batch plant	435	1,035	625	1,390
5—WTG delivery and installation	170	545	270	865
6—Utility collector line installation	190	675	285	1,075
7—Cleanup and restoration	205	750	300	1,190

In a number of instances, there are residences located 600 to 800 feet of where turbine construction activities could occur. The results in Table 3.11-10 indicate that construction activities could result in noise that exceeds Alameda County noise ordinance standards during nonexempt hours. Therefore, the exposure of residences to construction equipment noise is considered to be a significant impact. Implementation of Mitigation Measure NOI-2 would reduce this impact to a less-than-significant level.

Mitigation Measure NOI-2: Employ noise-reducing practices during decommissioning and new turbine construction

Project applicants will employ noise-reducing construction practices so that construction noise does not exceed Alameda County noise ordinance standards. Measures to limit noise may include the following:

- Prohibit noise-generating activities before 7 a.m. and after 7 p.m. on any day except Saturday or Sunday, and before 8 a.m. and after 5 p.m. on Saturday or Sunday.
- Locate equipment as far as practical from noise sensitive uses.
- Require that all construction equipment powered by gasoline or diesel engines have sound-control devices that are at least as effective as those originally provided by the manufacturer and that all equipment be operated and maintained to minimize noise generation.
- Use noise-reducing enclosures around noise-generating equipment where practicable.
- Implement other measures with demonstrated practicability in reducing equipment noise upon prior approval by the County.

In no case will the applicant be allowed to use gasoline or diesel engines without muffled exhausts.

Construction Traffic Noise

Based on the analysis for Vasco Wind Repowering Project (Contra Costa County 2010), which is in the program vicinity, and data provided by the project applicants, a typical 80 MW repowering project in the program area is anticipated to generate an average of 420 vehicle trips per day (300 truck trips and 120 worker trips) through the course of the construction period. The construction traffic noise impact is evaluated using the recent traffic volumes collated on Patterson Pass Road, which is considered as a typical major county road that would be used for construction crews to access the project area. The traffic volumes along Patterson Pass Road are about 2,700 to 3,700 vehicles per day (Alameda County 2013). The construction traffic increase would increase traffic noise by less than 2 dB, which would not be a noticeable increase at nearby residential uses along the major county roads. Therefore, the traffic noise impact during construction is considered to be less than significant.

Impact NOI-2a-2: Exposure of residences to noise during decommissioning and new turbine construction—program Alternative 2: 450 MW (less than significant with mitigation)

Construction Equipment Noise

Program Alternative 2 would generally involve the following construction phases.

- Phase 1—Decommissioning of existing wind turbines and foundation removal
- Phase 2—Construction of laydown areas, substations and switch yards
- Phase 3—Road construction
- Phase 4—Construction of wind turbine generator (WTG) foundations and batch plant
- Phase 5—WTG delivery and installation
- Phase 6—Utility collector line installation
- Phase 7—Cleanup and restoration

Table 3.11-7 lists the c equipment that is expected to be used for each construction phase, based on the assumptions provided in Appendix D.

Table 3.11-8 summarizes typical noise levels produced by anticipated construction equipment (Federal Highway Administration 2006). L_{max} sound levels at 50 feet are shown along with the typical acoustical use factors. The acoustical use factor is the percentage of time each piece of construction equipment is assumed to be operating at full power (i.e., its noisiest condition) during construction operation and is used to estimate L_{eq} values from L_{max} values. For example, the L_{eq} value for a piece of equipment that operates at full power 50% of the time (acoustical use factor of 50) is 3 dB less than the L_{max} value.

Table 3.11-9 summarizes the combined noise level of equipment associated with each construction phase.

Based on geometric attenuation of 6 dB per doubling of distance and additional attenuation resulting from ground absorption and atmospheric effects, potential construction noise levels at various distances for each construction phase have been calculated relative to the Alameda County noise ordinance standards. Table 3.11-10 summarizes the results of this analysis and identifies distances within which Alameda County noise standards could be exceeded as a result of the construction activities. The calculations of construction equipment noise levels are included in Appendix D.

In a number of instances, there are residences located 600 to 800 feet of where turbine construction activities could occur. The results in Table 3.11-10 indicate that construction activities could result in noise that exceeds Alameda County noise ordinance standards during nonexempt hours. Therefore, the exposure of residences to construction equipment noise is considered to be a significant impact. Implementation of Mitigation Measure NOI-2 would reduce this impact to a less-than-significant level.

Mitigation Measure NOI-2: Employ noise-reducing practices during decommissioning and new turbine construction

Construction Traffic Noise

Based on the analysis for Vasco Wind Repowering Project (Contra Costa County 2010), which is in the program vicinity, and data provided by the project applicants, a typical 80 MW repowering project in the program area is anticipated to generate an average of 420 vehicle trips per day (300 truck trips and 120 worker trips) through the course of the construction period. The construction traffic noise impact is evaluated using the recent traffic volumes collated on Patterson Pass Road, which is considered as a typical major county road that would be used for construction crews to access the project area. The traffic volumes along Patterson Pass Road are about 2,700 to 3,700 vehicles per day (Alameda County 2013). The construction traffic increase would increase traffic noise by less than 2 dB, which would not be a noticeable increase at nearby residential uses along the major county roads. Therefore, the traffic noise impact during construction is considered to be less than significant.

Impact NOI-2b: Exposure of residences to noise during decommissioning and new turbine construction—Golden Hills Project (less than significant with mitigation)

Construction noise levels associated with anticipated construction phases and equipment for repowering projects are discussed under Impact NOI-2a and summarized in Tables 3.11-7 and 3.11-9. Table 3.11-10 summarizes the distances within which Alameda County noise standards could be exceeded as a result of the construction activities.

In a number of instances, there are residences located within 800 feet of where turbine removal and restoration activities could occur. The results in Table 3.11-10 indicate that these activities could result in noise that exceeds Alameda County noise ordinance standards during nonexempt hours. This impact is therefore considered to be significant. Implementation of Mitigation Measure NOI-2 would reduce this impact to a less-than-significant level.

Mitigation Measure NOI-2: Employ noise-reducing practices during decommissioning and new turbine construction

As discussed under Impact NOI-2a-1 and NOI-2a-2, the construction traffic increase would increase traffic noise by less than 2 dB, which would not be a noticeable increase at nearby residential uses along the major county roads. Therefore, the impact of construction traffic noise is considered to be less than significant.

Impact NOI-2c: Exposure of residences to noise during decommissioning and new turbine construction—Patterson Pass Project (less than significant)

Construction noise levels associated with anticipated construction phases and equipment for repowering projects are discussed under Impact NOI-2a and summarized in Tables 3.11-7 and 3.11-9. Table 3.11-10 summarizes the distances within which Alameda County noise standards could be exceeded as a result of the construction activities.

Because the closest residence is located about 2,200 feet from the nearest turbines, which is beyond the impact distances identified in Table 3.11-10, the construction noise impact on residences is considered to be less than significant. No mitigation is required.

As discussed under Impact NOI-2a-1 and NOI-2a-2, the construction traffic increase would increase traffic noise by less than 2 dB, which would not be a noticeable increase at nearby residential uses along the major county roads. Therefore, the impact of construction traffic noise is considered to be less than significant.

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