4.10 NOISE

This section describes the potential effects of the proposed Project in relation to noise and vibration. Included in this chapter is background information on noise and vibration, a brief summary of the regulatory framework that pertains to the proposed Project, an evaluation of the significance of Project impacts including noise and land use compatibility, long-term noise level increases resulting from Project-generated traffic, temporary noise, and vibration impacts during construction, and cumulative impacts. This chapter incorporates the findings of the noise study prepared for the proposed Project by Wilson Ihrig & Associates (WIA), which underwent a third-party peer review, and supplements those findings with additional field measurements conducted by The Planning Center | DC&E, as well as with calculations for noise and vibration impacts. The WIA study is included as Appendix I of this Draft EIR.

A. Noise and Vibration Terminology

1. Noise

Noise is unwanted sound. Several noise measurement scales are used to describe noise in a specific location. A decibel (dB) is a unit of measurement that indicates the relative amplitude of a sound. The zero on the decibel scale is based on the lowest sound pressure that the healthy, unimpaired human ear can detect under controlled conditions. Sound levels in decibels are calculated on a logarithmic basis using the ratio of the assumed or measured sound pressure divided by a standardized, reference pressure (for sound, the reference pressure is 20 μPascals). Each 10 dB increase in sound level is perceived as an approximate doubling of loudness over a fairly wide range of amplitudes.

There are several methods of characterizing sound. The A-scale is a filter system that closely approximates the way the human ear perceives sound at different frequencies. Noise levels using A-weighted measurements are denoted with the abbreviation of "dB(A)" or "dBA." The A-weighting filter system is very commonly used in the measurement and reporting of community noise, as well as in nearly all regulations and ordinances. All sound levels in this report are A-weighted, unless noted otherwise.

Because sound levels can vary markedly over a short period of time, a method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, environmental sounds are described in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This energy-average or energy-equivalent sound/noise descriptor is abbreviated as L_{eq}. An hour is the most common time period over which energy-average sound is measured, but it can be measured over any duration (and the duration should be specified when the L_{eq} level is reported). Alternately, varying sound levels can be described by their statistical distribution over some fraction of a given observation period. These statistical sound levels are typically abbreviated as "L_n." For example, the L_{50} noise level represents the noise level that is exceeded n=50 percent of the time. That is, half of the time the noise level exceeds this level and half of the time the noise level is less than this level. For practical implementation, this level is representative of the noise that is exceeded 30 minutes in an hour. Similarly, the L_2, L_8, and L_{25} values represent the noise levels that are exceeded n=2, 8, and 25 percent of the time or, equivalently, 1, 5, and 15 minutes in any given hour. These "n" values are typically used to demonstrate compliance for stationary noise sources with a city's noise ordinance, as discussed below. Other values typically noted during a noise survey are the L_{min} and L_{max}. These values represent the minimum and maximum root-mean-square noise levels obtained over the measurement period.

Sensitivity to noise is subjective and varies from person to person, with the particular setting, and with the time-of-day. Sensitivity to noise typically increases during the evening and nighttime hours, when excessive noise can interfere with at-home activities and the ability to sleep. To account for these day/evening/night differences in sensitivity, 24-hour descriptors have been developed that incorporate artificial noise penalties that are added to quiet-time noise events. The Day/Night Average Sound Level, abbreviated as "L_d," is a measure of the cumulative noise exposure in a community, with a 10 dB addition applied to nocturnal (10:00 p.m. to 7:00 a.m.) noise levels. A similar 24-hour metric is the Community Noise Equivalent Level, or "CNEL," which extends the sensitivity adjustment by also applying a 3 dB addition to

noise levels in the evening hours (7:00 p.m. to 10:00 p.m.). For typical community noise environments, the L_{dn} and CNEL levels are nearly always within 1 dB of each other and, therefore, are commonly used interchangeably (as will be the case in this document).

Additional technical terms are defined in Table 4.10-1. To provide a frame of reference to common experiences, representative outdoor and indoor noise levels are shown in Table 4.10-2.

2. Groundborne Vibration

Ground vibration consists of rapidly fluctuating motions or waves with an average motion of zero. Several methods are typically used to quantify the amplitude of vibration including Peak Particle Velocity (PPV) and Root Mean Square (RMS) velocity. PPV is defined as the maximum instantaneous positive or negative peak of the vibration wave. RMS velocity is defined as the square root of the arithmetic mean (average) of the squares of the original velocity values. PPV and RMS vibration velocity amplitudes are used to evaluate human response to vibration. Table 4.10-3 displays human annoyance and the effects on buildings resulting from continuous vibration.

As discussed previously for noise, annoyance to vibration is also subjective and dependent on situational conditions such as the receptor's physical orientation, the frequency content of the vibrational energy, and the impulsiveness of the vibration (described, in part, by the crest factor). Vibrations may be found to be annoying at much lower levels than those shown in the table; depending on the level of activity and/or the sensitivity of the individual. To sensitive individuals, vibrations approaching the threshold of perception can be annoying.

Low-level vibrations frequently cause irritating, secondary vibration, such as a slight rattling of windows, doors, or stacked dishes. The rattling sound can give rise to exaggerated vibration complaints, even though there is very little risk of actual structural damage. In high noise environments, which are more prevalent where groundborne vibration approaches perceptible levels, this

TABLE 4.10-1 **DEFINITIONS OF ACOUSTICAL TERMS**

Term	Definitions
Decibel, dB	A unit of level that denotes the ratio between two quantities proportional to power; the number of decibels is 10 times the logarithm (to the base 10) of this ratio. For decibels describing sound pressures, the reference pressure is 20 μPascals.
Frequency, Hz	Of a function periodic in time, the number of times that the quantity repeats itself in one second (i.e., number of cycles per second).
A-Weighted Sound Level, dBA	The sound level obtained by use of the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted, unless noted otherwise.
Statistical Sound Level or n-exceedance Sound Level, L_n (e.g., L_{01}, L_{10}, L_{50}, L_{90})	The fast-response, A-weighted noise levels equaled or exceeded by a fluctuating sound level for n-percent of a stated time period. For example, 1 percent, 10 percent, 50 percent, and 90 percent of the stated period. The L_{10} level is commonly called the 'intrusive sound level' and is near the maximum level in that time period, while the L_{90} is commonly called the 'residual sound level' and is near the minimum level in that period.
Equivalent Continuous Noise Level, L_{eq}	The level of a steady sound that, in a stated time period and at a stated location, has the same A-weighted sound energy as the time-varying sound.
Community Noise Equivalent Level*, CNEL	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of five decibels to sound levels occurring in the evening from 7:00 p.m. to 10:00 p.m. and after the addition of 10 decibels to sound levels occurring in the nighttime between 10:00 p.m. and the following 7:00 a.m.
Day/Night Noise Level*, L_{dn}	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 10 decibels to sound levels occurring in the nighttime between 10:00 p.m. and 7:00 a.m.
L_{max}, L_{min}	The maximum and minimum A-weighted sound levels measured on a sound level meter, during a designated time interval, using fast-response time averaging. The L_{max} is equal to the L_0 and the L_{min} is equal to the L_{100}.
Ambient Noise Level	The all-encompassing noise associated with a given environment at a specified time. It is usually a composite of sounds from many sources and from many directions, both near and far, with no particular sound source being dominant.
Intrusive	The noise that intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, time of occurrence, and tonal or informational content, as well as the increment above the ambient noise level.

