# *Appendix F.*
# *Noise Calculations*

# *Noise Appendix*

## 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.

***Table 1***
***Change in Sound Pressure Level, dB***

| *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, Engineering Noise Control, 1988.

## 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.

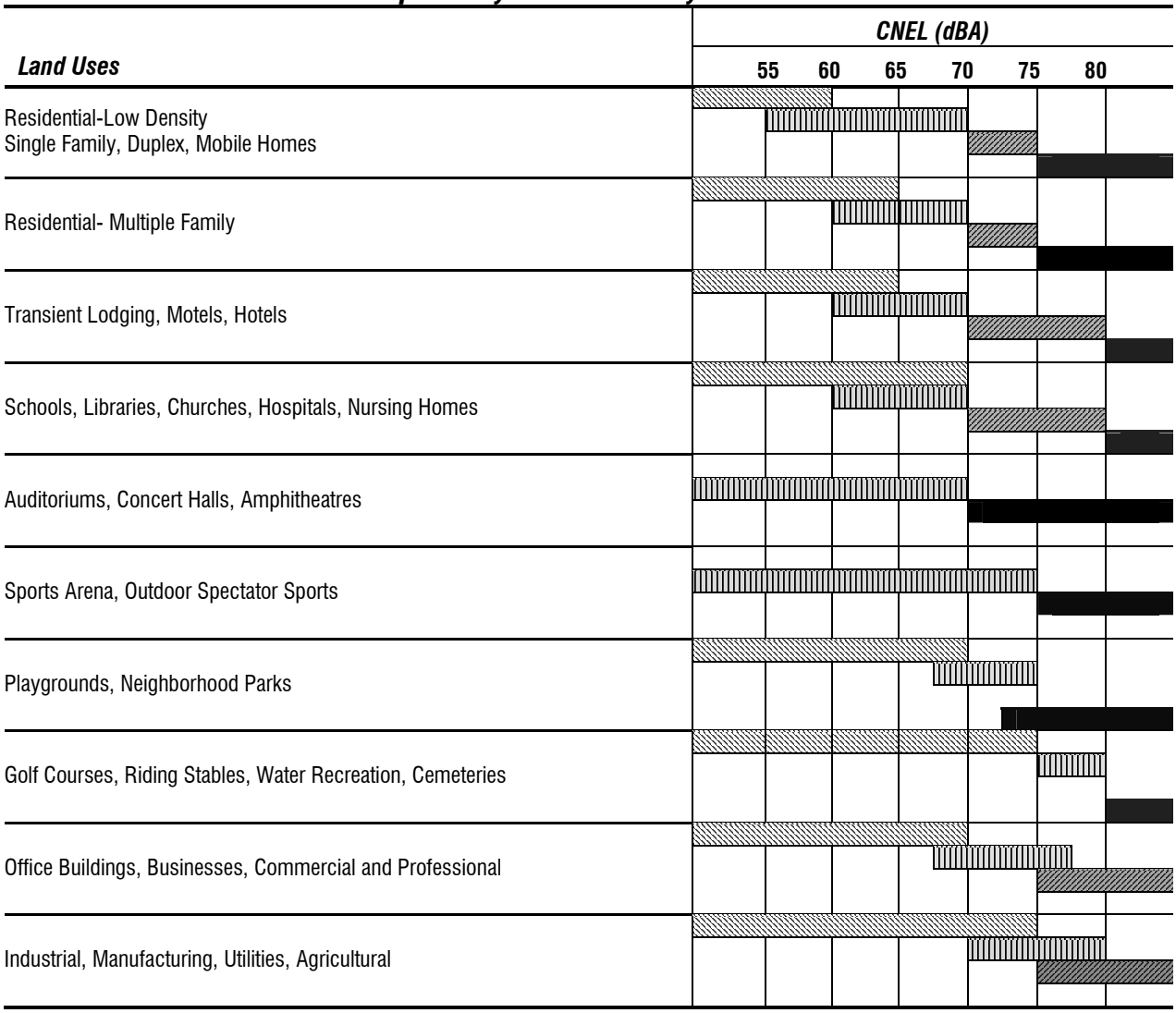
## Regulatory Environment

### *State of California*

*Noise Compatibility*

Table 2, presents a land use compatibility chart for community noise adopted by the California Office of Noise Control. This Table provides urban planners with a tool to gauge the compatibility of land uses relative to existing and future noise levels. Sensitive-type land uses, such as schools and homes, are "normally acceptable" in exterior noise environments up to 65 dBA CNEL and "conditionally acceptable" in areas up to 70 dBA CNEL. A "conditionally acceptable" designation implies that new construction or development should be undertaken only after a detailed analysis of the noise reduction requirements for each land use type is made and needed noise insulation features are incorporated in the design. By comparison, a "normally acceptable" designation indicates that standard construction can occur with no special noise reduction requirements.

