

A P P E N D I X E

NOISE BACKGROUND AND
MODELING DATA



Noise Background and Modeling Data

NOISE BACKGROUND

Terminology and Noise Descriptors

The following are brief definitions of noise terminology:

- **Sound.** A vibratory disturbance that, when transmitted by pressure waves through a medium such as air, is capable of being detected by a receiving mechanism, such as the human ear or a microphone.
- **Noise.** Sound that is loud, unpleasant, unexpected, or otherwise undesirable.
- **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 micropascals.
- **A-Weighted Decibel (dBA).** An overall frequency-weighted sound level in decibels which approximates the frequency response of the human ear.
- **Equivalent Continuous Noise Level (Leq).** The mean of the noise level averaged over the measurement period, regarded as an average level.
- **Day-Night Level (Ldn).** 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 PM to 7 AM. The L_{dn} and the CNEL are similar noise descriptors and rarely differ by more than 1 dBA.
- **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 to 10 PM and 10 dB added to the A-weighted sound levels occurring during the period from 10 PM to 7 AM.
- **Sensitive Receptor.** Noise- and vibration-sensitive receptors include land uses where quiet environments are necessary for enjoyment and public health and safety. Residences, schools, motels and hotels, libraries, religious institutions, hospitals, and nursing homes are examples.

L_{dn} and CNEL values rarely differ by more 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.

Characteristics of Sound

Sound is a pressure wave transmitted through the air. When an object vibrates, it radiates part of its energy as acoustical pressure in the form of a sound wave. Sound can be described in terms of amplitude (loudness), frequency (pitch), or duration (time). The standard unit of measurement of the loudness of sound is the decibel (dB). The human hearing system is not equally sensitive to sound at all frequencies. Sound waves below 16 Hz are not heard at all and are "felt" more as a vibration. Similarly, while people with extremely sensitive hearing can hear sounds as high as 20,000 Hz, most people cannot hear above 15,000 Hz. In all cases, hearing acuity falls off rapidly above about 10,000 Hz and

below about 200 Hz. Since the human ear is not equally sensitive to sound at all frequencies, a special frequency-dependent rating scale is usually used to relate noise to human sensitivity. The A-weighted decibel scale (dBA) performs this compensation by discriminating against frequencies in a manner approximating the sensitivity of the human ear.

Because of the physical characteristics of noise transmission and noise perception, the relative loudness of sound does not closely match the actual amounts of sound energy. Table 1, Change in Sound Pressure Level, dB, presents the subjective effect of changes in sound pressure levels. Typical human hearing can detect changes of approximately 3 dBA or greater under normal conditions. Changes of 1 to 3 dBA are detectable under quiet, controlled conditions and changes of less than 1 dBA are usually indiscernible. A change of 5 dBA or greater is typically noticeable to most people in an exterior environment and a change of 10 dBA is perceived as a doubling (or halving) of the noise.

<i>Table 1</i>	
<i>Change in Sound Pressure Level, dB</i>	
Change in Apparent Loudness	
± 3 dB	Threshold of human perceptibility
± 5 dB	Clearly noticeable change in noise level
± 10 dB	Half or twice as loud
± 20 dB	Much quieter or louder

Source: Bies and Hansen 2003.

Point and Line Sources

Noise may be generated from a point source, such as a piece of construction equipment, or from a line source, such as a road containing moving vehicles. Because noise spreads in an ever-widening pattern, the given amount of noise striking an object, such as an eardrum, is reduced with distance from the source. This is known as "spreading loss." The typical spreading loss for point source noise is 6 dBA per doubling of the distance from the noise source.

A line source of noise, such as vehicles proceeding down a roadway, would also be reduced with distance, but the rate of reduction is affected by of both distance and the type of terrain over which the noise passes. Hard sites, such as developed areas with paving, reduce noise at a rate of 3 dBA per doubling of the distance while soft sites, such as undeveloped areas, open space and vegetated areas reduce noise at a rate of 4.5 dBA per doubling of the distance. These represent the extremes and most areas would actually contain a combination of hard and soft elements with the noise reduction placed somewhere in between these two factors. Unfortunately, the only way to actually determine the absolute amount of attenuation that an area provides is through field measurement under operating conditions with subsequent noise level measurements conducted at varying distances from a constant noise source.