* Note: L_{dn} and CNEL values rarely differ by more than 1 dB. As a matter of practice, CNEL values are considered to be equivalent to and interchangeable with L_{dn} values and are treated as such in this assessment.
Source: Harris, Cyril, 1998. Handbook of Acoustical Measurements and Noise Control. Acoustical Society of America, 3rd Edition.

TABLE 4.10-2 **TYPICAL SOUND LEVELS**

Common Outdoor Activities	Noise Level, dBA Perception	Common Indoor Activities
Jet Engine (within 25 feet)	-140- damaging	None
Civil Defense Siren (within 25 feet)	-130- threshold of pain	None
Accelerating noisy motorcycle (within 10 feet)	-120- threshold of feeling	Hard rock band (close to stage)
Power Saw (at 3 feet)	-110- extremely loud	Other concert (close to stage)
Subway; Jet Fly-over (at 100 feet)	-100- very loud	
Gas Lawnmower (at 3 feet)	-95- very loud	Crying Baby (within 3 feet)
Tractor (at 25 feet)	-90- very loud	
Some Construction Equipment (at 50 feet)	-85- loud	Food Blender (at 1 foot)
Diesel Truck going 50 mph (at 50 feet)	-80- loud	Garbage Disposal (at 1 foot)
Noisy Urban Area during Daytime	-75- moderately loud	Busy restaurant
Gas Lawnmower (at 100 feet)	-70- moderately loud	Vacuum Cleaner (at 10 feet)
Commercial Area	-65- moderate	Normal Speech (at 3 feet)
Heavy Traffic (at 300 feet)	-60- moderate	Sewing machine
Air Conditioner	-55- moderate	Large Business Office
Quiet Urban Area during Daytime	-50- quiet	Dishwasher in Next Room
Quiet Urban Area	-45- quiet	Refrigerator
Quiet Urban Area during Nighttime	-40- faint	Theater, Large Conference Room (background)
Quiet Suburban Area during Nighttime	-35- faint	Average residence (without audio or video systems)
Quiet Suburban Area during Nighttime	-30- very faint	Library
Quiet Rural Area	-25- very faint	Bedroom at Night, Concert Hall (background)
Rustling Leaves	-20- very quiet	Broadcast/Recording Studio
Very Quiet Remote Area	-15- extremely quiet	Anechoic chamber or sound testing laboratory
Threshold of Human Hearing	-0-	Threshold of Human Hearing

Sources: California Department of Transportation, Noise, Air Quality, and Hazardous Waste Management Office, *Technical Noise Supplement*, November 2009. The Planning Center | DC&E reference files.

TABLE 4.10-3 **REACTION OF PEOPLE AND DAMAGE TO BUILDINGS FOR CONTINUOUS VIBRATION LEVELS**

Velocity Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.006 to 0.019	Threshold of perception: Possibility of intrusion	Vibration unlikely to cause damage of any type
0.08	Vibrations readily perceptible	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected
0.10	Level at which continuous vibrations begin to annoy people	Virtually no risk of "architectural" damage to normal buildings
0.20	Vibrations annoying to people in buildings	Threshold at which there is a risk of "architectural" damage to normal dwellings such as plastered walls or ceilings.
0.4 to 0.6	Vibrations considered unpleasant by people subjected to continuous vibrations	Vibration at this level would cause "architectural" damage and possibly minor structural damage.

Source: Transportation Related Earth-borne Vibrations. Caltrans, Technical Advisory, TAV-02-01-R9601, February 2002.

rattling phenomenon may also be produced by loud airborne environmental noise which causes induced vibration in exterior doors and windows.

Construction activities can cause vibration that varies in intensity depending on several factors. Pile driving and vibratory compaction equipment typically generate the highest construction-related groundborne vibration levels. Because of the impulsive nature of such activities, the use of the peak particle velocity (PPV) descriptor has been routinely used to measure and assess groundborne vibration and, almost exclusively, to assess the potential of vibration to induce structural damage and/or annoyance reactions from humans.

The two primary concerns with construction-induced vibration – the potential to damage a structure and the potential to interfere with the enjoyment of life – are evaluated against different vibration limits. Studies have shown that the threshold of perception for average persons is in the range of 0.008 to 0.012 inches/sec (0.2 to 0.3 mm/sec) in PPV. Human perception to vibration varies with the individual and is a function of the physical setting and the type of vibration. Persons exposed to elevated ambient vibration levels, such as people in an urban environment, may tolerate a higher vibration level.

One of the problems with developing suitable criteria for groundborne vibration is the limited research into human response to vibration and, more importantly, human annoyance inside buildings. The U.S. Department of Transportation, Federal Transit Administration has developed rational vibration limits that can be used to evaluate human annoyance to groundborne vibration. These criteria are primarily based on experience with rapid transit and commuter rail systems.

Structural damage can be classified as cosmetic only, such as minor cracking of building elements, or damage that may threaten the integrity of a building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher and there is no general consensus as to what amount of vibration may pose a threat for structural damage to a building. Construction-induced vibration that can be detrimental to the building is very rare and has only been observed in instances where the structure is in a high state of disrepair and the construction activity occurs immediately adjacent to the structure.

B. Regulatory Setting

Federal, State, and local regulatory criteria have been developed to minimize noise and vibration exposure at sensitive land uses. This section describes the regulatory framework related to noise and vibration in and around the Project site.