## *Table 2*
## *Land Use Compatibility for Community Noise Environments*




**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.

**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.

**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.

**Clearly Unacceptable:**
New construction or development generally should not be undertaken.

Source: California Office of Noise Control. Guidelines for the Preparation and Content of Noise Elements of the General Plan. February 1976. Adapted from the US EPA Office of Noise Abatement Control, Washington D.C. Community Noise. Prepared by Wyle Laboratories. December 1971.

*California Building Code*

The state of California's noise insulation standards are codified in the California Code of Regulations, Title 24, Building Standards Administrative Code, Part 2, California Building Code. These noise standards are applied tor new construction in California for the purpose of interior noise compatibility from exterior noise sources. The regulations specify that acoustical studies must be prepared when noise-sensitive structures, such as residential buildings, schools, or hospitals, are located near major transportation noise sources, and where such noise sources create an exterior noise level of 60 dBA CNEL or higher. Acoustical studies that accompany building plans must demonstrate that the structure has been designed to limit interior noise in habitable rooms to acceptable noise levels. For new residential buildings, schools, and hospitals, the acceptable interior noise limit for new construction in 45 dBA CNEL.

***County of Los Angeles Noise Standards***

*Stationary Noise Standards*

The County of Los Angeles noise and vibration regulation is provided within Title 12, Chapter 12.08, of the Municipal Code. Table 3 identifies the maximum permissible noise limits generated by stationary sources of noise at the boundary of a property. Pursuant to the Noise Control Ordinance, the County restricts noise levels generated at a property from exceeding certain noise levels for extended periods of time. The standards (summarized in Table 3) are applied to nontransportation fans, blowers, pumps, turbines, saws, engines, and other like machinery. These standards do not gauge the compatibility of developments in the noise environment, but provide restrictions on the amount and duration of noise generated at a property, as measured at the property line of the noise receptor. The County's Noise Ordinance is designed to protect people from objectionable nontransportation noise sources such as music, construction activity, machinery, pumps, and air conditioners. However, activities conducted at elementary, intermediate, secondary schools and colleges are exempt from the noise limitations of the County Code.

***Table 3***
***County of Los Angeles Exterior Noise Standards***

| Noise Zone | Time Period | Exterior Noise Limits | | | | |
|---|---|---|---|---|---|---|
| | | $L_{50}$ | $L_{25}$ | $L_{8}$ | $L_{2}$ | $L_{max}$ |
| Noise Sensitive Area | Anytime | 45 | 50 | 55 | 60 | 65 |
| Residential Properties | 10:00 pm to 7:00 am | 45 | 50 | 55 | 60 | 65 |
| | 7:00 am to 10:00 pm | 50 | 55 | 60 | 65 | 70 |
| Commercial Properties | 10:00 pm to 7:00 am | 55 | 60 | 65 | 70 | 75 |
| | 7:00 am to 10:00 pm | 60 | 65 | 70 | 75 | 80 |
| Industrial Properties | Anytime | 70 | 70 | 75 | 80 | 85 |

Source: County of Los Angeles Municipal Code Section 12.08.390
Note: According to the Los Angeles County Code, if the existing ambient noise environment exceeds the standards of the County Code, then the existing ambient noise levels become the exterior noise level standard.

The County also regulates construction noise through the County Code. The County prohibits the operation of construction equipment between weekday hours of 7:00 p.m. and 7:00 a.m., or at any time on Sundays or holidays, such that the sound there from creates a noise disturbance across a residential or commercial real-property line. The County also sets maximum noise limits for long-term construction operation as shown in Table 4.