Objects that block the line of sight attenuate the noise source if the receptor is located within the "shadow" of the blockage (such as behind a sound wall). If a receptor is located behind the wall, but has a view of the source, the wall would do little to reduce the noise. Additionally, a receptor located on the same side of the wall as the noise source may experience an increase in the perceived noise level, as the wall would reflect noise back to the receptor compounding the noise.

Noise Metrics

Several rating scales (or noise "metrics") exist to analyze adverse effects of noise, including traffic-generated noise, on a community. These scales include the equivalent noise level (L_{eq}), the community noise equivalent level (CNEL) and the day/night noise level (L_{dn}). L_{eq} is a measurement of the sound energy level averaged over a specified time period.

The CNEL noise metric is based on 24 hours of measurement. CNEL differs from L_{eq} in that it applies a time-weighted factor designed to emphasize noise events that occur during the evening and nighttime hours (when quiet time and sleep disturbance is of particular concern). Noise occurring during the daytime period (7:00 AM to 7:00 PM) receives no penalty. Noise produced during the evening time period (7:00 to 10:00 PM) is penalized by 5 dB, while nighttime (10:00 PM to 7:00 AM) noise is penalized by 10 dB. The L_{dn} noise metric is similar to the CNEL metric except that the period from 7:00 to 10:00 PM receives no penalty. Both the CNEL and L_{dn} metrics yield approximately the same 24-hour value (within 1 dB) with the CNEL being the more restrictive (i.e., higher) of the two.

Psychological and Physiological Effects of Noise

Physical damage to human hearing begins at prolonged exposure to noise levels higher than 85 dBA. Exposure to high noise levels affects the entire system, with prolonged noise exposure in excess of 75 dBA increasing body tensions, thereby affecting blood pressure and functions of the heart and the nervous system. In comparison, extended periods of noise exposure above 90 dBA would result in permanent cell damage. Table 2 shows typical noise levels from various noise sources.

*Table 2
Typical Noise Levels from Noise Sources*

<i>Common Outdoor Activities</i>	<i>Noise Level (dBA)</i>	<i>Common Indoor Activities</i>
	110	Rock Band
Jet Flyover at 1,000 feet		
	100	
Gas Lawn Mower at three 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		
	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 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	
Lowest Threshold of Human Hearing	0	Lowest Threshold of Human Hearing

Source: California Department of Transportation 2009.

Vibration

Vibration is an oscillatory motion through a solid medium in which the motion's amplitude can be described in terms of displacement, velocity, or acceleration. Vibration is normally associated with activities such as railroads or vibration-intensive stationary sources, but can also be associated with construction equipment, such as jackhammers, pile drivers, and hydraulic hammers. Vibration displacement is the distance that a point on a surface moves away from its original static position. The instantaneous speed that a point on a surface moves is described as the velocity, and the rate of change of the speed is described as the acceleration. Each of these descriptors can be used to correlate vibration to human response, building damage, and acceptable equipment vibration levels. During the construction of a building, the operation of construction equipment could cause groundborne vibration. The three main wave types of concern in the propagation of groundborne vibrations are surface or Rayleigh waves, compression or P-waves, and shear or S-waves.

- Surface or Rayleigh waves travel along the ground surface. They carry most of their energy along an expanding cylindrical wave front, similar to the ripples produced by throwing a rock into a lake. The particle motion is more or less perpendicular to the direction of propagation (known as retrograde elliptical).
- Compression or P-waves are body waves that carry their energy along an expanding

spherical wave front. The particle motion in these waves is longitudinal, in a push-pull motion. P-waves are analogous to airborne sound waves.

- Shear or S-waves are also body waves, carrying their energy along an expanding spherical wave front. Unlike P-waves, however, the particle motion is transverse, or perpendicular to the direction of propagation.