1. State Regulations

Multi-family housing in the State of California is subject to the environmental noise limits set forth in the 2007 California Building Code (Chapter 12, Appendix Section 1207.11.2). Also, the California Code of Regulations (CCR) Title 24 "Sound Transmission Control" requires an acoustical analysis for any new residential building located in an area where the annual Day-Night Noise level (L_{dn}) exceeds 60 decibels [dBA] (technical terms are defined in Section A, above). The report resulting from this analysis is required to show the topographical relationship of noise sources and dwelling sites, and to state the predicted noise exposure levels at the exterior of the proposed dwelling structures; considering present and future conditions as the basis for the predictions. The report is to identify noise attenuation measures to be applied and to provide an analysis demonstrating that the proposed buildings could be designed to limit intruding noise.[1] Title 24 also establishes that the maximum interior noise level at any habitable room due to exterior noise should be no more than 45 dBA L_{dn} or, equivalently, 45 dBA CNEL. Title 24 further requires that the building be oriented, shielded, and designed to have sufficient sound insulation so as to meet such maximum level attributable to exterior sources in any habitable room with all exterior doors and windows in the closed position.

2. Local Regulations

a. City of Lafayette General Plan Noise Element

The Noise Element of the City's General Plan sets forth several policies and programs to assess and control environmental noise. These policies and programs establish indoor and outdoor noise standards for residential uses.

To evaluate the compatibility between land uses and future noise in Lafayette, the Noise Element includes land use and noise compatibility guidelines, presented in Table 4.10-4 below. For ambient noise of up to 55 dBA L_{dn}, the development of multi-family residential projects are considered "normally

[1] As summarized in: Wilson Ihrig & Associates (WIA), June 16, 2011, CCR Title 24 Noise Study, The Terraces of Lafayette Multifamily Project, Lafayette, California.

TABLE 4.10-4 **CITY OF LAFAYETTE NOISE AND LAND USE COMPATIBILITY STANDARDS**

Land Use Category	Exterior Noise Exposure (Ldn dB) 55	60	65	70	75	80
Residential, Hotels, and Motels						
Outdoor Sports and Recreation, Neighborhood Parks and Playgrounds						
Schools, Libraries, Museums, Hospitals, Personal Care, Meeting Halls, Churches						
Office Buildings, Business Commercial and Professional						
Auditoriums, Concert Halls, Amphitheaters						

NORMALLY ACCEPTABLE
Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal, conventional construction, without any special insulation requirements.

CONDITIONALLY ACCEPTABLE
Specified land use may be permitted only after a detailed analysis of the noise reduction requirements and needed noise insulation features included in the design.

UNACCEPTABLE
New construction or development should generally not be undertaken because mitigation is usually not feasible to comply with noise element policies.

Source: City of Lafayette General Plan, Noise Element.

acceptable," and for ambient noise levels ranging from 55 dBA L_{dn} to 75 dBA L_{dn}, development of multi-family residential projects are considered "conditionally acceptable." Under "conditionally acceptable" conditions, the specified land use may be permitted only after a detailed analysis of the noise reduction requirements and needed noise insulation features included in the design.

Policy N-1.3 of the Noise Element, dealing with Noise and Land Use Compatibility Standards, was enacted to ensure that all new noise-sensitive development proposals be reviewed with respect to (the above matrix). Noise exposure shall be determined through actual on-site noise measurements.

Program N-1.2.2 includes criteria to evaluate noise impacts from new developments to sensitive uses. Substantial increase would result if a project would:

- Cause the Ldn in existing residential areas to increase by 3 dB or more; or
- Cause the Ldn in existing residential areas to increase by 2 dB or more if the Ldn would exceed 70 dB; or
- Cause the Ldn resulting exclusively from project-generated traffic to exceed an Ldn of 60 dBA at any existing residence.

For multi-family developments, the outdoor standard of 60 dBA L_{dn} applies for recreational areas such as pool and playground areas. For multi-family patios and balcony areas, the standard is 65 dBA L_{dn}. The basic indoor noise standard for residential uses is 45 dBA L_{dn}, which is consistent with the State's Title 24 requirements and which is promulgated in the Noise Element via Program N-1.4.3.

While the State Title 24 mandates an acoustical analysis for any new residential building located in an area where the annual Day-Night Noise level (L_{dn}) exceeds 60 decibels, the City's Noise Element (in Program N-1.4.2) uses an even stricter threshold of 55 dBA L_{dn}. Program N-1.4.2 states: "This study shall describe how the proposed Project will comply with the Noise and Land Use Compatibility Standards. The study shall also satisfy the requirements set forth in Title 24, part 2 of the California Government Code, Noise Insulation Standards, for multi-family attached dwellings, hotels, motels, etc., regulated by Title 24."

The City's Noise Element requirements for interior noise are contained in Policy N-1.4: "Residential and Noise Sensitive Land Use Standards: Require a

standard of 40 - 45 L_{dn} (depending on location) for indoor noise level for all new residential development including hotels and motels, and a standard of 55 L_{dn} for outdoor noise, except near the freeway. These limits shall be reduced by 5 dB for senior housing and residential care facilities." However, no indication is given in the Element as to which locations require mitigation of interior noise to 40 L_{dn}. As such, both the WIA report and this document use a 45 dBA L_{dn} criteria for interior noise, which is consistent with the requirements of the California Code of Regulations Title 24.

b. Lafayette Municipal Code

i. Community Noise

The Lafayette Municipal Code (Chapter 5-2) contains the City's Noise Ordinance. The Noise Ordinance is designed to control unnecessary, excessive, and annoying sounds from sources on private property by setting limits that cannot be exceeded at adjacent properties. The Noise Ordinance specifies noise levels that cannot be exceeded at adjacent properties for a specified period of time, as presented in Table 4.10-5.

The allowed noise level standards shown on Table 4.10-5 shall not be exceeded:

- For a cumulative period of more than thirty minutes in any hour; or
- The noise standard plus five dB(A) for a cumulative period of more than 15 minutes in any hour; or
- The noise standard plus ten dB(A) for a cumulative period of more than 5 minutes in any hour; or
- The noise standard plus fifteen dB(A) for a cumulative period of more than 1 minute in any hour; or
- The noise standard plus twenty dB(A) for any period of time.

ii. Construction Noise

The Municipal Code limits the hours of permitted construction to the hours of 8:00 a.m. to 8:00 p.m. Monday through Saturday, and between 10:00 a.m.

