

Friant-Kern Canal Pump-Back Project Environmental Impact Report

Appendix G1: Noise and Vibration Supporting Information

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Appendix G1 Noise and Vibration Supporting Information

This appendix presents a framework for understanding noise and vibration levels. In addition, this appendix provides a detailed description of existing noise and vibration levels and sensitive receptors with the potential to be affected by the proposed project, Low Flow Alternative, and Seasonal Alternative.

G1.1 Noise and Vibration Terminology

G1.1.1 Noise

Noise can be generally defined as unwanted sound. Sound, traveling in the form of waves from a source, 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 (referred to as sound level) is the most common descriptor used to characterize the loudness of an ambient sound level. It is measured in decibels (dB), with 0 dB corresponding roughly to the threshold of human hearing and 120–140 dB corresponding to the threshold of pain.

Sound pressure fluctuations can be measured in units of hertz (Hz), which correspond to the frequency of a particular sound. Typically, sound does not consist of a single frequency but rather a broad band of frequencies varying in levels of magnitude (sound power). The sound pressure level therefore constitutes the additive force exerted by a sound corresponding to the frequency/sound power level spectrum. The typical human ear is not equally sensitive to all frequencies of the audible sound spectrum. Consequently, when assessing potential noise impacts, sound is measured using an electronic filter that deemphasizes the frequencies below 1,000 Hz and above 5,000 Hz in a manner corresponding to the human ear's decreased sensitivity to low and extremely high frequencies and greater sensitivity to mid-range frequencies. This method of frequency weighting is referred to as A-weighting and is expressed in units of A-weighted dB (dBA). Frequency A-weighting follows an international standard methodology of frequency de-emphasis and is typically applied to community noise measurements. Some representative noise sources and their corresponding A-weighted noise levels are shown in Table G1-1.

Table G1-1. Typical Noise Levels

	Noise Level (dBA)
Common Outdoor Activities	
Jet flyover at 1,000 feet	105
Gas lawnmower at 3 feet	95
Diesel truck at 50 feet at 50 mph	85
Noise urban area, daytime	75
Gas lawnmower, 100 feet	70
Commercial area	65
Heavy traffic at 300 feet	60
Quiet urban daytime	50
Quiet urban nighttime	40
Quiet suburban nighttime	35
Quiet rural nighttime	25
Common Indoor Activities	
Rock band	110
Food blender at 3 feet	85
Garbage disposal at 3 feet	80
Vacuum cleaner at 10 feet	70
Normal speech at 3 feet	65
Large business office	55
Dishwasher in next room	50
Theater, large conference room (background)	40
Library	30
Bedroom at night, concert hall (background)	25
Broadcast/recording studio	15

Source: California Department of Transportation (Caltrans) 2013.

Key: dBA = A-weighted decibel scale; mph = miles per hour

A key concept in evaluating potential noise impacts is the perceived effect of incremental increase in existing noise levels. Table G1-2 presents the effect of increasing noise levels. For example, the table shows that an increase of 3 dBA is barely perceptible, an increase of 5 dBA is noticeable, and a 10 dBA increase would be perceived by someone to be a doubling of noise.

Table G1-2. Decibel Changes, Loudness, and Energy Loss

Sound Level Change (dBA)	Relative Loudness/ Impact	Acoustical Energy Gain (%)
0	Reference	0
+3	Barely Perceptible Change	50
+5	Noticeable Change	67
+10	Twice as Loud	90
+20	Four Times as Loud	99

Source: Federal Highway Administration (FHWA) 2011.

Key: dBA = A-weighted decibel scale

Noise analyses and regulations use the following terms:

- **L_{eq} : Equivalent energy level** – A-weighted sound level corresponding to a steady-state sound level that contains the same total energy as a varying signal over a given sample period. This is typically computed over 1-, 8-, and 24-hour sample periods.
- **L_{dn} : Day-night average level** – the energy average sound level for a 24-hour day determined after the addition of a 10 dBA penalty to all noise events occurring at night between 10:00 p.m. and 7:00 a.m. This is a useful measure for community noise impact because people in their homes are much more sensitive to noise at night when they are relaxing or sleeping than they are in the daytime.
- **L_{max} : Maximum noise level** – representing the highest sound level measured for a given period.
- **L_{min} : Minimum noise level** – representing the lowest sound level measured for a given period.
- **L_x : Statistical noise descriptor** – the noise level exceeded X% of a specified time period. For example, L_{10} indicates the noise level that is exceeded 10% of the time during a given period.
- **CNEL: Community Noise Equivalent Level** – a 24-hour average L_{eq} that includes the addition of five dBA to sound levels from 7:00 p.m. to 10:00 p.m. and an addition of 10 dBA to sound levels from 10:00 p.m. to 7:00 a.m. The CNEL is commonly used in California instead of the L_{dn} .

Noise effects on humans can range from annoyance to physical discomfort and harm. Sleeping patterns, speech communication, mental acuity, and heart and breathing rates can all be disturbed by noise. Perception of the noise is affected by its pitch, loudness, and character.

Sound levels from isolated point sources of noise typically decrease by about 6 dBA for every doubling of distance from the noise source. When the noise source is a continuous line, such as vehicle traffic on a highway, sound levels decrease by about 3 dBA for every doubling of distance. Noise levels also can be affected by several factors other than the distance from the noise source. Topographic features and structural barriers that absorb, reflect, or scatter sound waves can affect the reduction of noise levels. Atmospheric conditions (wind speed and direction, humidity levels, and temperatures) and the presence of dense vegetation also can affect the degree to which sound is attenuated over distance.