**Table 4**
**Maximum Construction Noise for Long-Term Operation**

| | Single-Family Residential | Multi-Family Residential | Semiresidential/ Commercial |
|---|---|---|---|
| Daily, except Sundays and legal holidays, 7:00 am to 8:00 pm | 60 dBA | 65 dBA | 70dBA |
| Daily, 8:00 pm to 7:00 am and all day Sunday and legal holidays | 50 dBA | 55 dBA | 60 dBA |

Source: County of Los Angeles Municipal Code Section 12.08.440 August 2005. Applies construction activities occurring for 10 days of more.

***Federal Transit Administration***

The human reaction to various levels of vibration is highly subjective. The FTA provides criteria, shown in Table 4, for acceptable levels of groundborne vibration for various types of land uses that are sensitive to vibration based on the relative perception of a vibration event.

**Table 4**
**Groundborne Vibration and Noise Impact Criteria – Human Annoyance**

| 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: United States Department of Transportation Federal Transit Administration (FTA), *Transit Noise and Vibration Impact Assessment,* May 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 annoyance standards presented above, the FTA also applies standards for construction vibration damage, as shown in Table 5. Structural damage is possible for typical residential construction 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 normal dwelling houses.

**Table 5**
**Groundborne Vibration and Noise Impact Criteria – Structural Damage**

| Building Category | PPV (in/sec) | 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, *Transit Noise and Vibration Assessment,* May 2006.
Notes: RMS velocity calculated from vibration level (VdB) using the reference of one microinch/second.

**Noise and Vibration Sensitive Receptors**

Noise and vibration sensitive uses include residential land uses where quiet environments are necessary for enjoyment and public health and safety.

**Federal Highway Administration (FHWA) Traffic Noise Prediction Model**
**Aveson Charter School**

| Roadway Segment | Speed | 24-hour Traffic Volume | | | Distance to CNEL from Roadway Centerline | | | | Noise Level (CNEL or Ldn) at Distance from Roadway Centerline | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Existing | | | | Future No Project | | | | Future With Project | | | | Change From Existing | Change due to Project |
| | | Existing | Future Without Project | Future With Project | 50.0 Feet | 60 CNEL | 65 CNEL | 70 CNEL | 50.0 Feet | 60 CNEL | 65 CNEL | 70 CNEL | 50.0 Feet | 60 CNEL | 65 CNEL | 70 CNEL | | |
| Allen Avenue | | | | | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 0.0 | 0.0 |
| North of Altadena Drive - 25 | 25 | 1,300 | 1,330 | 1,500 | 59.4 | 45 | 21 | 10 | 59.5 | 46 | 21 | 10 | 60.0 | 50 | 23 | 11 | 0.6 | 0.5 |
| Altadena Dr to Mendocino St - | 35 | 3,000 | 3,100 | 3,220 | 64.1 | 94 | 44 | 20 | 64.3 | 96 | 45 | 21 | 64.4 | 99 | 46 | 21 | 0.3 | 0.2 |
| South of Mendocino Street - 3 | 35 | 5,000 | 5,100 | 5,190 | 66.3 | 132 | 61 | 29 | 66.4 | 134 | 62 | 29 | 66.5 | 136 | 63 | 29 | 0.2 | 0.1 |
| Pinecrest Drive | | | | | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 0.0 | 0.0 |
| Allen Ave to Skyview Drive - 2 | 25 | 960 | 980 | 1,160 | 58.0 | 37 | 17 | 8 | 58.1 | 38 | 17 | 8 | 58.9 | 42 | 20 | 9 | 0.8 | 0.7 |
| Skyview Dr to Loma Alta Dr - | 25 | 750 | 770 | 950 | 57.0 | 31 | 15 | 7 | 57.1 | 32 | 15 | 7 | 58.0 | 37 | 17 | 8 | 1.0 | 0.9 |
| East of Loma Alta Drive - 25 | 25 | 400 | 410 | 420 | 54.2 | 21 | 10 | 4 | 54.4 | 21 | 10 | 5 | 54.5 | 21 | 10 | 5 | 0.2 | 0.1 |
| Loma Alta Drive | | | | | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 0.0 | 0.0 |
| West of School Site - 25 | 25 | 600 | 610 | 620 | 56.0 | 27 | 13 | 6 | 56.1 | 27 | 13 | 6 | 56.1 | 28 | 13 | 6 | 0.1 | 0.1 |
| Northwest of Pinecrest Drive - | 25 | 700 | 710 | 890 | 56.7 | 30 | 14 | 6 | 56.7 | 30 | 14 | 7 | 57.7 | 35 | 16 | 8 | 1.0 | 1.0 |
| Altadena Drive | | | | | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 0.0 | 0.0 |
| West of Lake Avenue - 35 | 35 | 9,600 | 9,800 | 9,820 | 69.2 | 205 | 95 | 44 | 69.3 | 207 | 96 | 45 | 69.3 | 208 | 96 | 45 | 0.1 | 0.0 |
| Lake Ave to Allen Ave - 35 | 35 | 9,000 | 9,200 | 9,230 | 68.9 | 196 | 91 | 42 | 69.0 | 199 | 92 | 43 | 69.0 | 199 | 92 | 43 | 0.1 | 0.0 |
| East of Allen Avenue - 35 | 35 | 6,800 | 6,900 | 6,920 | 67.7 | 163 | 75 | 35 | 67.7 | 164 | 76 | 35 | 67.8 | 164 | 76 | 35 | 0.1 | 0.0 |
| Lake Avenue | | | | | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 0.0 | 0.0 |
| South of Altadena Drive - 35 | 35 | 11,500 | 11,700 | 11,710 | 70.0 | 231 | 107 | 50 | 70.0 | 233 | 108 | 50 | 70.0 | 234 | 108 | 50 | 0.1 | 0.0 |
| Mendocino Street | | | | | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 0.0 | 0.0 |
| West of Allen Avenue - 35 | 35 | 3,000 | 3,100 | 3,130 | 64.1 | 94 | 44 | 20 | 64.3 | 96 | 45 | 21 | 64.3 | 97 | 45 | 21 | 0.2 | 0.0 |
| | | | | | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 4.8 | 0 | 0 | 0 | 0.0 | 0.0 |