TABLE 4.10-5 **CITY OF LAFAYETTE NOISE ORDINANCE STANDARDS**

	Noise Level Limit Standard—dBA	
Receiving Land Use Category	**10 p.m. to 7 a.m.**	**7 a.m. to 10 p.m.**
Single-family residential	45	50
Multi-family residential, schools, libraries, public spaces	50	55
Commercial	60	55

Source: Lafayette Municipal Code, Table 5-205.

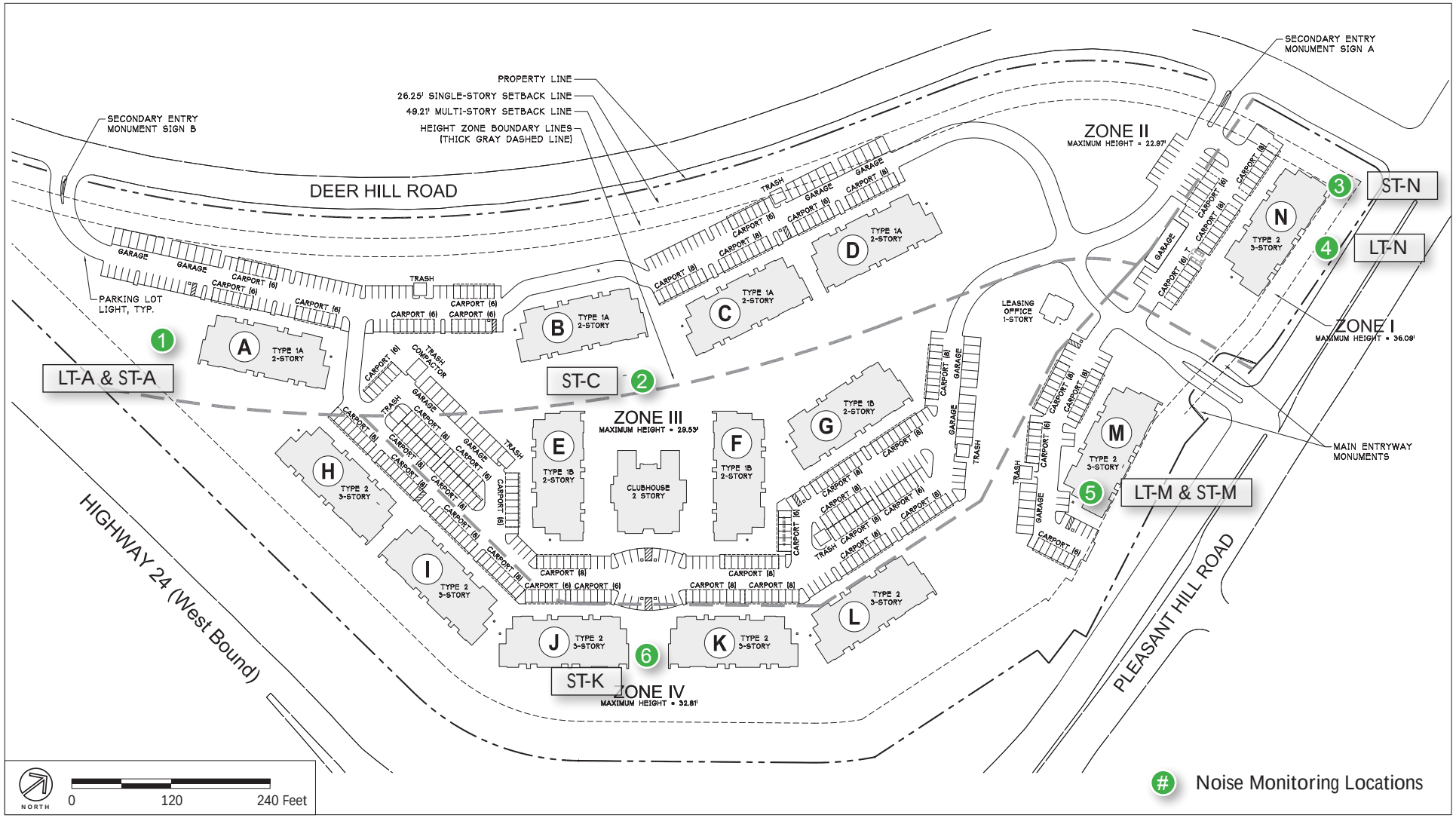
to 6:00 p.m. on Sundays and legal holidays, provided that such construction activities do not exceed 80 dBA at the nearest affected property or individual equipment items do not exceed 83 dBA at 50 feet (Section 5-208[d]). For construction equipment that does not create a noise disturbance, as defined by the stationary noise limits, construction activities can operate between 7:00 a.m. and 10:00 p.m. (Section 5-207[e]).[2]

C. Existing Conditions

1. Noise

An ambient noise survey and acoustical evaluation was completed by Wilson Ihrig Associates Inc. (WIA) in June of 2011. Ambient noise monitoring was conducted by WIA at three locations to determine the existing noise levels in the Project site. Long term noise level measurements were taken continuously from May 19 to May 25, 2011 (i.e., seven full day, inclusively) and provided typical hourly ($L_{eq\text{-}1hr}$), and daily levels (L_{dn}). Short-term noise level measurements were also taken at five locations by WIA during this same survey period to evaluate the noise frequency spectrum. The noise monitoring locations taken at the Project site by WIA are presented in Figure 4.10-1, and the results

[2] City of Lafayette, 2011. City of Lafayette Municipal Code.



Source: LCA Architects.

FIGURE 4.10-1

ON-SITE NOISE LEVEL MEASUREMENT LOCATIONS

of the noise level measurements taken at the Project site are summarized in Table 4.10-6; the methodology and detailed results of the noise measurements are included in Appendix I.

The long term noise levels in the Project site taken at location LT-A, which is representative of the south exposure for proposed Building A, H, I and J, measured 68 dBA L_{dn}. The long-term noise measurements taken at location LT-M, which is representative of the south exposure of buildings K&L measured 67 dBA L_{dn}. The long-term noise measurements taken at location LT-N, which is representative of the east exposure of Building N measured 73 dBA L_{dn}. These measurements indicate that the major sources of noise in the Project site are vehicular traffic on Pleasant Hill Road on the east side of the site, and traffic on State Highway 24 on the south and west sides of the site. The Project site is also affected by BART train pass-bys and background traffic noise on Deer Hill Road and Interstate 680, located about 1 mile to the east.