G1.1.2 Vibration

Vibration refers to ground-borne noise and perceptible motion. The most common impacts from ground-borne vibration include annoyance, movement of the building floors, rattling of windows, shaking of items on shelves or hanging on walls, disruption of vibration-sensitive operations or activities, and triggering of landslides. Vibrations caused by construction can be interpreted as energy transmitted in waves through the soil mass. These energy waves generally dissipate with distance from the vibration source due to spreading of the energy and frictional losses. Thus, ground-borne vibrations from most construction activities rarely reach the levels that can damage structures but can achieve the perceptible ranges in buildings close to construction sites (Federal Transit Administration [FTA] 2006).

In extreme cases, vibration can cause damage to buildings or equipment. In most circumstances, common ground-induced vibrations related to roadway traffic and construction activities pose no threat to buildings or structures, with the occasional exception of blasting and sheet pile-driving during construction. To assess the potential for structural damage associated with vibration, the vibratory ground motion near the affected structure is measured in terms of peak particle velocity (PPV) in the vertical and horizontal directions, typically in units of inches per second (in/sec). The PPV is defined as the maximum instantaneous peak of the vibration signal. California Department of Transportation (Caltrans) estimates that frequent generation of vibration at levels exceeding 0.3 in/sec can damage older residential structures and levels exceeding 0.2 in/sec can cause annoyance to humans (Caltrans 2020).

Annoyance from vibration often occurs when the vibration exceeds the threshold of perception. A vibration level that causes annoyance would be well below the damage threshold for normal buildings. Ground-borne vibration generally does not provoke adverse human reaction to those who are outdoors, as the effects associated with the shaking of building are absent.

Construction activities can either result in continuous or single-impact (transient) vibration impacts. Typical equipment or activities that could result in continuous vibration impacts include excavation equipment, traffic, vibratory pile drivers, and vibratory compaction equipment; examples of transient vibration sources include blasting and drop balls. Some construction activities, like jackhammers or impact pile drivers, can continually generate single transient events at a high frequency; however, for evaluation purposes, such equipment would be regarded as having frequent or continuous vibration impacts.

G1.1.2.1 Study Area

The study area for noise includes Lake Woollomes and Shafter-Wasco check structure (Kern County) and Deer Creek check structure (Tulare County) where construction would occur. Figure G1-1 to Figure G1-3 depict the study area and the sensitive receptors for each of the project sites.



Figure G1-1. Nearest Sensitive Receptor to the Shafter-Wasco Site



Figure G1-2. Nearest Sensitive Receptor to the Lake Woollomes Site



Figure G1-3. Nearest Sensitive Receptor to the Deer Creek Site

G1.2 Existing Conditions

Noise sources currently existing in the study area are of three general types: agricultural noise, general stationary noise, and general mobile noise. No major sources of vibration are known to exist in the area of the analysis.

Farm operations produce noise from a variety of sources. These sources include heavy equipment for plowing and harvesting, dairy equipment, crop-spraying aircraft, wind turbines for frost protection, on-site processing equipment, and irrigation water pumps. In addition to affecting the farmers and farm laborers, agricultural noise affects those living in or near agricultural areas.

General stationary noises (i.e., those emanating from fixed locations) are associated with a variety of land uses. Stationary sources include air conditioning units, power tools, motors, generators, appliances, and manufacturing and industrial facilities. Noise-sensitive receptors may have stationary noise sources at their locations.

General mobile noise sources include vehicles, aircraft, and trains. Mobile noise is usually temporary and variable but can be intense and annoying because of its abruptness and intensity. In urban areas, these mobile sources contribute to the ambient noise.

Kern and Tulare Counties vary from rural to urban environments and includes farming, industrial, residential, and commercial noise sources. The sections below describe the prevailing noise conditions (and vibration conditions, if unusual) and noise-and vibration-sensitive receptors in the study area. Overall, no major long-term sources of vibration are known to exist in the study area.

As summarized in Chapter 3, in specific areas of Kern and Tulare Counties, transportation noise is the dominant noise source. These sources include railroads, vehicular traffic, and airports. Shafter Airport, in Kern County, is the nearest airport to the project area and is approximately 1.6 miles southeast of the Shafter-Wasco site. Other areas of Kern and Tulare Counties are dominated by agricultural land uses and are relatively quiet. Freight and passenger trains pass through both counties frequently and constitute a primary source of noise.

Specific noise sources throughout Kern and Tulare Counties include sand and gravel excavation; a biomass electrical generating plant; trucking companies; chicken farms; fruit, nut, and vegetable processing and packaging plants; dog kennels; auto wreckers; winery processing facilities; dairies; recreational boating; and an auto racetrack.

G1.2.1 Kern County

Noise contours were developed in 1995 for highways in Kern County and summarized within the *Kern County General Plan (Appendix G)*. Two highways, State Routes (SR) 99 and 43, are adjacent to the Shafter-Wasco proposed construction area. SR 99, 65, and 155 are adjacent to the Lake Woollomes proposed construction area within Kern County. Noise contour analysis results for the available highways are summarized below in Table G1-3.

Table G1-3. Highway Noise Contour Estimates- Kern County Project Vicinity

Segment	Post Miles	Dist. To Ldn= 65 dB (feet)	Dist. To Ldn= 60 dB (feet)	Dist. To Ldn= 55 dB (feet)	Reference	Post Mile
Shafter-Wasco						
State Route 46 @ State Route 43	1 mi. either direction	80	190	400	Intersection (Wasco)	5.122
State Route 46 @ State Route 99	1 mi. either direction	60	125	300	Intersection (Famoso)	57.79
Lake Woollomes						
State Route 155@ State Route 99	0.00-1.00	50	50	110	Intersection	0

Source: Kern County 1995.

Key: Ldn=Day Night Average Sound Level; mi= miles

G1.2.2 Tulare County

Noise contours were developed in 2010 for highways in Tulare County and summarized within the *Tulare County General Plan Environmental Impact Report (Appendix F)*. Three highways, SR 65, 99, and 190, are adjacent to the Deer Creek proposed construction area within Tulare County. Noise contour analysis results for the highways are summarized below in Table G1-4.

