ENVIRONMENTAL NOISE ASSESSMENT
Residential Development at 109 Ellis Street (AP 007 361 003)
PETALUMA, CALIFORNIA

December 11, 2018

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INTRODUCTION AND SUMMARY

This report presents the results of an environmental noise assessment completed for the 109 Ellis Street Urban Infill Project, a residential development with 12 apartment units in 3 buildings on a 30,696 square foot site located between Madison Street and Martin Circle, north of McKinley Elementary, west of Madison Street and south of Washington Creek in Petaluma, CA. (see Figure 1). The purpose for this noise assessment is to evaluate the compatibility of the development with respect to the environmental noise levels at the project site and evaluate noise impacts upon sensitive receptors in the area.

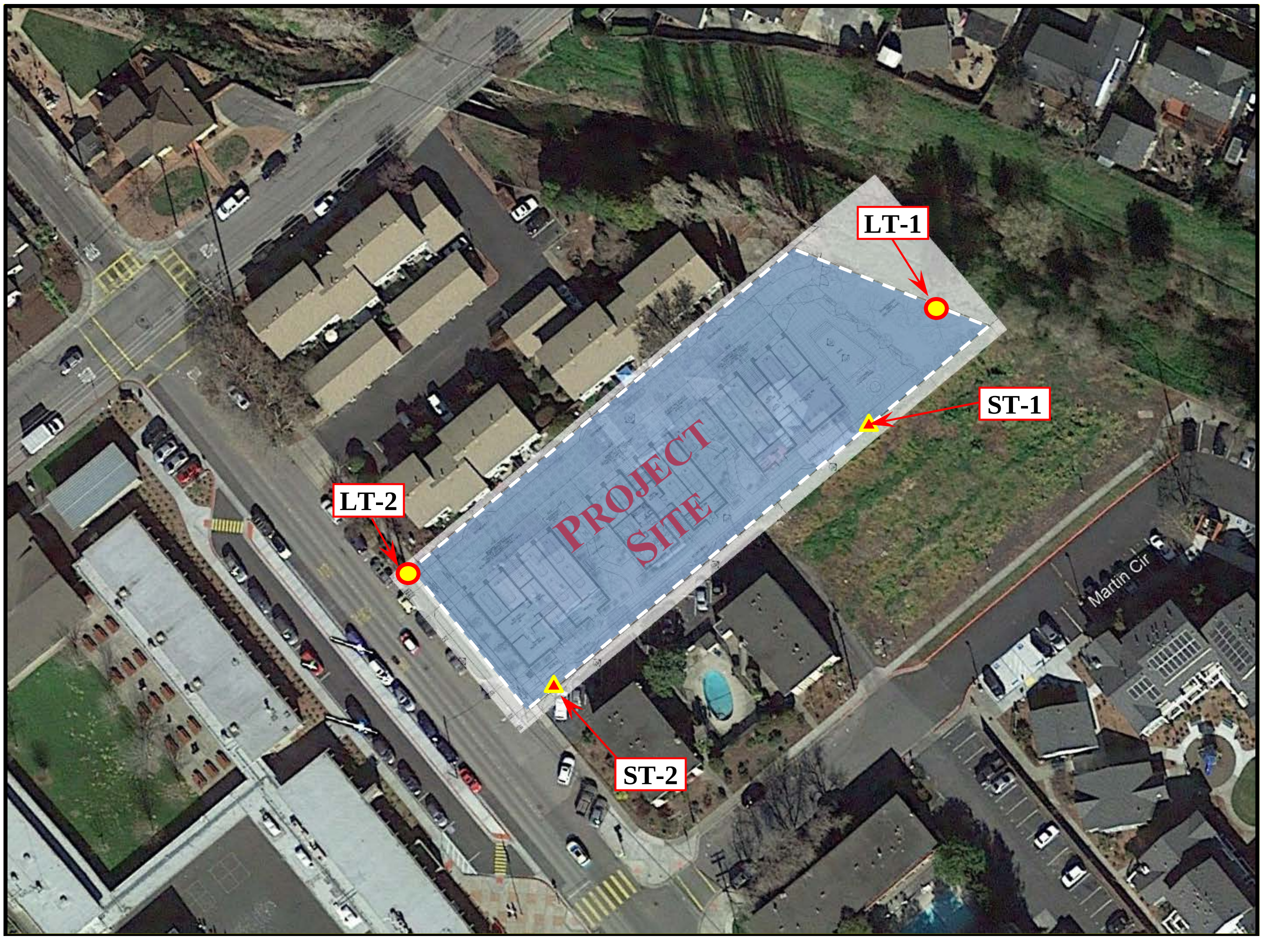


Figure 1: Project Site and Vicinity

The Setting Section of this report presents the fundamentals of environmental noise and vibration, describes regulatory criteria that are applicable in the project's assessment, and summarizes the results of a survey of the existing noise environment at the project site and vicinity. The Impacts and Mitigation Measures Section describes the significance criteria used to evaluate project impacts, provides a discussion of each project impact, and presents mitigation measures, where necessary, allow the development to be compatible with surrounding land uses and to comply with applicable regulatory criteria.

SETTING

FUNDAMENTALS OF ENVIRONMENTAL ACOUSTICS

Noise may be defined as unwanted sound. Noise is usually objectionable because it is disturbing or annoying. The objectionable nature of sound could be caused by its *pitch* or its loudness. *Pitch* is the height or depth of a tone or sound, depending on the relative rapidity (frequency) of the vibrations by which it is produced. Higher pitched signals sound louder to humans than sounds with a lower pitch. *Loudness* is intensity of sound waves combined with the reception characteristics of the ear. Intensity may be compared with the height of an ocean wave in that it is a measure of the amplitude of the sound wave.