The peak particle velocity (PPV) or the root mean square (RMS) velocity is usually used to describe vibration amplitudes. PPV is defined as the maximum instantaneous peak of the vibration signal and RMS is defined as the square root of the average of the squared amplitude of the signal. PPV is more appropriate for evaluating potential building damage, whereas RMS is typically more suitable for evaluating human response.

The units for PPV and RMS velocity are normally inches per second (in/sec). Often, vibration is presented and discussed in dB units to compress the range of numbers required to describe the vibration. All PPV and RMS velocity are in in/sec and all vibration levels in this study are in dB relative to 1 micro-inch per second (abbreviated as VdB). The threshold of perception is approximately 65 VdB. Typically groundborne vibration generated by manmade activities attenuates rapidly with distance from the source of the vibration. Manmade vibration problems are usually confined to short distances (500 feet or less) from the source.

Construction generally includes a wide range of activities that can generate groundborne vibration. In general, demolition of structures generates the highest vibrations. Vibratory compactors or rollers, pile drivers, and pavement breakers can generate perceptible amounts of vibration at distances within 200 feet of the vibration sources. Heavy trucks can also generate groundborne vibrations that vary, depending on vehicle type, weight, and pavement conditions. Potholes, pavement joints, discontinuities, differential settlement of pavement, etc., all increase the vibration levels from vehicles passing over a road surface. Construction vibration is normally of greater concern than vibration of normal traffic on streets and freeways with smooth pavement conditions. Trains generate substantial quantities of vibration due to their engines, steel wheels, and heavy loads.

Operation of construction equipment generates vibrations that spread through the ground and diminish in amplitude (strength) with distance from the source. The effect on buildings near a construction site varies depending on soil type, ground strata, and receptor building construction. The generation of vibration can range from no perceptible effects at the lowest vibration levels, to low rumbling sounds and perceptible vibrations at moderate levels, to slight damage at the highest levels. Ground vibrations from construction activities rarely reach levels that can damage structures, but can achieve the perceptible ranges in buildings close to a construction site.

Sensitive Receptors

Certain land uses are particularly sensitive to noise and vibration. Noise- and vibration-sensitive uses include land uses where quiet environments are necessary for enjoyment and public health and safety. Residences, schools, guest lodging, libraries, religious institutions, hospitals, nursing homes, and passive recreation areas are generally more sensitive to noise than commercial and industrial land use.

NOISE AND VIBRATION REGULATORY ENVIRONMENT

Noise

To limit exposure of people to intrusive and physically and/or psychologically damaging noise levels, the federal government, the State of California, some county governments, and most municipalities in the state have established standards and ordinances to control noise.

The United States Environmental Protection Agency (USEPA) has developed general guidelines for recommended maximum noise levels to protect public health and welfare and the hearing of workers exposed to occupational noise.

State

Cities and counties in California are preempted by federal law from controlling noise generated from most mobile sources, including noise generated by vehicles and trucks on the roadway, trains on the railroad, and airplanes. Table 3 shows a land use compatibility chart for community noise adopted by the State of California as part of General Plan Guidelines.¹ This table provides urban planners with a tool to gauge the compatibility of new land uses relative to existing and future noise levels. As shown in the table, hotels, motels, and other transient lodging are normally acceptable land uses up to a noise level of 65 dBA CNEL.

¹ California Office of Noise Control, *Guidelines for the Preparation and Content of Noise Elements of the General Plan*, February 1976. Included in the State of California General Plan Guidelines.