Table G1-4. Highway Noise Contour Estimates- Tulare County Project Vicinity

Segment	Ldn at 100 feet from Roadway Centerline
Deer Creek	
State Route 65 from Porterville S. Limits – Avenue 96	66.7
State Route 99 from State Route 190 – Kern County Line	72.4
State Route 190 from State Route 99 – State Route 65	63.3

Source: Tulare County 2010.

Key: Ldn=Day Night Average Sound Level; mi= miles

G1.2.3 Noise Sensitive Receptors

Generally, any place where quiet is an essential element of a land use's intended purpose would qualify as a noise-sensitive receptor, such as concert pavilions and historic monuments with significant outdoor use. Places where people normally sleep, like residences, hotels, and hospitals, qualify as noise-sensitive receptors. For these types of receptors, nighttime sensitivity to noise must be considered. Various institutional land uses where excessive noise could interfere with speech, meditation, and concentration also qualify as noise sensitive receptors. These land uses include schools, libraries, theaters, churches, cemeteries, monuments, and museums. Parks may also be considered noise-sensitive receptors, but this classification is also dependent on their use. For example, a park used primarily for active recreation would not be considered a noise-sensitive receptor (FTA 2006).

For the proposed project, Low Flow Alternative, and Seasonal Alternative, the closest sensitive receptors to each construction area are identified below in Table G1-5:

Table G1-5. Sensitive Receptors Nearest Each Construction Area

Sensitive Receptors	Distance from Center of Construction (feet)
Shafter-Wasco	
Residence on Fresno Avenue	8,110
Lake Woollomes	
Residence on Pond Road	2,800
Deer Creek	
Residence on Road 208	1,220

G1.3 Assessment Methods

This section describes the approach and methods used to analyze the noise and vibration impacts related to construction and operation of the proposed project, Low Flow Alternative, and Seasonal Alternative. The focus of this analysis is on potential temporary construction and long-term impacts to local noise-sensitive receptor sites located near the study area. Off-site vehicle trip assumptions are consistent with those used in Section 4.16, Traffic and Transportation, and construction and operational activities are consistent with those used in Section 4.3, Air Quality.

Activities with the potential for generating short-term, temporary increases in noise levels include construction activities and construction-related traffic. Operation of upgraded and new facilities have the potential for long-term noise impacts.

The noise level at nearby sensitive receptors during the construction of each alternative was calculated by (1) attenuating the construction sound level for distance to the receptor and (2) logarithmically adding the attenuated construction noise source level to the ambient noise level. Construction noise was predicted using the equations and guiding principles from the FHWA Roadway Construction Noise Model (RCNM). The RCNM database provides maximum noise levels for various pieces of construction equipment at a reference distance of 50 feet. The types of construction equipment that could be used during the construction of each alternative, the percentage of time that the equipment would operate at full power (usage factor) during an hour, and each piece's maximum noise level are presented in Table G1-6. The construction equipment for the proposed project is anticipated to operate 8-10 hours per day, five to six days per week, 5 to 6 months per site (work at each site may happen concurrently) beginning 2023. Nighttime construction could occur in the event of an unforeseen need to refill the Friant-Kern Canal (FKC) or in order to complete work on critical path items.

Table G1-6. Construction Equipment Types and Noise Levels

Equipment Type	Usage Factor	L _{max} at 50 Feet
All Other Equipment Greater than 5 hp	50%	85
Auger Drill Rig	20%	84
Compactor (ground)	20%	83
Concrete Mixer Truck	40%	79
Concrete Pump Truck	20%	81
Concrete Saw	20%	90
Crane	16%	81
Dozer	40%	82
Drill Rig Truck	20%	79
Dump Truck	40%	76
Excavator	40%	81
Flat Bed Truck	40%	74
Front End Loader	40%	79
Generator	50%	81
Grader	40%	85
Roller	20%	80
Scraper	40%	84
Slurry Trenching Machine	50%	80

Source: FTA 2006.

Key: hp = horsepower; L_{max} = maximum noise level measured during a monitoring period

G1.4 Noise and Vibration Calculation Summary Tables

The noise calculations shown below present impacts for the proposed project, Low Flow Alternative, and Seasonal Alternative. The construction equipment type and quantity would be the same for the proposed project and Low Flow Alternative. In addition, the quantity of pumps at each site would be the same for the proposed project and Low Flow Alternative. As such, the noise calculations for the proposed project and Low Flow Alternative are presented together in Section G1.4.1. Due to differing construction details under the Seasonal Alternative, including no pump-back structure being constructed/operated at Deer Creek, the noise calculations for this alternative are presented separately in Section G1.4.2.

G1.4.1 Proposed Project and Low Flow Alternative

Table G1-7 summarizes the daytime and nighttime unmitigated L_{eq} that would occur at the nearest sensitive receptor from each construction area under the proposed project and Low Flow Alternative. Construction actions associated with the proposed project and Low Flow Alternative would increase daytime noise levels at the residence on Pond Road (Lake Woollomes) and the residence on Road 208 (Deer Creek) above the 10 dBA threshold when compared to existing conditions. Nighttime construction under the proposed project and Low Flow Alternative would

increase nighttime noise levels at the three sensitive receptors above the 5 dBA threshold when compared to existing conditions. Detailed calculations are provided in Appendix G2.