**Assumptions:** Speed Limits based on the Traffic Report prepared by Garland Associates (2009)

Federal Highway Administration Highway Traffic Noise Prediction Model, December, 1978. Baseline California vehicle noise levels from Caltrans, TAN 95-03, 1995

Simplified to 2 lanes 6.1 meters= 20.0

future 6.1 meters= 20.0

Noise path decay parameter for hard site

24-hour distribution of traffic volu Analysis of L.A. County 24-ho Analysis of L.A. County 24-hour traffic counts for selected arterial streets

70% day (7-7), 15% evening (7-10), 15% night (10-7)

92% LDA, 3% MDT, 5% HDT

Site paramet 0.0

HALFSEP 1/2 lane separation 6.1

HALFSEPFUT 1/2 lane separation (ful 6.1

California base noise levels:

Autos 5.2+38.8 Log10 (speed, mi/hr) = -2.8 + 38.8 Log10 (speed, km/hr) ARB standard fleet mix for air quality analysis

Light trucks: 35.3 + 25.6 Log10 (speed, mi/hr) = 30 + 25.6 Log10 (speed, km/hr) Heavy trucks for noise model includes heavy diesel tractor-trailers only

Heavy trucks: 25-31 mi 51.9 + 19.2 Log10 (speed, mi/hr) = 47.9 + 19.2 Log10 (spee Medium trucks for noise model includes buses and bobtail trucks

35-65 mi 50.4 + 19.2 Log10 (speed, mi/hr) = 46.4 + 19.2 Log10 (spee Autos includes cars, vans, pickups and light trucks

31-35 mi straight line interpolation between above two curves

# Construction Generated Vibration

| | Small Bulldozer | Closest Distance | Average Distance |
|---|---|---|---|
| **Receptor Location: Off-Site Residences** | | **50** | **145** |
| **Vibration Annoyance Assessment** | | | |
| Approximate Velocity at 25 ft (VdB) | 58 | | |
| Approximate Velocity (VdB) at Receptor (Closest) | 52 | | |
| Approximate Velocity (VdB) at Receptor (Average) | 43 | | |
| **Criteria** | **78** | | |
| **Structural Damage Assessment** | | | |
| Approximate RMS Velocity at 25 feet (inch per second) | 0.003 | | |
| Approximate Velocity (inch/sec) at Receptor (Closest) | 0.001 | | |
| **Criteria** | **0.2** | | |

[1.] Determined based on use of jackhammers or pneumatic hammers that may be used for pavement demolition at a distance of 25 feet

Notes: RMS velocity calculated from vibration level (VdB) using the reference of one microinch/second.