In addition to the concepts of pitch and loudness, there are several noise measurement scales, which are used to describe noise in a particular location. *A decibel (dB)* is a unit of measurement, which indicates the relative amplitude of a sound. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Sound levels in decibels are calculated on a logarithmic basis. An increase of 10 decibels represents a ten-fold increase in acoustic energy, while 20 decibels is 100 times more intense, 30 decibels is 1,000 times more intense, etc. There is a relationship between the subjective noisiness or loudness of a sound and its intensity. Each 10-decibel increase in sound level is perceived as approximately a doubling of loudness over a fairly wide range of intensities. Technical terms are defined in Table 1.

There are several methods of characterizing sound. The most common in California is the *A-weighted sound level or dBA.* This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive. Representative outdoor and indoor noise levels in units of dBA are shown in Table 2.

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-equivalent sound/noise descriptor is called L_{eq}. The most common averaging period is hourly, but L_{eq} can describe any series of noise events of arbitrary duration.

The scientific instrument used to measure noise is the sound level meter. Sound level meters can accurately measure environmental noise levels to within about plus or minus 1 dBA. Various computer models are used to predict environmental noise levels from sources, such as roadways and airports. The accuracy of the predicted models depends upon the distance the receptor is from the noise source. Close to the noise source, the models are accurate to within about plus or minus 1 to 2 dBA.

Since the sensitivity to noise increases during the evening and at night -- because excessive noise interferes with the ability to sleep -- 24-hour descriptors have been developed that incorporate artificial noise penalties added to quiet-time noise events. The *Community Noise Equivalent Level, CNEL,* is a measure of the cumulative noise exposure in a community, with a 5 dB penalty added to evening (7:00 pm - 10:00 pm) and a 10 dB addition to nocturnal (10:00 pm - 7:00 am) noise levels. The *Day/Night Average Sound Level, DNL or* L_{dn}, is essentially the same as CNEL, with the exception that the evening time period is dropped and all occurrences during this three-hour period are grouped into the daytime period.