Table G1-7. Maximum 1-Hour Construction Phase L_{eq} (dBA) Increase Over Existing – Proposed Project and Low Flow Alternative

Sensitive Receptor	Total Noise Level ¹ (dBA)	Increased Noise Level (dBA)	Significant? ²
Daytime			
Residence on Fresno Ave	43	3	No
Residence on Pond Road	53	13	Yes
Residence on Road 208	61	21	Yes
Nighttime			
Residence on Fresno Ave	40	10	Yes
Residence on Pond Road	53	23	Yes
Residence on Road 208	61	31	Yes

Notes:

¹ Ambient (background) noise level during existing conditions equal to 40 dBA during the day and 30 dBA at night.

² Daytime significant increased noise threshold is 10 dBA and nighttime significant increased noise level threshold is 5 dBA.

Key: dBA = A-weighted decibel scale

Table G1-8 summarizes the peak day maximum PPV (in/sec) at sensitive receptors under the proposed project and Low Flow Alternative. Detailed calculations are provided in Appendix G2. No construction actions under the proposed project and Low Flow Alternative would generate PPV levels above the 0.3 in/sec significance threshold.

Table G1-8. Peak Day Maximum PPV at Sensitive Receptors near Proposed Project and Low Flow Alternative Construction

Sensitive Receptor	Maximum PPV (in/sec)	Significant?
Shafter-Wasco		
Residence on Fresno Avenue	0.000188	No
Lake Woollomes		
Residence on Pond Road	0.000925	No
Deer Creek		
Residence on Road 208	0.00321	No

Note: Significance threshold: 0.3 in/sec

Key: in/sec= inch per second; PPV= peak particle velocity

Table G1-9 summarizes operational noise levels at the sensitive receptors nearest each construction site. Detailed calculations are provided in Appendix H2. Operating the proposed project and Low Flow Alternative would not exceed significance criterion.

Table G1-9. 8-Hour Operational Noise Level at Sensitive Receptors (dBA) – Proposed Project and Low Flow Alternative

Sensitive Receptor	Unmitigated Leq (dBA)	Significant?
Shafter-Wasco		
Residence on Fresno Ave	41	No ¹
Lake Woollomes		
Residence on Pond Road	48	No ¹
Deer Creek		
Residence on Road 208	55	No ²

Notes:

¹ Consistent with the Kern County General Plan (Kern County 2009), the operational noise threshold is 65 dBA.

² Consistent with the Tulare County General Plan (Tulare County 2012), the operational noise threshold is 60 dBA.

G1.4.1.1 Traffic Noise

Table G1-10 summarizes construction vehicle noise levels under the proposed project and Low Flow Alternative. Detailed calculations are provided in Appendix G2. Traffic noise under the proposed project and Low Flow Alternative would not exceed significance criterion.

Table G1-10. Construction Vehicles – Equivalent Noise Levels under the Proposed Project and Low Flow Alternative

Type	Roadway	Existing 2022 AADT ¹	Maximum Daily Truck Hauling Trips	Maximum Daily Worker Trips	Speed (mph)	Equivalency Factor for Heavy- Duty Vehicles	Equivalent Vehicles	Total With Project	Increase Ratio
State Route	Ave 95/Terra Bella at SR-65	4,773	169	80	55	10.4	1,838	6,610	1.39
Local	CR 208 at Deer Creek Site	847	175	0	35	19.1	3,343	4,189	4.95
State Route	SR-65 N of SR-155	8,000	169	80	55	10.4	1,838	9,838	1.23
State Route	SR-155 W of SR-65	480	169	80	55	10.4	1,838	2,318	4.83
State Route	SR-155 E of SR-99	18,550	169	80	55	10.4	1,838	20,388	1.10
State Route	SR-99 S of SR-155	69,000	169	80	55	10.4	1,838	70,838	1.03
State Route	SR-99 N of SR-46	68,000	507	160	55	10.4	5,433	73,433	1.08
State Route	SR-99 N of Ledro Hwy	71,000	332	160	55	10.4	3,613	74,613	1.05
State Route	SR-46 W of SR-99	6,800	175	0	55	10.4	1,820	8,620	1.27
State Route	SR-46 E of SR-43	6,800	175	0	55	10.4	1,820	8,620	1.27
State Route	SR-43 S of SR-46	7,500	175	0	55	10.4	1,820	9,320	1.24
Local	Merced Ave W of SR-43	506	175	0	35	19.1	3,343	3,849	7.61
Local	Lerdo Hwy W of SR-43	6,059	350	0	35	19.1	6,685	12,744	2.10
Local	Lerdo Hwy W of SR-99	16,255	332	80	35	19.1	6,421	22,676	1.40
Local	Pond Rd E of SR-99	4,233	338	80	35	19.1	6,536	10,769	2.54
Maximum								7.61	
Significant?²								No	

Note:

¹ On Caltrans' Traffic Census Program, the latest year of available data is 2022. As such, 2022 was selected as the existing year to reflect more realistic level of traffic (Caltrans 2024).

² Impacts would be significant if equivalent traffic volume increases by nine times (10 dBA increase). Doubling of the noise source produces only a 3 dB increase, which is a barely perceptible change with no audible change in traffic noise (FHWA 2011).

G1.4.2 Seasonal Alternative

Table G1-11 summarizes the daytime unmitigated L_{eq} that would occur at the nearest sensitive receptor from each construction area under the Seasonal Alternative. Construction actions associated with the Seasonal Alternative would increase daytime noise levels at the residence on Road 208 (Deer Creek) above the 10 dBA threshold when compared to existing conditions. No nighttime construction is proposed under the Seasonal Alternative. Detailed calculations are provided in Appendix G2.

Table G1-11. Maximum 1-Hour Construction Phase L_{eq} (dBA) Increase Over Existing – Seasonal Alternative

Sensitive Receptor	Total Noise Level ¹ (dBA)	Increased Noise Level (dBA)	Significant? ²
Residence on Fresno Ave	41	1	No
Residence on Pond Road	50	10	Yes

Notes:

¹ Ambient (background) noise level during existing conditions equal to 40 dBA.