Table 3
Land Use Compatibility for Community Noise Exposure

Land Uses	CNEL (dBA)					
	55	60	65	70	75	80
Residential-Low Density Single Family, Duplex, Mobile Homes	Diagonal lines	Vertical lines	Horizontal lines	Diagonal lines	Black	Black
Residential- Multiple Family	Diagonal lines	Vertical lines	Horizontal lines	Diagonal lines	Black	Black
Transient Lodging, Motels, Hotels	Diagonal lines	Vertical lines	Horizontal lines	Diagonal lines	Black	Black
Schools, Libraries, Churches, Hospitals, Nursing Homes	Diagonal lines	Vertical lines	Horizontal lines	Diagonal lines	Black	Black
Auditoriums, Concert Halls, Amphitheatres	Vertical lines	Horizontal lines	Diagonal lines	Black	Black	Black
Sports Arena, Outdoor Spectator Sports	Vertical lines	Horizontal lines	Diagonal lines	Black	Black	Black
Playgrounds, Neighborhood Parks	Diagonal lines	Vertical lines	Horizontal lines	Diagonal lines	Black	Black
Golf Courses, Riding Stables, Water Recreation, Cemeteries	Diagonal lines	Vertical lines	Horizontal lines	Diagonal lines	Black	Black
Office Buildings, Businesses, Commercial and Professional	Diagonal lines	Vertical lines	Horizontal lines	Diagonal lines	Black	Black
Industrial, Manufacturing, Utilities, Agricultural	Diagonal lines	Vertical lines	Horizontal lines	Diagonal lines	Black	Black

Explanatory Notes

Diagonal lines	<p>Normally Acceptable: Specified land use is satisfactory based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.</p>	Diagonal lines	<p>Normally Unacceptable: New construction or development should generally be discouraged. If new construction does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.</p>
Vertical lines	<p>Conditionally Acceptable: New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and the needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.</p>	Black	<p>Clearly Unacceptable: New construction or development should generally not be undertaken.</p>

Source: California Office of Noise Control, Guidelines for the Preparation and Content of Noise Elements of the General Plan, February 1976. Included in the State of California General Plan Guidelines.

Local – City of Cupertino

The Noise Ordinance is designed to control unnecessary, excessive, and annoying sounds by setting limits that cannot be exceeded at adjacent properties. The Noise Ordinance requirements are not applicable to mobile noise sources (such as cars and heavy trucks) that are traveling on public roadways. Control of the mobile noise sources on public roads is preempted by federal and State laws. However, the Noise Ordinance does apply to vehicles while they are on private property.

Section 10.48.020 of the City’s Municipal Code states that the noise control program established by Municipal Code Chapter 10.48, Community Noise Control, of Title 10, Public Peace, Safety, and Morals, shall be administered by and is the responsibility of, the Noise Control Officer (NCO).

Section 10.48.021 of the City’s Municipal Code states that the NCO shall have, in addition to any other vested authority, the power to:

- A. Review of Public and Private Projects. Review of public and private projects, subject to mandatory review or approval by other departments, for compliance with this ordinance, if such projects are likely to cause noise in violation of Municipal Code Chapter 10.48;
- B. Inspections. Upon presentation of proper credentials and with permission of the property owner or occupant, enter and investigate a potential ordinance violation on any property or place, and inspect any report or records at any reasonable time. If permission is refused or cannot be obtained, a search warrant may be obtained from a court of competent jurisdiction upon showing of probable cause to believe that a violation of this chapter may exist. Such inspection may include administration of any necessary tests.

Section 10.48.022 of the City’s Municipal Code requires the NCO, within a reasonable time after the effective date of the ordinance codified in Municipal Code Chapter 10.48, to:

- A. Guidelines, Testing Methods and Procedures. Develop and promulgate guidelines, testing methods and procedures as required. Any noise measurement procedure used in enforcement of Municipal Code Chapter 10.48 which tends to underestimate the actual noise level of the source being measured shall not invalidate the enforcement action;
- B. Investigate and Pursue Violations. In consonance with provisions of Municipal Code Chapter 10.48, investigate and pursue possible violations;
- C. Delegation of Authority. Delegate functions, where appropriate under Municipal Code Chapter 10.48, to other personnel and to other departments, subject to approval of the City Manager.

Section 10.48.023 of the City’s Municipal Code establishes the duties and responsibilities of other departments:

- A. Departmental Actions. All City departments shall, to the fullest extent consistent with other law, carry out their programs in such a manner as to further the policy and intent of Municipal Code Chapter 10.48.
- B. Project Approval. All departments whose duty it is to review and approve new projects, or changes to existing projects, that may result in the production of disturbing noise, shall consult with the NCO prior to any such approval.