TABLE 1: Definitions of Acoustical Terms Used in this Report

Term	Definitions
Decibel, dB	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20.
Sound Pressure Level	Sound pressure is the sound force per unit area, usually expressed in micro Pascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure (e.g., 20 micro Pascals). Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure. Normal human hearing is between 20 Hz and 20,000 Hz. Infrasonic sound are below 20 Hz and Ultrasonic sounds are above 20,000 Hz.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using 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.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period. The hourly Leq used for this report is denoted as dBA $L_{eq[h]}$.
Day-Night Level, L_{dn}	The equivalent noise level for a continuous 24-hour period with a 10-decibel penalty imposed during nighttime and morning hours (10:00 pm to 7:00 am).
Community Noise Exposure Level, CNEL	CNEL is the equivalent noise level for a continuous 24-hour period with a 5-decibel penalty imposed in the evening (7:00 pm to 10:00 pm) and a 10-decibel penalty imposed during nighttime and morning hours (10:00 pm to 7:00am)
L_1, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Source: Handbook of Acoustical Measurements and Noise Control, Harris, 1998.

TABLE 2: Typical Noise Levels in the Environment

Common Outdoor Noise Source	Noise Level (dBA)	Common Indoor Noise Source
	110 dBA	Rock band
Jet fly-over at 1,000 feet		
	100 dBA	
Gas lawn mower at 3 feet		
	90 dBA	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	80 dBA	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower, 100 feet	70 dBA	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	60 dBA	
		Large business office
Quiet urban daytime	50 dBA	Dishwasher in next room
Quiet urban nighttime	40 dBA	Theater, large conference room
Quiet suburban nighttime		
	30 dBA	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	20 dBA	
		Broadcast/recording studio
	10 dBA	
	0 dBA	

Source: Technical Noise Supplement (TeNS), Caltrans, November 2009.

FUNDAMENTALS OF GROUNDBORNE VIBRATION

Ground vibration consists of rapidly fluctuating motions or waves with an average motion of zero. Several different methods are typically used to quantify vibration amplitude. One is the Peak Particle Velocity (PPV) and another is the Root Mean Square (RMS) velocity. The PPV is defined as the maximum instantaneous positive or negative peak of the vibration wave. The RMS velocity is defined as the average of the squared amplitude of the signal. The PPV and RMS vibration velocity amplitudes are used to evaluate human response to vibration. In this section, a PPV descriptor with units of mm/sec or in/sec is used to evaluate construction generated vibration for building damage and human complaints. Table 3 displays the reactions of people and the effects on buildings that continuous vibration levels produce. The annoyance levels shown in Table 3 should be interpreted with care since vibration may be found to be annoying at much lower levels than those shown, depending on the level of activity 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 rattling phenomenon may also be produced by loud airborne environmental noise causing induced vibration in exterior doors and windows.

TABLE 3: Reaction of People and Damage to Buildings for Continuous Vibration Levels

Vibration 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 Earthborne Vibrations (Caltrans Experiences), Technical Advisory, Vibration TAV-02-01-R9601, California Department of Transportation, February 20, 2002.

Construction activities can cause vibration that varies in intensity depending on several factors. The use of pile driving and vibratory compaction equipment typically generate the highest construction related ground-borne vibration levels. Because of the impulsive nature of such activities, the use of the peak particle velocity descriptor (PPV) has been routinely used to measure and assess ground-borne vibration and almost exclusively to assess the potential of vibration to induce structural damage and the degree of annoyance for 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 in/sec PPV. Human perception to vibration varies with the individual and is a function of 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.

Structural damage can be classified as cosmetic only, such as minor cracking of building elements, or may threaten the integrity of the 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 the 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 at a high state of disrepair and the construction activity occurs immediately adjacent to the structure.

REGULATORY BACKGROUND

The proposed project would be subject to noise-related regulations, plans, and policies established within documents prepared by the State of California and the City of Petaluma. These planning documents are implemented during the environmental review process to limit noise exposure at existing and proposed noise sensitive land uses. Applicable planning documents include: The California Environmental Quality Act (CEQA) Guidelines, Appendix G, the Health and Safety Element of the Petaluma 2025 General Plan, the City of Petaluma Noise Ordinance, and . Regulations, plans, and policies presented within these documents form the basis of the significance criteria used to assess project impacts.

