APPENDIX H
Friant-Kern Canal Middle Reach Capacity Correction Project

Noise Baseline Terminology and Noise Levels

BUREAU OF RECLAMATION

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Noise and Vibration

This appendix describes background information related to noise and vibration for the Friant-Kern Canal Middle Reach Capacity Correction Project (Project) Draft Environmental Impact Statement/Environmental Impact Report (Draft EIS/R). Acronyms and abbreviations used in this appendix are listed in Appendix A of the Draft EIS/R.

Noise and Vibration Terminology

Table H-1 provides terminology that is used to discuss noise in Section 3, Noise subsection, in the Draft Environmental Impact Statement/Environmental Impact Report (Draft EIS/R). Table H-2 shows typical noise levels for common noise sources.

Table H-1. Definition of Acoustical Terms

Term	Definition
dB, decibel	Unit of measurement of sound level.
dBA, decibel A-weighted	A unit of measurement of sound level corrected to the A–weighted scale, as defined in ANSI S1.4–1971 (R1976), using a reference level of 20 micropascals (0.00002 Newtons per square meter).
A-weighted scale	A sound measurement scale that corrects the pressures of individual frequencies according to human sensitivities. The scale is based on the fact that the region of highest sensitivity for the average ear is between 2,000 and 4,000 Hz. Sound levels are measured on a logarithmic scale in decibels, dB. The universal measure for environmental sound is the A–weighted sound level, dBA.
Hz, hertz	Unit of measurement of frequency, numerically equal to cycles per second.
Loudness	Listeners' perception of sound pressure incident in their ear.
L_{01}, L_{10}, L_{50}, L_{90}	The A–weighted noise levels that are exceeded 1%, 10%, 50%, and 90 % of the time during the measurement period.
L_{eq}, equivalent noise level	Also, called the equivalent continuous noise level. It is the continuous sound level that is equivalent, in terms of noise energy content, to the actual fluctuating noise existing at a location over a given period, usually 1 hour. L_{eq} is usually measured in hourly intervals over long periods in order to develop 24-hour noise levels.
CNEL, community noise equivalent level	The CNEL is a measure of the cumulative noise exposure in the community, with greater weights applied to evening and nighttime periods. This noise descriptor is the equivalent noise level over a 24-hour period mathematically weighted for the evening and nighttime hours when residents are more sensitive to intrusive noise. The daytime period is from 7:00 a.m. to 7:00 p.m., evening is from 7:00 p.m. to 10:00 p.m., and nighttime is from 10:00 p.m. to 7:00 a.m. A weighting factor of 5 dB is added to the measured evening levels (7 p.m. to 10 p.m.) and 10 dB to the nighttime levels (10 p.m. to 7 a.m.). The weighted levels over a 24-hour period are then averaged to produce the single number CNEL rating.
L_{dn}, day/night noise level	The same as CNEL except that the evening time period is not considered separately, but instead is included as part of the daytime period. Measurements of both CNEL and L_{dn} in the same residential environments reveal that CNEL is usually slightly higher (by less than 1 dB) than L_{dn} due to the evening factor weighting.
L_{min}, L_{max}	The minimum and maximum A-weighted noise level during the measurement period.

Term	Definition
Ambient noise level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	Noise that intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends on its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.
Acoustical Usage Factor	Acoustical usage factor is the fraction of time that the equipment generates noise at the maximum level.

Table H-2. Typical Sound Levels of Common Noise Sources

Decibels	Description
130	Threshold of pain
120	Jet aircraft take-off at 100 feet
110	Riveting machine at operator's position
100	Shot-gun at 200 feet
90	Bulldozer at 50 feet
80	Diesel locomotive at 300 feet
70	Commercial jet aircraft interior during fight
60	Normal conversation speech at 5–10 feet
50	Open office background level
40	Background level within a residence
30	Soft whisper at 2 feet
20	Interior of recording studio

Source: Kern County 2004

The measurement of any sound level requires language used specifically for the measurement of acoustical conditions. Decibel, or dB, is the preferred unit for measuring sound levels using the logarithmic scale to account for the large range in audible sound intensities. A general rule for the dB scale is that a 10 dB increase in sound is perceived as a doubling of loudness by the human ear (Federal Highway Administration 2017). For example, a 55 dB sound level would sound twice as loud as a 45 dB sound level. The average healthy person cannot detect differences of 1 dB, whereas a 5 dB change is clearly noticeable.

Several sound measurement descriptors are used to assess the effects of sound on the human environment. These include the equivalent sound level (L_{eq}), which is the level of a constant sound that has the same sound energy as the actual fluctuating sound; L_{eq} is similar to the average sound level. The day-night sound level, L_{dn}, is similar to the 24-hour L_{eq}, except that a 10-dB penalty is added to sound levels between 10 p.m. and 7 a.m. to account for the greater sensitivity of people to sound at night. The community noise level (CNEL) also places a

weighted factor on sound events occurring in the evening hours. The L_{90} value is the sound level that is exceeded 90 percent of the time and is often used to describe the background or residual sound level.

Vibration

Operation of heavy construction equipment, particularly pile drivers and other impact devices such as pavement breakers, creates seismic waves that radiate along the surface of the earth and downward into the earth. These surface waves can be felt as ground vibration. Vibration from operation of such equipment can result in effects ranging from annoyance of people to damage of structures. Varying geology and distance result in different vibration levels containing different frequencies and displacements. In all cases, vibration amplitudes decrease with increasing distance.

Perceptible ground-borne vibration is generally limited to areas within a few hundred feet of construction activities. As seismic waves travel outward from a vibration source, they excite the particles of rock and soil through which they pass and cause them to oscillate. The actual distance that these particles move is usually only a few ten-thousandths to a few thousandths of an inch. The rate or velocity (in inches per second) at which these particles move is the commonly accepted descriptor of the vibration amplitude, referred to as the peak particle velocity (PPV). Table H-3 summarizes guideline vibration annoyance potential criteria suggested by the California Department of Transportation (Caltrans), and Table H-4 summarizes guideline vibration damage potential criteria suggested by Caltrans.

Table H-3. Guideline Vibration Annoyance Potential Criteria

Human Response	Transient Sources (Maximum PPV [inches per second])	Continuous/Frequent Sources (Maximum PPV [inches per second])
Barely perceptible	0.04	0.01
Distinctly perceptible	0.25	0.04
Strongly perceptible	0.9	0.10
Severe	2.0	0.4

Notes: Transient sources, such as blasting or drop balls, create a single isolated vibration event. Continuous/frequent intermittent sources include impact pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment.
Source: California Department of Transportation 2004.

Table H-4. Guideline Vibration Damage Potential Criteria

Structure and Condition	Transient Sources (Maximum PPV [inches/second])	Continuous/Frequent Sources (Maximum PPV [inches per second])
Extremely fragile historic buildings, ruins, ancient monuments	0.12	0.08
Fragile buildings	0.2	0.1
Historic and some old buildings	0.5	0.25
Older residential structures	0.5	0.3
New residential structures	1.0	0.5
Modern industrial/commercial buildings	2.0	0.5

Notes: Transient sources, such as blasting or drop balls, create a single isolated vibration event. Continuous/frequent intermittent sources include impact pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment.
Source: California Department of Transportation 2013.