To evaluate the existing conditions at the homes in the vicinity of the Project site, noise level measurements were taken by The Planning Center | DC&E on December 6, 2011. Table 4.10-7 summarizes the results of the noise level measurements taken at nearby homes in the vicinity of the Project site. These noise level measurements were taken at off-site locations (shown in Figure 4.10-2) to evaluate the existing noise conditions at the residential areas nearest to the Project site and to assess potential impacts from the proposed Project to off-site uses. The noise measurement detailed results are presented in Appendix I.

2. Vibration

There are no major stationary sources of groundborne vibration in the vicinity of the Project site. BART trains operate on a rail line approximately 150 feet south of the Project site boundary (and approximately 240 feet south of the nearest proposed Project apartment building). To evaluate groundborne impacts to the Project site, the Federal Transit Administration's (FTA) general vibration assessment methodology was utilized. The procedure provides

TABLE 4.10-6 **ON-SITE EXISTING NOISE LEVELS SUMMARY**

Measurement Location[a]	Noise Levels (dBA) L_{DN}	Noise Levels (dBA) L_{eq}	Measurement Type
LT-A	68	–	Long-term (7-day average)
LT-M	66	–	Long-term (7-day average)
LT-N	73	–	Long-term (7-day average)
ST-A	–	65	Short-term (approximately 15 minutes)
ST-B	–	61	Short-term (approximately 15 minutes)
ST-K	–	63	Short-term (approximately 15 minutes)
ST-M	–	63	Short-term (approximately 15 minutes)
ST-N	–	62	Short-term (approximately 15 minutes)

[a] On-Site noise monitoring locations included in Figure 4.10-1.
Source: Noise monitoring was conducted May 19, 2011 by Wilson, Ihrig & Associates.

TABLE 4.10-7 **OFF-SITE EXISTING NOISE LEVELS SUMMARY**

Measurement Location[a]	Noise Levels (dBA) L_{DN}	Noise Levels (dBA) L_{eq}	Measurement Type
ST-1	–	54	Short-term (approximately 15-minutes)
ST-2	–	66	Short-term (approximately 15-minutes)
ST-3	–	67	Short-term (approximately 15-minutes)

[a] Off-Site noise monitoring locations included in Figure 4.10-2.
Source: Noise monitoring was conducted on December 06, 2011 by The Planning Center | DC&E.

Source: Google Earth Pro 2011; The Planning Center | DC&E, 2012.

FIGURE 4.10-2

OFF-SITE NOISE LEVEL MEASUREMENT LOCATIONS

screening distances from the rail line to the property line, where further analysis would be required to evaluate vibration impacts. For FTA Category 1 land uses (i.e. residences and buildings where people normally sleep), the critical distance from the right-of-way is 200 feet.[3] Although the property line is 150 feet from the rail line, the proposed residential structures are no closer than 240 feet, so the actual land uses that would potentially be subject to groundborne vibration are beyond the screening distance. The distance of the site to the tracks is outside the screening distance that would require further evaluation, therefore, vibration from BART train pass-bys are not significant, and no further evaluation to analyze vibration impacts would be required for this source of vibration.

D. Standards of Significance

The proposed Project would have a significant impact with regard to noise if it would result in any of the following:

1. Exposure of people to or generation of noise levels in excess of standards established in the local General Plan or noise ordinance, or applicable standards of other agencies.
2. Exposure of people to or generation of excessive groundborne vibration or groundborne noise levels.
3. Substantial permanent increase in ambient noise levels in the Project vicinity above levels existing without the Project.
4. A substantial temporary or periodic increase in ambient noise levels in the Project vicinity above levels existing without the Project.
5. For a project located within an airport land use plan or where such a plan has not been adopted, within two miles of a public airport or public-use airport, exposure of people residing or working in the Project area to excessive noise levels.

[3] Federal Transit Administration, 2006. Transit Noise and Vibration Impact Assessment, FTA-VA-90-1003-06, Chapter 9, Table 9-2.

6. For a project within the vicinity of a private airstrip, exposure of people residing or working the Project area to excessive noise levels.

E. Impact Analysis

This section discusses the potential noise related impacts as a result of the development of the proposed Project.

1. Would the Project expose people to or generate noise levels in excess of established standards.

As discussed above, the City of Lafayette set noise standards for exterior and interior noise for new residential developments. Wilson Ihrig & Associates (WIA) prepared an acoustical study to evaluate the noise impacts to the proposed Project and to propose architectural design features needed to meet the City's interior noise standards. In the WIA study, future noise was estimated assuming a standardized annual traffic volume increase over the next 10 years (see Appendix I for additional information). This corresponds to an effective increase over the coming decade of 1 dB above the existing conditions for traffic-related noise. Based on the results of the WIA noise measurements taken at the Project site and on the adjustments to account for future traffic growth, the proposed Project would be exposed to future exterior noise levels between 67 and 74 dBA L_{dn} at some of the building facades. These results, in concert with the recommended architectural design features, would be considered 'conditionally acceptable' in terms of the City's Land Use/Noise Compatibility standards presented in Table 4.10-4.

a. Exterior Noise Requirements

The Noise Element, Program N-1.4.2, requires that an acoustical study be conducted for all new residential projects with a future L_{dn} noise exposure of 55 L_{dn} or greater. Similarly, the State of California Title 24 requires such an acoustical study if projected noise exposures are above 60 L_{dn}. The WIA was prepared to comply with the State's Title 24 and City's Noise Element requirements.

As an extension of the Noise and Land Use Compatibility Standards, acceptable outdoor environments are defined as: "The standard for maximum outdoor noise levels in residential areas is an L_{dn} of 60 dB(A). This standard is applied where outdoor use is a major consideration, such as backyards in single-family housing developments and recreation areas in multifamily developments. This standard should not be applied to outdoor areas such as small decks and balconies typically associated with multifamily residential developments which can have a higher standard of 65 Ldn."