State CEQA Guidelines.

The CEQA contains guidelines to evaluate the significance of effects of environmental noise attributable to a proposed project. Under CEQA, noise impacts would be considered significant if the project would result in:

(a) Exposure of persons 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;
(b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels;
(c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project;
(d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project;
(e) 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, if the project would expose people residing or working in the project area to excessive noise levels; or
(f) For a project within the vicinity of a private airstrip, if the project would expose people residing or working in the project area to excessive noise levels.

CEQA does not define what noise level increase would be considered substantial. Typically, project-generated noise level increases of 3 dBA L_{dn} or greater would be considered significant where exterior noise levels would exceed the normally acceptable noise level standard (60 dBA L_{dn} for residential land uses). Where noise levels would remain at or below the normally acceptable noise level standard with the project, noise level increases of 5 dBA L_{dn} or greater would be considered significant.

On December 17, 2015, the California Supreme Court issued a decision in California Building Industry Association v. Bay Area Air Quality Management District (Case No. S213478). The Court held that the California Environmental Quality Act “generally does not require an analysis of how existing environmental conditions will impact a project’s future users or residents” and that CEQA's "relevant provisions are best read to focus almost entirely on how projects affect the environment."

As such, the four (4) CEQA checklist items (items a, b, e, and f) regarding non-project generated noise exposure increases (e.g., exposure of the project residents to exterior or interior noise levels, as well as existing (non-project related) groundborne vibration and aircraft noise), are not required analysis under CEQA since these items involve the surrounding environment's impact on the project residents. Such analysis contained herein of Impact 1 and suggested measures to address noise or vibration exposure to project residents, is included in this report for informational purposes and for compliance with the City of Petaluma General Plan and/or Municipal Code requirements and Title 24, Part 2 of the California Building Code as opposed to CEQA.

2016 California Building Code, Title 24, Part 2.

Section 1207.4 of the current (2016) California Building Code (CBC) states that interior noise levels attributable to exterior sources shall not exceed 45 dB(A) Ldn or CNEL (consistent with the noise element of the local general plan) in any habitable room. Though this section does to not explicitly apply this interior limit to multifamily residential buildings, in keeping with the requirements of prior editions of the CBC this limit is applied to any habitable room for new dwellings other than detached single-family dwellings.

City of Petaluma General Plan 2025

Section 10.2 of the City of Petaluma's Health and Safety Element includes objectives and policies applicable to the proposed residential project. The City's objective is to, "Protect public health and welfare by eliminating or minimizing the effects of existing noise problems, and by minimizing the increase of noise levels in the future." Single-family and duplex residential land uses are considered "normally acceptable" up to 60 dBA L_{dn} or CNEL while multi-family residential land uses are considered "normally acceptable" up to 65 dBA L_{dn} or CNEL. Single-family, duplex and multi-family residential land are all considered "conditionally acceptable" up to 70 dBA L_{dn} or CNEL, "normally unacceptable" between 70 and 75 dBA L_{dn} or CNEL, and "clearly unacceptable" above 75 dBA L_{dn} or CNEL. The following General Plan policies are applicable to the proposed residential project.

Policy A: Continue efforts to incorporate noise considerations into land use planning decisions and guide the locations and design of transportation facilities to minimize the effects of noise on adjacent land uses.

Policy B: Discourage location of new noise-sensitive uses, primarily homes, in areas with projected noise levels greater than 65 dBA CNEL. Where such uses are permitted, require incorporation of mitigation measures to ensure that interior noise levels do not exceed 45 dB CNEL.