² Daytime significant increased noise threshold is 10 dBA.

Key: dBA = A-weighted decibel scale

Table G1-12 summarizes the peak day maximum PPV (in/sec) at sensitive receptors under the Seasonal Alternative. Detailed calculations are provided in Appendix H2. No construction actions under the Seasonal Alternative would generate PPV levels above the 0.3 in/sec significance threshold.

Table G1-12. Peak Day Maximum PPV at Sensitive Receptors near Seasonal Alternative Construction

Sensitive Receptor	Maximum PPV (in/sec)	Significant?
Shafter-Wasco		
Residence on Fresno Avenue	0.000026	No
Lake Woollomes		
Residence on Pond Road	0.000128	No

Note: Significance threshold: 0.3 in/sec

Key: in/sec= inch per second; PPV= peak particle velocity

Table G1-13 summarizes operational noise levels at the sensitive receptors nearest each construction site. Detailed calculations are provided in Appendix G2. Operating the Seasonal Alternative would not exceed significance criterion.

**Table G1-13. 8-Hour Operational Noise Level at Sensitive Receptors (dBA) –
Seasonal Alternative**

Sensitive Receptor	Unmitigated Leq (dBA)	Significant?
Shafter-Wasco		
Residence on Fresno Ave	41	No ¹
Lake Woollomes		
Residence on Pond Road	45	No ¹

Notes:

¹ Consistent with the Kern County General Plan (Kern County 2009), the operational noise threshold is 65 dBA.

² Consistent with the Tulare County General Plan (Tulare County 2012), the operational noise threshold is 60 dBA.

G1.5 References

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Friant-Kern Canal Pump-Back Project Environmental Impact Report

Appendix G2: Noise and Vibration Calculations

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Construction Noise - Equipment
Proposed Project and Low Flow Alternative

Table 1. 1-Hour Daytime Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'	Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
Peak Day	Excavator	Excavator	40%	81	77	2	3	84	80
	Backhoe	Backhoe	40%	78	74	1	0	78	74
	Bulldozer	Dozer	40%	82	78	1	0	82	78
	Compactor	Compactor (ground)	20%	83	76	2	3	86	79
	Generator	Generator	50%	81	78	2	3	84	81
	Water Truck	Tractor	40%	84	80	2	3	87	83
	Crane/ Lift	Crane	16%	81	73	1	0	81	73
	Scraper	Scraper	40%	84	80	2	3	87	83
	Hand Tools	Pneumatic Tools	50%	85	82	1	0	85	82
	Peak Day Total							94	90

Table 2. 1-Hour Nighttime Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'	Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
Peak Day	Excavator	Excavator	40%	81	77	2	3	84	80
	Backhoe	Backhoe	40%	78	74	1	0	78	74
	Bulldozer	Dozer	40%	82	78	1	0	82	78
	Compactor	Compactor (ground)	20%	83	76	2	3	86	79
	Generator	Generator	50%	81	78	2	3	84	81
	Water Truck	Tractor	40%	84	80	2	3	87	83
	Crane/ Lift	Crane	16%	81	73	1	0	81	73
	Scraper	Scraper	40%	84	80	2	3	87	83
	Hand Tools	Pneumatic Tools	50%	85	82	1	0	85	82
	Peak Day Total							94	90

Table 3. 1-Hour Daytime Construction Noise Level at the Receptor (dBA)

Location	Residence on Fresno Ave	Residence on Pond Road	Residence on Road 208
Distance from the Center of Construction Activity to a Receptor (ft)	8,110	2,800	1,220
1-Hour Construction Noise Level at 50 ft (dBA)	90	90	90
Distance Divergence (dBA)	44.2	35.0	27.7
Atmospheric Attenuation (dBA)	6.67	2.30	1.00
1-Hour Construction Noise Level at the Receptor (dBA)	39	53	61
Daytime Unmitigated Leq (Construction Noise + Existing) (dBA)	43	53	61
Daytime Increase Over Existing (dBA)	3	13	21
Significant?	No	Yes	Yes

Table 4. 1-Hour Nighttime Construction Noise Level at the Receptor (dBA)

Location	Residence on Fresno Ave	Residence on Pond Road	Residence on Road 208
Distance from the Center of Construction Activity to a Receptor (ft)	8,110	2,800	1,220
1-Hour Construction Noise Level at 50 ft (dBA)	90	90	90
Distance Divergence (dBA)	44.2	35.0	27.7
Atmospheric Attenuation (dBA)	6.67	2.30	1.00
1-Hour Construction Noise Level at the Receptor (dBA)	39	53	61
Nighttime Unmitigated Leq (Construction Noise + Existing) (dBA)	40	53	61
Nighttime Increase Over Existing (dBA)	10	23	31
Significant?	Yes	Yes	Yes

County

Tulare

Kern

Significance Level

Daytime

Nighttime

10 dBA

5 dBA

Existing Noise Levels

Land Use Type

Daytime Background Noise (dBA)

Nighttime Background Noise (dBA)