The WIA study found that existing and future exterior noise at the Project site was above the 65 L_{dn} value across most of the site under existing topographical conditions. With the proposed Project in place, the study found that the noise exposure levels in all open areas behind the proposed structures would be less than 60 L_{dn} due to the barrier effect of the edges of the graded terraces and the buildings. The WIA analyses concluded that given the high degree of shielding from structures, sound walls or fences would not be necessary to mitigate noise in outdoor areas.[4] The proposed development buildings labeled A, H, I, J, and K would provide shielding primarily from State Highway 24 traffic sources, while Buildings L, M, and N would provide shielding from Pleasant Hill Road sources. Given the relatively dense spacing between most of the proposed housing units, sufficient shielding from traffic noise is expected for open areas on the interior portions of the Project site such that outdoor exposures will be less than 60 L_{dn}.[5] Thus, the proposed Project would comply with the land use compatibility standards of the Noise Element for outdoor spaces, resulting in a *less-than-significant* impact.

b. Interior Noise Requirements

The Lafayette Land Use Compatibility Standard and Title 24 requirements establish a maximum interior noise level of 45 L_{dn} for all new residential development.

[4] Wilson Ihrig & Associates, 2011. CCR Title 24 Noise Study, The Terraces of Lafayette Multifamily Project, Lafayette, California.

[5] Wilson Ihrig & Associates, 2011, CCR Title 24 Noise Study, The Terraces of Lafayette Multifamily Project, Lafayette, California.

According to the WIA study, future exterior noise levels would reach 70 to 74 dBA L_{dn} at some building facades. With a commonly applied noise reduction factor of 15 dB for open windows in a typical bedroom/living room space, the WIA report concluded that interior noise levels would exceed the standard open exterior windows. For this situation, the California Building Code mandates an alternative method of supplying fresh air (such as mechanical ventilation) to allow the occupant the option of controlling noise by closing the windows (and still having a source of fresh air). The WIA report presented several options for alternative fresh air supplies, including ducted air through HVAC systems; use of passive, ducted air inlets; and/or the use of "Z-duct" air intake devices (please refer to the WIA report in Appendix I for additional details).

For standard residential construction with closed windows, a typical noise reduction factor of 20 to 25 decibels can be assumed.[6] With a 74 L_{dn} exterior noise environment and a 25 dB reduction, the interior levels without additional attenuation would be above 45 L_{dn} (i.e. $74_{exterior} - 25_{reduction} = 49_{interior}$ dBA). Therefore, standard construction materials and methods would not provide sufficient exterior-to-interior noise attenuation to meet the 45 dBA L_{dn} noise threshold for interior rooms. Without additional noise attenuation features, Buildings A, H, I, J, K, L, M, and N, which face State Route 24 or Pleasant Hill Road and have exterior noise levels above 70 L_{dn}, the projected interior levels would exceed the 45 dBA L_{dn} noise standard and would result in a significant impact prior to mitigation. However, implementation of special noise control treatments, including sound-rated windows and doors, plus a suitable form of ventilation (as discussed above), would be required to reduce interior noise levels to below the 45 dBA L_{dn} threshold.

[6] NPC Library: Protective Noise Levels, http://www.nonoise.org/library/levels/levels.htm, accessed on February 7, 2012.

2. Would the Project expose people to or generate excessive groundborne vibration or noise.

a. Groundborne vibration or noise from existing facilities

As previously noted, the Project site would not be exposed to excessive groundborne noise or vibration from either the BART line or other potential sources and the long-term impact would be *less than significant*.

b. Groundborne vibration or noise from Project construction

During construction of the proposed Project, operation of heavy construction equipment has the potential to generate high ground vibration levels which have the potential to cause structural damage and/or annoyance to nearby sensitive receptors. Vibration levels generated by construction activities would vary depending on distance from the source, soil conditions, construction methods, and the equipment used. This analysis evaluates the potential for architectural damage or annoyance due to vibration caused by construction equipment.

The nearest existing structures to the proposed Project include a ranch with outdoor classes and a summer camp for children directly north of the Project site across Deer Hill Road. The threshold at which there is a risk of "architectural" damage (visible cracks) to normal dwellings, such as plastered walls or ceilings, is 0.2 inches per second peak particle velocity (PPV). Heavy construction equipment such as bulldozers, backhoe/hoe rams, and jackhammers generally generate vibration levels of less than 0.1 in/sec PPV[7] at a reference distance of 25 feet. These closest vibration-sensitive receptors are 195 feet and 240 feet, respectively, from the closest potential construction activities (near the site boundary). At these distances, the potential construction-related vibration would be well below the FTA's 0.2 PPV inches/second criteria for vibration-induced architectural damage at the surrounding structures. For other existing structures that are more distant from the Project site (than the above ranch/camp property), such as the single-family residential land uses east of Pleasant Hill Road, the day care center along Stanley Boulevard, and

[7] Federal Transit Administration, 2006, Transit Noise and Vibration Impact Assessment, FTA-VA-90-1003-06. Vibration levels measured at 25 feet.

several schools in the area, the groundborne vibration from Project sources would be significantly reduced by the relatively long propagation pathways and would result in construction-related vibration that would be considerably below the FTA's 0.2 PPV inches/second criteria for vibration-induced architectural damage. The vibration damage evaluation results are summarized in Table 4.10-8.

From these results, therefore, architectural damage from vibration impacts would be *less than significant* and no mitigation measures are required.

In addition to architectural damage, the Project construction activities have the potential to create vibration-related annoyance responses at the nearest sensitive receptors. Peak vibration levels occur when construction equipment operates directly adjacent to the property line. Although the maximum vibration could be perceptible in certain instances, peak vibration events occur infrequently. In addition, construction activities occur during weekdays which are least sensitive portions of the day. Therefore, construction vibration impacts are based on the average vibration levels that would be experienced by sensitive receptors the majority of the time. Note that commercial and industrial land uses are not considered to be noise- or vibration-sensitive land uses. Table 4.10-9 shows vibration levels from construction equipment operating at the Project site at the pertinent vibration-sensitive residential land uses.

Average vibration levels for large off-road construction equipment would not exceed 60 VdB at the nearest off-site land uses and would not exceed the FTA criterion for vibration annoyance of 75 VdB. Therefore, impacts from vibration annoyance are *less than significant* and no mitigation measures are required.

3. Would the Project lead to a permanent increase in ambient noise levels.

The proposed Project would be developed with residential uses and there would be no major stationary sources of noise from the Project. Minor

TABLE 4.10-8 **CONSTRUCTION-RELATED ARCHITECTURAL DAMAGE**

Nearest Structure	Distance	Projected Construction Vibration, PPV (in/sec)[a]	Vibration Damage Threshold, PPV (in/sec)[b]	Exceeds Threshold?
House near west corner	240 feet	0.0034	0.30	No
Ranch plus house	195 feet	.0045	0.30	No

[a] Vibration levels from the listed off-road construction equipment are equivalent to vibration levels generated by a large bulldozer based at a distance of 25 feet.
[b] Per methodology from FTA Chapter 12, with the threshold based on engineered concrete and masonry buildings, per Table 12-3.
Source: The Planning Center | DC&E, 2012.