Policy C: Ensure that the City's Noise Ordinance and other regulations:

- Require that applicants for new noise-sensitive development in areas subject to noise levels greater than 65 dB CNEL obtain the services of a professional acoustical engineer to provide a technical analysis and design of mitigation measures.
- Require placement of fixed equipment, such as air conditioning units and condensers, inside or in the walls of new buildings or on roof-tops of central units in order to reduce noise impacts on any nearby sensitive receptors.

Policy D: Continue to require control of noise or mitigation measures for any noise-emitting construction equipment or activity. The City's Noise Ordinance establishes controls on construction-related noise.

Policy E: As part of development review, use Figure 10-2: Land Use Compatibility Standards to determine acceptable uses and installation requirements in noise-impacted areas.

Policy F: Discourage the use of sound walls anywhere except along Highway 101 and/or along the NWPRA corridor without findings that such walls will not be detrimental to community character. When sound walls are deemed necessary, integrate them into the streetscape.

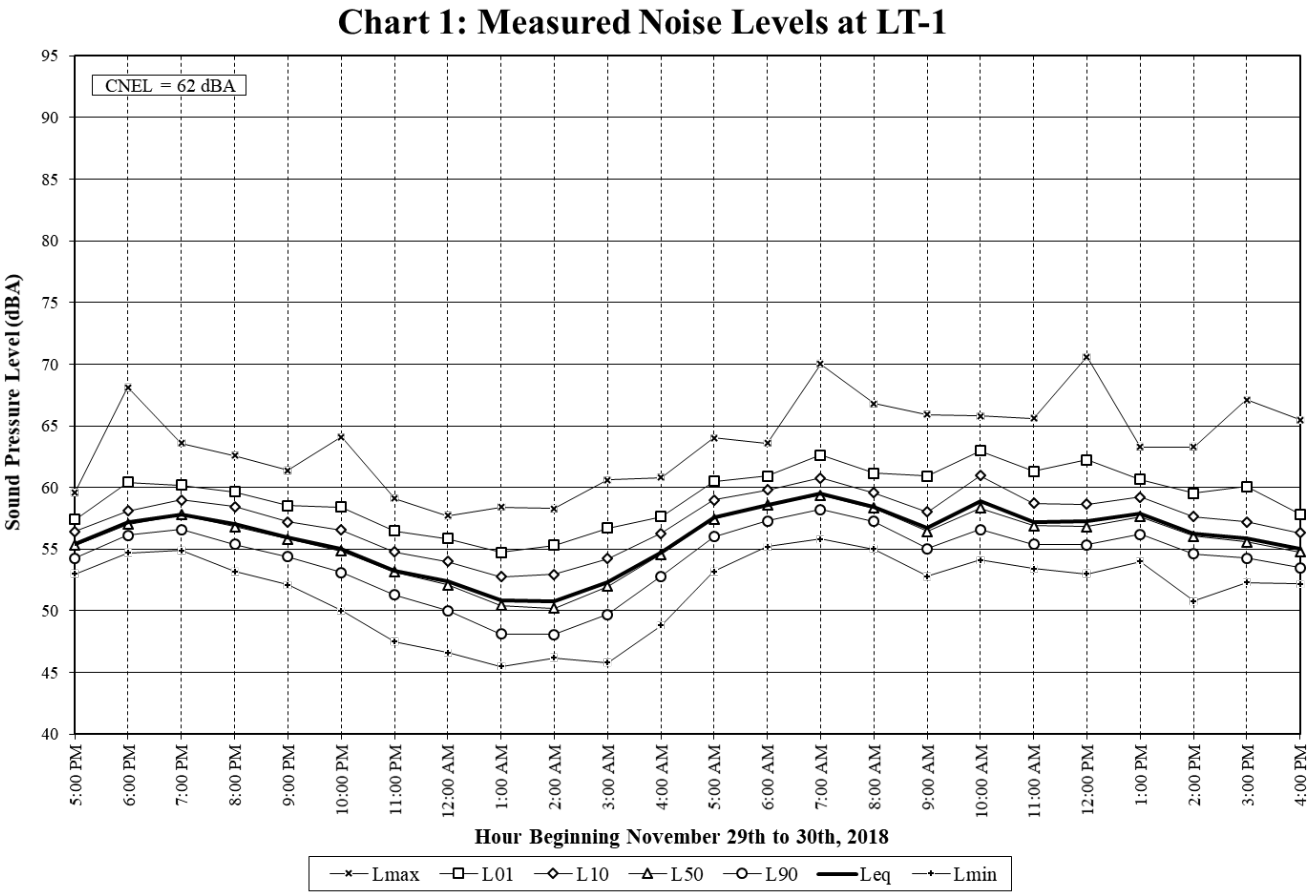
Policy G: In making a determination of impact under the California Environmental Quality Act (CEQA) consider an increase of four or more dBA to be "significant" if the resulting noise level would exceed that described as normally acceptable for the affected use in Figure 10-3: Land Use Compatibility for Community Noise Environments.