- C. Contracts. Any written contract, agreement, purchase order, or other instrument whereby the City is committed to the expenditure of \$5,000 dollars or more in return for goods or services, and which involves noise-producing activities, shall contain provisions requiring compliance with Municipal Code Chapter 10.48.

Section 10.48.029 of the City's Municipal Code allows construction conducted by the homeowner or resident of a single dwelling, using domestic construction tools is allowed on holidays between the hours of 9:00 a.m. and 6:00 p.m.

Section 10.48.030 of the City's Municipal Code states that provisions of Municipal Code Chapter 10.48 shall not apply to the emission of sound for the purpose of alerting persons to the existence of an emergency, or the emission of sound in the performance of emergency work.

Section 10.48.031 of the City's Municipal Code establishes special exceptions from Municipal Code Chapter 10.48:

- A. The NCO shall have the authority, consistent with this section, to grant special exceptions which may be requested.
- B. Any person seeking a special exception pursuant to this section shall file an application with the NCO. The application shall contain information which demonstrates that bringing the source of sound, or activity for which the special exception is sought, into compliance with this chapter would constitute an unreasonable hardship on the applicant, on the community, or on other persons. Prior to issuance of an exception, the NCO shall notify owners and/or occupants of nearby properties which may be affected by such exceptions. Any individual who claims to be adversely affected by allowance of the special exceptions may file a statement with the NCO containing any information to support his claim. If the NCO finds that a sufficient controversy exists regarding an application, a public hearing may be held.
- C. In determining whether to grant or deny the application, the NCO shall balance the hardship to the applicant, the community, and other persons of not granting the special exception against the adverse impact on the health, safety, and welfare of persons affected, the adverse impact on property affected, and any other adverse impacts of granting the special exception. Applicants for special exceptions and persons contesting special exceptions may be required to submit any information the NCO may reasonably require. In granting or denying an application, the NCO shall place on public file a copy of the decision and the reasons for denying or granting the special exception.
- D. Special exceptions shall be granted by notice to the applicant containing all necessary conditions, including a time limit on the permitted activity. The special exception shall not become effective until all conditions are agreed to by the applicant. Noncompliance with any condition of the special exception shall terminate it and subject the person holding it to those provisions of this chapter regulating the source of sound or activity for which the special exception was granted.
- E. Application for extension of time limits specified in special exceptions or for modification of other substantial conditions shall be treated like applications for initial special exceptions under subsection B of this section.

Section 10.48.032 of the City's Municipal Code states that appeals of any decision of the NCO shall be made to the City Council.

Section 10.48.040 of the City’s Municipal Code sets daytime and nighttime maximum noise levels for residential and non-residential land uses, presented in Table 4 below.

<i>Table 4</i>		
<i>Ambient Base Noise Levels</i>		
<i>Land use at point of origin</i>	<i>Maximum Noise Level at Complaint Site of Receiving Property (A-Decibels)</i>	
	<i>Nighttime</i>	<i>Daytime</i>
Residential	50	60
Non-residential	55	65

Section 10.48.050 of the City’s Municipal Code allows brief noise incidents exceeding the limits shown in Table 4 above during the daytime period only; providing, that the sum of the noise duration in minutes plus the excess noise level does not exceed twenty in a two-hour period. A noise increment of 5 dBA is allowed for up to 15 minutes in a 2-hour period, or an increment of 10 dBA for up to 10 minutes in a 2-hour period, or an increment of 15 dBA for up to 5 minutes in a 2-hour period, or an increment of 20 dBA for up to 1 minute in a 2-hour period.