TABLE 4.10-9 **CONSTRUCTION-RELATED VIBRATION ANNOYANCE**

Nearest Structure	Distance	Projected Construction Vibration, VdB[a]	Vibration Damage Threshold, VdB[b]	Exceeds Threshold?
House near west corner	240 feet	58	75	No
Ranch plus house	195 feet	60	75	No

[a] Vibration levels from the listed off-road construction equipment are equivalent to vibration levels generated by a large bulldozer based at a distance of 25 feet.
[b] Per methodology from FTA Chapter 8, with the threshold based on Category 2 Receptors (residential uses) and 'occasional events' from the vibration source.
Source: The Planning Center | DC&E, 2012.

stationary-related noise from the operation of air conditioning units, and noise from the parking lots would be masked by traffic noise on Deer Hill Road and Pleasant Hill Road. Further, the Project would be required to comply with the noise ordinance standards presented in Table 4.10-5. Conse-

quently, the proposed Project's long-term, stationary-related noise impacts to off-site uses would be *less than significant*, and no mitigation is required.

Potential long-term noise increases could be caused by Project-related traffic. A noise analysis was performed to identify the magnitude of potential traffic noise impacts on roadways around the Project site.

As previously discussed, substantial increase would result if Project-related traffic would:

- Cause the L_{dn} in existing residential areas to increase by 3 dB or more; or
- Cause the L_{dn} in existing residential areas to increase by 2 dB or more if the L_{dn} would exceed 70 dB; or
- Cause the L_{dn} resulting exclusively from Project-generated traffic to exceed an L_{dn} of 60 dBA at any existing residence.

To evaluate the potential noise level increases from Project-related traffic, the traffic forecasts included in the Traffic Impact Study prepared for this EIR by TJKM were utilized. The traffic study indicates that the largest existing traffic flows in the area around the Project site are presently on Pleasant Hill Road between State Highway 24 and Stanley Road/Deer Hill Road. This also holds true for future; Project-related traffic increases as the largest portion of Project traffic would utilize Pleasant Hill Road. As discussed in Chapter 4.13, Traffic and Transportation, the proposed Project would generate 158 trips during the AM peak hour, and 191 trips during the PM peak hour. The portion of Project trips that would use Pleasant Hill Road (between State Highway 24 and Stanley Road/Deer Hill Road) were calculated based on the TJKM intersection distribution analysis. Noise calculations (see Appendix I) show that the increase in traffic along the highest traffic flow segment, Pleasant Hill Road, would be less than 5 percent. This incremental increase in traffic flow equates to an associated noise level increase of less than 0.2 dB, which is well below the most restrictive criterion of a 2 dB increase. Therefore, the long-term traffic noise impacts of the proposed Project to off-site uses would be *less than significant*.

4. Would the Project create a temporary or periodic increase in ambient noise levels.

Short-term construction activities would periodically increase ambient noise levels in the Project vicinity and would subside once construction of the proposed Project is completed. Construction activities associated with the proposed Project are estimated to take up to 20 months to complete. The noisiest phase, grading and site preparation, would occur over a nine-month period.

a. Construction Vehicles

The transport of workers and equipment to the construction site would incrementally increase noise levels along site access roadways. Even though there would be a relatively high single-event noise exposure potential with passing trucks (a maximum noise level of 86 dBA at 50 feet),[8] the expected number of workers and trucks is minimal relative to the existing traffic flows on streets adjacent to the Project site. The truck trips would be spread throughout the workday and would primarily occur during non-peak traffic periods. The primary construction traffic access roadway is expected to be Pleasant Hill Road. Estimated traffic flows on the segment of Pleasant Hill Road between State Highway 24 and Deer Hill Road are 25,000 vehicles per day.[9] From Applicant projections for construction activities, haul trucks would consist of approximately 300 trips per day (in and out of the Project site). Vehicle trips for workers would be less than this; most likely below 50 daily trips. These levels of haul truck and worker vehicle traffic flows (350 trips) would be negligible compared to the volumes of traffic currently generated on this roadway segment (25,000 existing trips). Therefore, these impacts are *less than significant* at noise receptors along the construction routes.

[8] California Department of Transportation, 2009, Technical Noise Supplement. Prepared by ICF International.

[9] The average daily volume of any given roadway segment is estimated as 5 times the AM peak, added to 5 times the PM peak volume. The AM and PM peak volumes on Pleasant Hill Road are both approximately 2,500 ±10 cars. Thus, (5 x 2,500) + (5 x 2,500) = 25,000.

b. Construction Equipment

Noise generated during construction is based on the type of equipment used, the location of the equipment relative to sensitive receptors, and the timing and duration of the noise-generating activities. Noise levels are the average noise levels for each construction phase. Each stage involves the use of different kinds of construction equipment and, therefore, has its own distinct noise characteristics.

Noise levels from construction activities are usually dominated by the loudest piece of construction equipment. Noise levels from Project-related construction activities were calculated assuming the use of all applicable construction equipment at the same time at average distances (center of construction site to nearest property line of nearest noise-sensitive receptor off-site) and are shown in Table 4.10-10.

Average noise levels at the closest residential land uses to the north and northwest could be in the range of 67 to 74 dBA L_{eq} for periods during the highest levels of construction activity. While the magnitude of the average noise levels would be higher than the ambient noise environment at noise-sensitive land uses, construction activities would fluctuate throughout the workday as equipment would not be in use at the same time at one location, nor for an extended period of time on any given workday. Furthermore, construction activities would comply with the Municipal Code. As presented in Section B.2.b.ii, Construction Noise, above, the Municipal Code limits the hours of permitted construction activities, as well as the noise emissions of construction equipment. Enforcement of the noise standards is under the purview of the City Code Enforcement Officer. Overall, construction activities would generally be restricted to the least noise-sensitive portions of the day, and maximum noise levels would be infrequent throughout the workday for the approximately 20-month duration. Implementation of mitigation measures would ensure that noise levels from construction activities would not impact nearby sensitive receptors. With the implementation of the Mitigation Measure N-2 (see Section G below), construction noise would remain *less than significant*.