Petaluma Noise Ordinance.
The Noise Ordinance, in Municipal Code Section 22-301, establishes quantitative noise limits for stationary noise sources such as machinery and commercial activities to protect the public from disturbance caused by unnecessary or excessive noise. The basic noise limit is a level of 60 dBA L_{eq} measured on a receiving property. Noise generating construction activities are prohibited between 10 PM and 7 AM.

EXISTING NOISE ENVIRONMENT
The proposed project is located opposite (north of) Ellis Street from McKinley Elementary School between Madison and Martin Circle south of Washington Creek in Petaluma, CA. (see Figure 1). The purpose for this noise assessment is to evaluate the compatibility of the development with respect to the environmental noise levels at the project site and evaluate noise impacts upon sensitive receptors in the area. The existing noise environment at the project site results primarily from distant vehicle and truck traffic on Highway 101 north of Washington Creek, local neighborhood and school related traffic on Ellis Street to the south, and maintenance and operational noise from the existing multifamily uses to the east and west.

A noise monitoring survey was conducted between 5 pm on Thursday November 29th and 5pm on Friday November 30th, 2018 to quantify the existing weekday noise environment on the project site. The noise monitoring survey included two long-term noise measurements at locations indicated as LT-1 & LT-2 in Figure 1. All noise measurements were conducted with Larson Davis Laboratories (LDL) Type I Model 820 Sound Level Meter fitted with a ½-inch pre-polarized condenser microphone and windscreen. The meters were calibrated with a Larson Davis Model CA250 precision acoustic calibrator prior to and following the measurement survey.

The first long-term noise measurement, LT-1, was located on the northern property line of the site closest to Highway 101 on the trunk of a tree at a height of 12 feet above grade. This position was approximately 350 feet from the centerline of Ellis Street, 150 feet from the centerline of Martin Circle, and over 1,000 feet south of the Highway 101 right of way. The measured noise levels at this location, including the energy equivalent noise level (L_{eq}), maximum (L_{max}), minimum (L_{min}), and the noise levels exceeded 10, 50 and 90 percent of the time (indicated as L_{10}, L_{50} and L_{90}) are shown on Chart 1.