Section 10.48.041 of the City’s Municipal Code limits the use of motorized equipment for landscape maintenance activities to the hours of 8:00 a.m. to 8:00 p.m. on weekdays, and 9:00 a.m. to 6:00 p.m. on weekends and holidays, with the exception of landscape maintenance activities for public schools, public and private golf courses, and public facilities, which are allowed to begin at 7:00 a.m. The use of motorized equipment for landscape maintenance activities during these hours is exempted from the limits of Section 10.48.040; provided, that reasonable efforts are made by the user to minimize the disturbances to nearby residents by, for example, installation of appropriate mufflers or noise baffles, running equipment only the minimal period necessary, and locating equipment so as to generate minimum noise levels on adjoining properties.

Section 10.48.052 of the City’s Municipal Code allows outdoor events open to the general public on nonresidential property, such as parades, rallies, fairs, concerts and special sales and promotional events, involving generation of noise levels higher than would normally occur, by use of the human voice, public address systems, musical instruments, electronic amplification systems, and similar sound-producing activities, upon obtaining an appropriate permit from the city, and subject to the following general limitations:

- The event shall not produce noise levels above 70 dBA on any residential property for a period longer than three hours during daytime.
- The event shall not produce noise levels above 60 dBA on any residential property during the period from eight p.m. to eleven p.m., and above 55 dBA for any other nighttime period.
- Continuous or repeated peak noise levels above 95 dBA shall not be produced at any location where persons may be continuously exposed.

The conditions imposed upon the event or activity in the permit issued by the City, regarding maximum noise level, location of noise sources, or duration of activity, for example, may be more limiting than this

section, to protect certain individuals, areas or nearby activities which would otherwise be disturbed, and these permit conditions, when in conflict with this section, are overriding.

Section 10.48.053 of the City's Municipal Code allows grading, construction, and demolition activities to exceed the noise limits of Section 10.48.040 during the daytime hours (7:00 a.m. to 8:00 p.m. on weekdays and 9:00 a.m. to 6:00 p.m. on weekends), provided that the equipment utilized has high-quality noise muffler and abatement devices installed and in good condition. In addition, the activity must meet one of the following two criteria:

1. No individual device produces a noise level more than 87 dBA at a distance of 25 feet (7.5 meters); or
2. The noise level on any nearby property does not exceed 80 dBA.

This section also prohibits construction activities within seven hundred fifty feet of a residential area on Saturdays, Sundays and holidays, and during the nighttime period (8:00 p.m. to midnight, and from midnight to 7:00 a.m., and periods on weekends from 6:00 p.m. to midnight and from midnight to 9:00 a.m.), unless it meets the nighttime standards of Section 10.48.040 listed in Table 4 above.

Section 10.48.054 of the City's Municipal Code prohibits noise produced in any multiple-family dwelling unit from producing a noise level exceeding 45 dBA five feet from any wall in any adjoining unit during the period between 7:00 a.m. and 10:00 p.m., or exceeding 40 dBA during hours from 10:00 p.m. to 7:00 a.m. the following day.

Section 10.48.055 of the City's Municipal Code prohibits motor vehicles, including automobiles, trucks, motorcycles, motor scooters and trailers or other equipment towed by a motor vehicle, from remaining in one location with the engine or auxiliary motors running for more than three minutes in any hour, in an area other than on a public right-of-way, unless:

- The regular noise limits of Section 10.48.040 are met while the engine and/or auxiliary motors are running; or
- The vehicle is in use for provision of police, fire, medical, or other emergency services.

Section 10.48.056 of the City's Municipal Code establishes the ownership or operation of a motor vehicle, including automobiles, trucks, motorcycles and other similar devices of a type subject to registration, as defined in California Vehicle Code, which has a faulty, defective, deteriorated, modified, replaced, or no exhaust and/or muffler system, and which produces an excessive and disturbing noise level, as defined in California Vehicle Code Sections 27150 and 27151, as a violation of Municipal Code Chapter 10.48.

The Stationary Vehicle Test Procedure, as adopted by the California Highway Patrol, may be utilized as prima facie evidence of violation of this section.