Source: Based on methodology from the United States Department of Transportation Federal Transit Administration, *Transit Noise and Vibration Impact Assessment* (2006).

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 07/13/2009
Case Description: Aveson

**** Receptor #1 ****

| Description | Land Use | Baselines (dBA) Daytime | Evening | Night |
|---|---|---|---|---|
| Residential | Residential | 55.0 | 50.0 | 45.0 |

| Description | Impact Device | Usage (%) | Equipment Spec Lmax (dBA) | Actual Lmax (dBA) | Receptor Distance (feet) | Estimated Shielding (dBA) |
|---|---|---|---|---|---|---|
| Backhoe | No | 40 | | 77.6 | 50.0 | 0.0 |

Results

Noise Limits (dBA)

Noise Limit Exceedance (dBA)

| Night | Day | Calculated (dBA) Evening | Night | Day Evening | Night | Evening |
|---|---|---|---|---|---|---|
| Equipment | Lmax Leq | Lmax Leq | Lmax Leq | Lmax Leq | Lmax Leq | Lmax Leq |
| Backhoe | 77.6 73.6 | N/A N/A | N/A N/A | N/A N/A | N/A N/A | N/A N/A |
| Total | 77.6 73.6 | N/A N/A | N/A N/A | N/A N/A | N/A N/A | N/A N/A |

## Noise Modeling of Daytime Athletic Field Activities at Noise-Sensitive Uses

### Monitored Noise Levels

| Outdoor Athletic Fields | Initial Sound Pressure | | | | | | Initial number of noise sources | Measurement Distance | Based on Noise Monitoring of: |
|---|---|---|---|---|---|---|---|---|---|
| | Leq | L50 | L25 | L16 | L8 | Lmax | | | |
| Football Field | 57.0 | 51.2 | 53.2 | 54.5 | 57.5 | 72.7 | 17 | 50 | Football |
| Soccer Fields | 59.8 | 53.8 | 56.6 | 58.4 | 61.3 | 86.5 | 39 | 14 | Soccer |
| Tennis Courts | 59.5 | 58.6 | 60.0 | 60.8 | 62.1 | 73.3 | 10 | 20 | Tennis |
| Basketball Courts | 63.6 | 61.9 | 64.0 | 65.3 | 66.9 | 77.1 | 12 | 27 | Basketball |
| Pool | 63.6 | 61.9 | 64.0 | 65.3 | 66.9 | 77.1 | 12 | 27 | Basketball |
| Baseball/Softball Field | 53.6 | 51.5 | 53.3 | 54.4 | 56.4 | 77.7 | 25 | 147 | Softball |

### Daytime Play Field Noise Levels at 50 feet

| Outdoor Athletic Fields | New number of noise sources | Hard Ground? | Hard (0) or Soft Site | Distance to Property Line | Future Sound Pressure Level | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Leq | L50 | L25 | L16 | L8 | Lmax |
| Football Field | 17 | No | 0.66 | 50 | 57.0 | 51.2 | 53.2 | 54.5 | 57.5 | 72.7 |
| Soccer Fields | 39 | No | 0.66 | 50 | 45.1 | 39.1 | 41.9 | 43.7 | 46.6 | 71.8 |
| Tennis Courts | 10 | Yes | 0.00 | 50 | 51.5 | 50.6 | 52.0 | 52.8 | 54.1 | 65.3 |
| Basketball Courts | 12 | Yes | 0.00 | 50 | 58.2 | 56.5 | 58.6 | 59.9 | 61.5 | 71.7 |
| Pool | 12 | No | 0.66 | 50 | 56.5 | 54.8 | 56.9 | 58.2 | 59.8 | 70.0 |
| Baseball/Softball Field | 25 | Yes | 0.00 | 50 | 63.0 | 60.9 | 62.7 | 63.8 | 65.8 | 87.1 |

Athletic Field Noise data obtianed from noise monitoring of Sports Activities conducted by The Planning Center at Miles Square Park in Fountain Valley, California.