Rural Residential

40

30

Construction Noise - Traffic
Proposed Project and Low Flow Alternative

Table 5. Construction Vehicles - Equivalent Noise Levels

Type	Roadway	Existing 2022 AADT	Maximum Daily Truck Hauling Trips	Maximum Daily Worker Trips	Speed (mph)	Equivalency Factor for Heavy- Duty Vehicles	Equivalent Vehicles	Total With Project	Increase Ratio
State Route	Ave 95/Terra Bella at SR-65	4,773	169	80	55	10.4	1,838	6,610	1.39
Local	CR 208 at Deer Creek Site	847	175	0	35	19.1	3,343	4,189	4.95
State Route	SR-65 N of SR-155	8,000	169	80	55	10.4	1,838	9,838	1.23
State Route	SR-155 W of SR-65	480	169	80	55	10.4	1,838	2,318	4.83
State Route	SR-155 E of SR-99	18,550	169	80	55	10.4	1,838	20,388	1.10
State Route	SR-99 S of SR-155	69,000	169	80	55	10.4	1,838	70,838	1.03
State Route	SR-99 N of SR-46	68,000	507	160	55	10.4	5,433	73,433	1.08
State Route	SR-99 N of Ledro Hwy	71,000	332	160	55	10.4	3,613	74,613	1.05
State Route	SR-46 W of SR-99	6,800	175	0	55	10.4	1,820	8,620	1.27
State Route	SR-46 E of SR-43	6,800	175	0	55	10.4	1,820	8,620	1.27
State Route	SR-43 S of SR-46	7,500	175	0	55	10.4	1,820	9,320	1.24
Local	Merced Ave W of SR-43	506	175	0	35	19.1	3,343	3,849	7.61
Local	Lerdo Hwy W of SR-43	6,059	350	0	35	19.1	6,685	12,744	2.10
Local	Lerdo Hwy W of SR-99	16,255	332	80	35	19.1	6,421	22,676	1.40
Local	Pond Rd E of SR-99	4,233	338	80	35	19.1	6,536	10,769	2.54

Note:

Impacts would be significant if equivalent traffic volume increases by nine times (10 dBA increase).

Maximum
Significant?

7.61
No

Doubling of the noise source produces only a 3 dB increase, which is a barely perceptible change; therefore, there would be no audible change in traffic noise.
FHWA. 2011. Highway Traffic Noise: Analysis and Abatement Guidance.

Operational Noise Impacts
Proposed Project and Low Flow Alternative

Table 5. 8-Hour Operational Noise Level at Sensitive Receptors (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'	Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
Lake Woollomes									
Operation	Pump Station	Pumps	50%	81	78	4	6	87	84
Deer Creek									
Operation	Pump Station	Pumps	50%	81	78	4	6	87	84
Shafter-Wasco									
Operation	Pump Station	Pumps	50%	81	78	6	8	89	86

Table 6. 8-Hour Operational Noise Level for Lake Woollomes

Residence on Pond Road	
Distance from the Center of Operational Activity to a Receptor (ft)	2800
Distance Divergence (dBA)	35
Atmospheric Attenuation (dBA)	2.30
8-Hour Operational Noise Level at the Receptor (dBA)	47
Unmitigated Leq (Operational Noise + Existing) (dBA)	48
Increase Over Existing (dBA)	8
Significant?	No

Table 7. 8-Hour Operational Noise Level for Deer Creek

Residence on Road 208	
Distance from the Center of Operational Activity to a Receptor (ft)	1220
Distance Divergence (dBA)	28
Atmospheric Attenuation (dBA)	1.00
8-Hour Operational Noise Level at the Receptor (dBA)	55
Unmitigated Leq (Operational Noise + Existing) (dBA)	55
Increase Over Existing (dBA)	15
Significant?	No

Table 8. 8-Hour Operational Noise Level for Shafter-Wasco

Residence on Fresno Avenue	
Distance from the Center of Operational Activity to a Receptor (ft)	8110
Distance Divergence (dBA)	44
Atmospheric Attenuation (dBA)	6.67
8-Hour Operational Noise Level at the Receptor (dBA)	35
Unmitigated Leq (Operational Noise + Existing) (dBA)	41
Increase Over Existing (dBA)	1
Significant?	No

Operational Significance Level (dBA)

Tulare County 60
Kern County 65

Source: Tulare General Plan
Source: Kern General Plan

Existing Noise Levels

Land Use Type Rural Residential
Background Noise (dBA)
Daytime 40
Nighttime 30

Construction Noise - Equipment
Seasonal Alternative

Table 9. 1-Hour Daytime Construction Noise Level at 50 Feet (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'	Number of Equipment	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
Peak Day	Crane	Crane	16%	81	73	1	0	81	73
	Deck Truck	Flat Bed Truck	40%	74	70	1	0	74	70
	Hand Tools	Pneumatic Tools	50%	85	82	3	5	90	87
Peak Day Total								90	87

Table 10. 1-Hour Daytime Construction Noise Level at the Receptor (dBA)

Location	Residence on Fresno Ave	Residence on Pond Road
Distance from the Center of Construction Activity to a Receptor (ft)	8,110	2,800
1-Hour Construction Noise Level at 50 ft (dBA)	87	87
Distance Divergence (dBA)	44.2	35.0
Atmospheric Attenuation (dBA)	6.67	2.30
1-Hour Construction Noise Level at the Receptor (dBA)	36	50
Daytime Unmitigated Leq (Construction Noise + Existing) (dBA)	41	50
Daytime Increase Over Existing (dBA)	1	10
Significant?	No	Yes

County	Significance Level
Tulare	Daytime 10 dBA
Kern	Nighttime 5 dBA

Existing Noise Levels	
Land Use Type	Rural Residential
Daytime Background Noise (dBA)	40
Nighttime Background Noise (dBA)	30

Operational Noise Impacts
Seasonal Alternative

Table 12. 8-Hour Operational Noise Level at Sensitive Receptors (dBA)

Phase	Equipment Description	RCNM Equipment Types	Usage Factor	Equipment Lmax @ 50'	Equipment Leq(h) @ 50'	Number of Equipment*	Add to Single Source Level (dBA)	Total Lmax @ 50'	Total Leq(h) @ 50'
Lake Woollomes									
Operation	Seasonal Pump-back	Pumps	50%	81	78	2	3	84	81
	Generator	Generator	50%	81	78	2	3	84	81
Lake Woollomes Total								87	84
Shafter-Wasco									
Operation	Seasonal Pump-back	Pumps	50%	81	78	4	6	87	84
	Generator	Generator	50%	81	78	4	6	87	84
Shafter-Wasco Total								90	87

* Seasonal pumps have a designed flow rate of 50 cfs (Red Bluff Diversion Dam Pumps Evaluation, Provost & Pritchard 2018).