Section 10.48.057 of the City's Municipal Code establishes ownership or operation of the following as a violation of Municipal Code Chapter 10.48:

- Any off-road recreational vehicle, including all-terrain vehicles, dirt bikes, dune buggies and other similar devices, as defined in Division 16.5 of the California Vehicle Code, which has a faulty, defective, deteriorated, modified, replaced, or no exhaust and/or muffler system, and which produces an excessive and disturbing noise level, as specified in California Vehicle Code Section 38365;

- Any off-road recreational vehicle producing a noise level:
 1. Exceeding 98 dBA within twenty inches of any component at an intermediate engine speed of 2,000 to 4,000 revolutions per minute in a stationary position; or
 2. Exceeding 80 dBA under any condition of acceleration, speed, grade, and load at a distance of 50 feet. At greater or lesser measurement distances, the maximum noise level changes by 4 dB for each doubling or halving of distance. The sound level meter shall be set for FAST response for this measurement.

Section 10.48.061 of the City's Municipal Code establishes it as unlawful and a nuisance for any person to keep, maintain or permit upon any lot or parcel of land within the City under his control any animal, including any fowl, which by any sound or cry shall habitually disturb the peace and comfort of any person in the reasonable and comfortable enjoyment of life or property.

Section 10.48.062 of the City's Municipal Code establishes it as unlawful and a nuisance for any person to make or allow vehicular deliveries or pickups to or from commercial establishments (defined as any store, factory, manufacturing, or industrial plant used for the sale, manufacturing, fabrication, assembly or storage of goods, wares and merchandise) by the use of private roads, alleys or other ways located on either side or the back of any building housing the commercial establishment where such private road, alley or other way lies between the building and any adjacent parcel of land zoned for residential purposes, between the hours of 8:00 p.m. and 8:00 a.m. weekdays (Monday through Friday) and 6:00 p.m. and 9:00 a.m. on weekends (Saturday and Sunday) and holidays except as may be permitted under Section 10.48.029.

Section 10.48.070 of the City's Municipal Code states that any person who violates the provisions of this chapter shall be guilty of a misdemeanor and upon conviction thereof shall be punished as provided in Chapter 1.12.

Vibration

Cupertino General Plan Policy 6-62, Construction and Maintenance Activities, requires construction contractors to use the best available technology to minimize excessive noise and vibration from construction equipment such as pile drivers, jack hammers, and vibratory rollers. Methods to reduce vibration during construction would include the use of smaller equipment, use of well-maintained equipment, use of static rollers instead of vibratory rollers, and drilling of piles as opposed to pile driving. The City’s Municipal Code, however, establishes no specific vibration regulations. In addition, there are no applicable state regulations.

For the purpose of this analysis, thresholds provided by the Federal Transit Administration (FTA) are utilized. The human reaction to various levels of vibration varies from person to persons and is highly subjective. Table 5 shows the level at which vibration becomes perceptible based on various types of land uses that are sensitive to vibration.

*Table 5
Vibration Perceptibility*

Land Use Category	Max L_v (VdB)¹	Description
Workshop	90	Distinctly felt vibration. Appropriate to workshops and nonsensitive areas
Office	84	Felt vibration. Appropriate to offices and non-sensitive areas.
Residential – Daytime	78	Barely felt vibration. Adequate for computer equipment.
Residential – Nighttime	72	Vibration not felt, but groundborne noise may be audible inside quiet rooms.

Source: FTA 2006.
¹ As measured in 1/3 octave bands of frequency over the frequency ranges of 8 to 80 Hz.

In addition to the vibration standards for human annoyance, the FTA also has vibration standards for architectural damage, as shown in Table 6. Architectural damage is possible when the peak particle velocity (PPV) exceeds 0.2 inch per second. This criterion is the threshold at which there is a risk of damage to residential buildings. For structures of reinforced concrete, steel, or timber, architectural damage is possible when the PPV exceeds 0.5 inch per second.

*Table 6
Groundborne Vibration Impact Criteria, Architectural Damage*

Building Category	PPV (inches per second)¹	VdB
I. Reinforced concrete, steel, or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Nonengineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Source: FTA 2006.
¹ RMS velocity calculated from vibration level (VdB) using the reference of one micro-inch per second.

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