TABLE 4.10-10 **AVERAGE CONSTRUCTION NOISE LEVELS**

Noise-Sensitive Land Use		Average Construction Noise Levels (dBA Leq)				
		Ground Clearing and Demolition	Site Preparation	Foundation Construction	Building Construction	Finishing and Cleanup
Adjacent Residential (across Deer Hill Road and Pleasant Hill Road)	Average – 500 Feet[a]	76	80	73	74	80
	When near Property Line – 240 Feet	70	74	67	68	74

Notes: Noise levels based on noise level of All Applicable Equipment in Use as indicated in Bolt el al. Does not include attenuation as a result of intervening topography or structures.
[a] Average distance is defined as the approximate distance from the receiving property line to the center of construction activities.
Source: Bolt, Beranek and Newman, Inc., 1971. Noise from Construction Equipment and Operations, Building Equipment and Home Appliances. Prepared for the United States Environmental Protection Agency, Washington, DC.

5. Cumulative Impacts

Cumulative noise impacts occur when traffic associated with a development, in combination with reasonably foreseeable projects, causes noise levels to substantially increase at an existing residential area. As noted above, noise levels associated with the proposed Project on Pleasant Hill Road and Deer Hill Road would not result in a significant impact.

The Project's stationary noise sources would not generate substantial noise due to the operation of stationary noise sources and would be comparable to existing noise emissions from similar areas around the site. Increases in stationary source noise associated with the proposed Project would comply with the Municipal Code limits and would not substantially increase the existing noise environment.

In summary, the proposed Project would not contribute a "cumulatively considerable" increase in noise (1 dB or more in L_{dn}) to cumulative noise level increases of 3 dBA L_{dn} or more. Thus, permanent increases in ambient noise levels resulting from the proposed Project, in combination with expected growth in the general area, would result in a *less-than-significant* impact.

F. Impacts and Mitigation Measures

Impact NOISE-1: Because standard construction methods are not expected to provide enough insulation to achieve City 45 dBA L_{dn} interior noise standards,[10] a *significant* impact would occur without additional noise protection measures. WIA utilized building elevations and floor plans prepared by the proposed Project's architect to determine the exterior-to-interior noise reductions necessary to meet interior noise standards. Mitigation Measure Noise-1 is required to meet the City's interior noise standard.

[10] Wilson Ihrig & Associates (WIA), June 16, 2011, CCR Title 24 Noise Study, The Terraces of Lafayette Multifamily Project, Lafayette, California.

Mitigation Measure NOISE-1: The exterior glazing, entry doors, exterior wall, and supplemental ventilation design features shall be designed to achieve a 45 dBA L_{dn} interior noise standard. These features are summarized below and additional details are provided in the WIA report that is included in Appendix I.

- Two classes of exterior glazing are indicated for windows, sliding glass doors, and entry doors:
  - Class I elements shall have a minimum OITC 24/STC 28 rating
  - Class II elements shall have a minimum OITC 21/STC 25 rating

  (Note: The different classes are based on the location of proposed buildings on the Project site, per Figures 12 and 13 of the WIA report. Also note that the recommended OITC/STC ratings are for full window assemblies (glass and frame), rather than just for the glass itself.)

- If hard floor surfaces (such as hardwood or ceramic tile) are used, then the minimum recommended glazing rating (above) shall be increased by two OITC/STC points for windows serving those rooms.

- Entrance doors, together with their perimeter seals, shall have STC ratings not less than 26. Such tested doors shall operate normally with commercially available seals. Solid-core wood-slab doors 1-3/8 inches (35 mm) thick minimum or 18 gage insulated steel-slab doors with compression seals all around, including the threshold, may be considered adequate without other substantiating information.

- Acceptable acoustical caulking, applied per the manufacturer's directions, shall be used to properly seal windows, doorways, electrical outlets (in exterior walls), and the indicated intersections of interior gypsum wall board (GWB) installations throughout the affected buildings.

- Potential architectural element suppliers shall verify the acoustical performance ratings by providing laboratory test data for the specific assembly type submitted for the Project.

- Exterior wall assemblies shall have a minimum OITC 38 (comparable to STC 50) rating. This can be achieved with 'typical' assembly de-

signs for this type of multi-family development, which were assumed to consist of 7/8-inch stucco over plywood shear sheathing, 4- to 6-inch deep studs, fiberglass batt insulation in the stud cavity, and at least one layer of 5/8-inch gypsum board on the interior face of the wall.

- Supplemental ventilation shall be provided in the architectural design so as to allow for closed windows as well as the adequate supply of fresh air per applicable building codes.

Significance After Mitigation: Through the selection of appropriate architectural elements and with proper construction and installation techniques, interior impacts resulting from exterior noise levels would be reduced to a *less-than-significant* level.

Impact NOISE-2: While the magnitude of the average noise levels would be higher than the ambient noise environment at noise-sensitive land uses during the construction phase, construction activities and the associated noise emissions would fluctuate both daily and throughout the entire construction schedule. By use of the following methods and procedures, construction noise will be reduced to the extent reasonably feasible.

Mitigation Measures NOISE-2: The construction contractor shall adhere to the following measures during construction activities:

- Use of construction equipment shall be restricted to the hours of 8:00 a.m. to 6:00 p.m. Monday through Friday.
- Material deliveries and haul-off truck trips shall be restricted to the hours of 7:00 a.m. to 10:00 p.m. Monday through Friday. Further, all such construction trips shall avoid, to the extent reasonably feasible, peak traffic periods along Pleasant Hill Road and Deer Hill Road (i.e. morning rush hour, mid-afternoon school pick-up time, and afternoon rush hour).
- Prior to the start of and for the duration of construction, the contractor shall properly maintain and tune all construction equipment in ac-

cordance with the manufacturer's recommendations to minimize noise emissions.

- Prior to use of any construction equipment, the contractor shall fit all equipment with properly operating mufflers, air intake silencers, and engine shrouds no less effective than as originally equipped by the manufacturer.
- During construction, the construction contractor shall place stationary construction equipment and material delivery (loading/unloading) areas so as to maintain the greatest distance from the nearest residences.
- The construction contractor shall post a sign at the work site that is clearly visible to the public, providing a contact name and telephone number for lodging a noise complaint.

These measures shall be listed on the grading plan and monitored by the City during construction.

Significance After Mitigation: Through the selection of appropriate construction equipment and operating techniques, coupled with adherence to the City of Lafayette time-of-day restrictions, construction noise levels would be reduced to *a less-than-significant* level.