Table 13. 8-Hour Operational Noise Level for Lake Woollomes

Residence on Pond Road	
Distance from the Center of Operational Activity to a Receptor (ft)	2800
Distance Divergence (dBA)	35
Atmospheric Attenuation (dBA)	2.30
8-Hour Operational Noise Level at the Receptor (dBA)	47
Unmitigated Leq (Operational Noise + Existing) (dBA)	48
Increase Over Existing (dBA)	8
Significant?	No

Table 14. 8-Hour Operational Noise Level for Shafter-Wasco

Residence on Fresno Avenue	
Distance from the Center of Operational Activity to a Receptor (ft)	8110
Distance Divergence (dBA)	44
Atmospheric Attenuation (dBA)	6.67
8-Hour Operational Noise Level at the Receptor (dBA)	36
Unmitigated Leq (Operational Noise + Existing) (dBA)	41
Increase Over Existing (dBA)	1
Significant?	No

Operational Significance Level (dBA)

Kern County 65

Source: Kern General Plan

Existing Noise Levels

Land Use Type Rural Residential

Background Noise (dBA)

Daytime 40

Nighttime 30

Table 9. Atmospheric Attenuation

Assumptions	Tulare	Kern
Ambient pressure (kPa)	101.3	101.3
Temperature (F)	68	68
Relative humidity (%)	90	90
Frequency of noise source (Hz)	500	500
Air Attenuation Coefficient (α, dB/km)	2.7	2.7
(dB/ft)	0.0008	0.0008

$A_{air} = \alpha d$

Conversion:
0.3048 m/ft
1000 m/km

Weather in Tulare County

Average temperature 60.4 °F
Average relative humidity 76.11 %

Weather in Kern County

Average temperature 61.5 °F
Average relative humidity 76.9 %

Reference:

Harris, Cyril M. 1998. Handbook of Acoustical Measurements and Noise Control. 3rd ed. - Chapter 3 Calculation of Attenuation
<http://www.usa.com/tulare-county-ca-weather.htm>; <http://www.usa.com/kern-county-ca-weather.htm>

Table 10. Equipment noise emissions and acoustical usage factors database

Equipment Description	Impact Device?	Acoustical Use Factor	Spec 721.560 Lmax @ 50ft (dBA, slow)	Actual Measured Lmax @ 50 ft (dBA, slow)
All Other Equipment > 5 hp	No	50%	85	N/A
Auger Drill Rig	No	20%	85	84
Backhoe	No	40%	80	78
Bar Bender	No	20%	80	N/A
Blasting	Yes	1%	94	N/A
Boring Jack Power Unit	No	50%	80	83
Chain Saw	No	20%	85	84
Clam Shovel (dropping)	Yes	20%	93	87
Compactor (ground)	No	20%	80	83
Compressor (air)	No	40%	80	78
Concrete Batch Plant	No	15%	83	N/A
Concrete Mixer Truck	No	40%	85	79
Concrete Pump Truck	No	20%	82	81
Concrete Saw	No	20%	90	90
Conveyor	No	100%	90	90
Crane	No	16%	85	81
Dozer	No	40%	85	82
Drill Rig Truck	No	20%	84	79
Drum Mixer	No	50%	80	80
Dump Truck	No	40%	84	76
Excavator	No	40%	85	81
Flat Bed Truck	No	40%	84	74
Front End Loader	No	40%	80	79
Generator	No	50%	82	81
Generator (<25KVA, VMS signs)	No	50%	70	73
Gradall	No	40%	85	83
Grader	No	40%	85	N/A
Grapple (on backhoe)	No	40%	85	87
Horizontal Boring Hydr. Jack	No	25%	80	82
Hydra Break Ram	Yes	10%	90	N/A
Impact Pile Driver	Yes	20%	95	101
Jackhammer	Yes	20%	85	89
Man Lift	No	20%	85	75
Mounted Impact Hammer (hoe ram)	Yes	20%	90	90
Pavement Scarifier	No	20%	85	90
Paver	No	50%	85	77
Pickup Truck	No	40%	55	75
Pneumatic Tools	No	50%	85	85
Pumps	No	50%	77	81
Refrigerator Unit	No	100%	82	73
Rivit Buster/Chipping Gun	Yes	20%	85	79
Rock Drill	No	20%	85	81
Roller	No	20%	85	80
Sand Blasting (Single Nozzle)	No	20%	85	96
Scraper	No	40%	85	84
Shears (on backhoe)	No	40%	85	96
Slurry Plant	No	100%	78	78
Slurry Trenching Machine	No	50%	82	80
Soil Mix Drill Rig	No	50%	80	N/A
Tractor	No	40%	84	N/A
Vacuum Excavator (vac-truck)	No	40%	85	85
Vacuum Street Sweeper	No	10%	80	82
Ventilation Fan	No	100%	85	79
Vibrating Hopper	No	50%	85	87
Vibratory Concrete Mixer	No	20%	80	80
Vibratory Pile Driver	No	20%	95	101
Warning Horn	No	5%	85	83
Welder/Torch	No	40%	73	74

Usage factor is the percentage of time during a construction noise operation that a piece of construction equipment is operating at full power. In case of construction blasting, the equipment gives a very short duration blast and can be quantified by using a 1% usage factor in the RCNM to allow for some prediction.

FHWA. RCNM User's Guide - Table 1. CA/T equipment noise emissions and acoustical usage factors database.

Table 11. Average Ambient Noise Levels for Various Land Uses

Land Use Description	Average Ldn (dBA)	Daytime Leq (dBA)	Nighttime Leq (dBA)
Wilderness	35	35	25
Rural Residential	40	40	30
Quiet Suburban Residential	50	50	40
Normal Suburban Residential	55	55	45
Urban Residential	60	60	50
Noisy Urban Residential	65	65	55
Very Noisy Urban Residential	70	70	60

Source: U.S. EPA, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, March 1974.

Table 12. Noise Reductions from Mitigation Measures

Mitigation Type	Reduction (dBA)
Noise barrier or other obstruction just barely breaks the line-of-sight between the noise source and the receptor	3
Noise source completely enclosed or completely shielded with solid barrier located close to the source	8
Enclosure and/or barrier with some gaps	5
Noise source completely enclosed and completely shielded with a solid barrier located close to the source	10
Noise source enclosed or shielded with heavy vinyl noise curtain material	5

Source: FHWA. RCNM User's Guide Appendix A Best Practices for Calculating Estimated Shielding for Use in the RCNM

Construction Equipment

Table 13. Equipment Description Lookup Table

Equipment Description	RCNM Description
Barges	
Boats	
Bulldozer	Dozer
Chipper	All Other Equipment > 5 hp
Concrete Pumpers	Concrete Pump Truck
Concrete Saw Cutters	Concrete Saw
Concrete Trucks	Concrete Mixer Truck
Cranes	Crane
Dredges	
Drill Rig	Auger Drill Rig
Dump Truck	Dump Truck
Equipment and Material Delivery Trucks	
Excavator	Excavator
Flatbed Trucks (on site)	Flat Bed Truck
Grader	Grader
Gravel /Paving Trucks	
Loaders	Front End Loader
Portable Diesel Generators	Generator
Roller	Roller
Scraper	Scraper
TBM	
Truck Mounted Drill Rig (Wells)	Drill Rig Truck
Vertical Conveyor	
Vibrating Plate	Compactor (ground)
Water Truck	Dump Truck
Wheel Trencher	Slurry Trenching Machine

Note:

Equipment without RCNM descriptions are not included in the noise analysis.

Table 14. Number of Equivalent Vehicles as a Function of Vehicle Type and Speed Based on TNM Reference Energy Mean Emission Levels

Speed (km/h [mph])	Equivalent Vehicles		
	1 Heavy Truck	1 Medium Truck	1 Auto
56 (35)	19.1	7.1	1
64 (40)	15.1	5.8	1
72 (45)	12.9	5	1
80 (50)	11.5	4.5	1
88.5 (55)	10.4	4.1	1
97 (60)	9.6	3.7	1
105 (65)	7.9	3.5	1
113 (70)	8.3	3.2	1

Source: Caltrans. 2009. *Technical Noise Supplement*. Prepared by ICF Jones & Stokes. November.

Construction Vibration - Equipment
Proposed Project and Low Flow Alternative

Table 15. Construction Vibration

Phase	Equipment Description	Equivalent Equipment Types	Distance (ft):	At Source	Residence on Fresno Ave	Residence on Pond Road	Residence on Road 208
				25	8,110	2,800	1,220
			Number of Equipment	PPV (in/sec)	PPV (in/sec)	PPV (in/sec)	PPV (in/sec)
Peak Day	Excavator	Large Bulldozer	2	0.178	0.000030	0.000150	0.000522
	Backhoe	Small bulldozer	1	0.003	0.000001	0.000003	0.000009
	Bulldozer	Large Bulldozer	1	0.089	0.000015	0.000075	0.000261
	Compactor	Vibratory Roller	2	0.420	0.000072	0.000354	0.001232
	Generator	n/a	2	n/a	n/a	n/a	n/a
	Water Truck	Loaded Trucks	2	0.152	0.000026	0.000128	0.000446
	Crane/ Lift	Loaded Trucks	1	0.076	0.000013	0.000064	0.000223
	Scraper	Large Bulldozer	2	0.178	0.000030	0.000150	0.000522
	Hand Tools	n/a	1	n/a	n/a	n/a	n/a
Peak Day Total				N/A	0.000188	0.000925	0.00321

Significance Threshold

0.3 in/sec

Construction Vibration - Equipment
Seasonal Alternative

Table 16. Construction Vibration

Phase	Equipment Description	Equivalent Equipment Types	Distance (ft):	At Source	Residence on Fresno Ave	Residence on Pond Road
			Number of Equipment	25	8,110	2,800
				PPV (in/sec)	PPV (in/sec)	PPV (in/sec)
Peak Day	Crane	Loaded Trucks	1	0.076	0.000013	0.000064
	Deck Truck	Loaded Trucks	1	0.076	0.000013	0.000064
	Hand Tools	n/a	1	n/a	n/a	n/a
Peak Day Total				N/A	0.000026	0.000128

Significance Threshold

0.3 in/sec

Table 17. Vibration Source Levels for Construction Equipment

Equipment	PPV at 25 ft (in/sec)	Approximate Lv[†] at 25 ft
Pile Driver (impact)	0.644	104
Pile Driver (sonic)	0.17	93
Clam shovel drop (slurry wall)	0.202	94
Hydromill (slurry wall) - in soil	0.008	66
Hydromill (slurry wall) - in rock	0.017	75
Vibratory Roller	0.21	94
Hoe Ram	0.089	87
Large Bulldozer	0.089	87
Caisson Drilling	0.089	87
Loaded Trucks	0.076	86
Jackhammer	0.035	79
Small bulldozer	0.003	58

Source: Federal Transit Administration. 2006. *Transit Noise and Vibration Impact Assessment*. FTA-VA-90-1003-06. May.

Note:

Values for pile drivers are based on the typical vibration source levels.

† RMS velocity in decibels (VdB) re 1 micro-inch/second