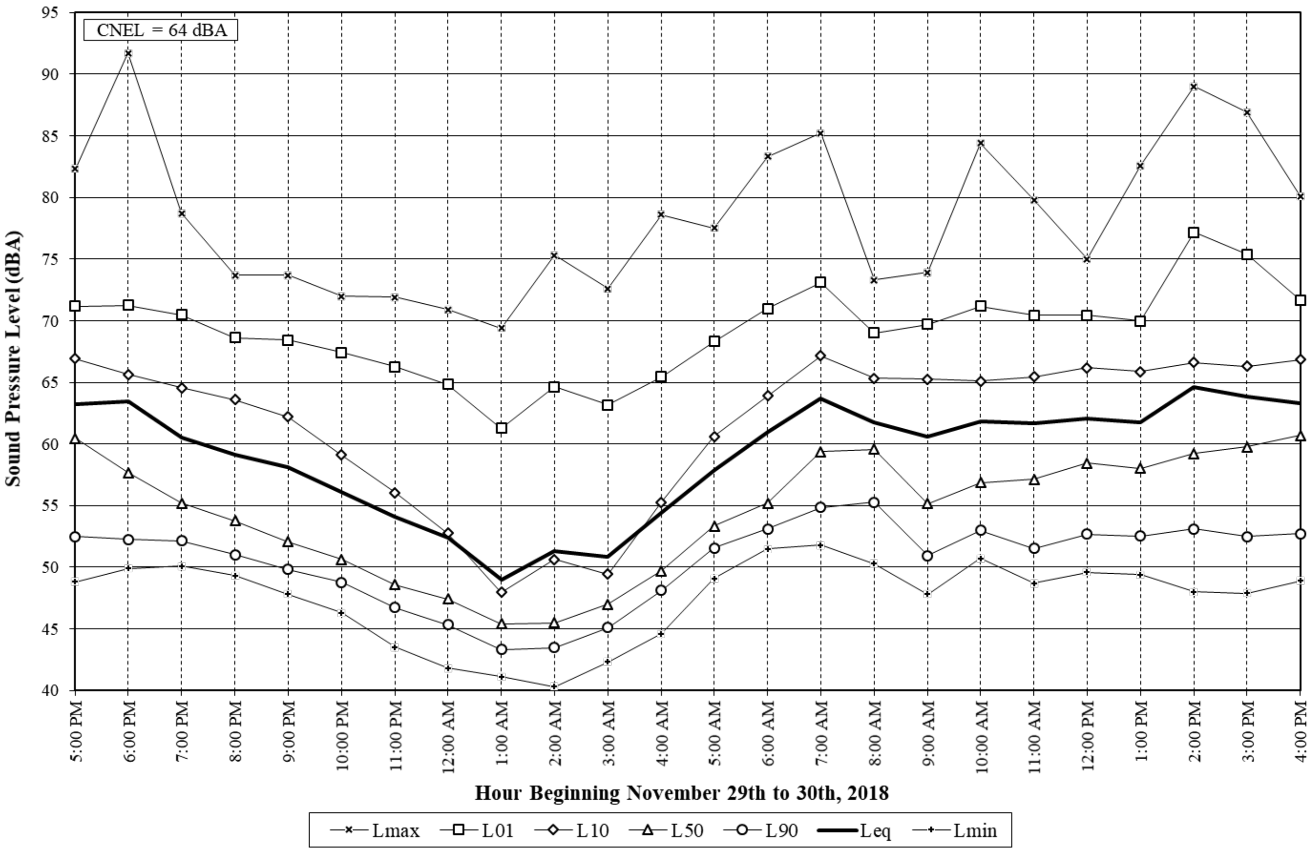


A review of Chart 1 indicates that the noise levels at site LT-1 followed a diurnal pattern characteristic of distant traffic noise, but with elevated noise levels in the morning, mid-day and evening and late night hours due to local events. The average daytime noise levels at this measurement position were found to range from 55 to 60 dBA L_{eq} and the average hourly nighttime noise levels ranging from 50 to 59 dBA L_{eq}. The Community Noise Equivalent Level (CNEL) for the 24-hour measurement period at position LT-1 was 62 dBA.

The second long-term noise measurement, LT-2, was located near Ellis Street project frontage, at a height of 12 feet above grade on a utility pole at the edge of Ellis Street approximately 30 feet from the centerline of this roadway. The measured noise levels at this location, including the energy equivalent noise level (L_{eq}), maximum (L_{max}), minimum (L_{min}), and the noise levels exceeded 10, 50 and 90 percent of the time (indicated as L_{10}, L_{50} and L_{90}) are shown on Chart 2.

A review of Chart 2 indicates that the noise levels at site LT-2 also followed a diurnal pattern characteristic of traffic noise with more significant morning and afternoon contributions from roadway and school related noise sources. The average daytime noise levels at this measurement position were found to range from 56 to 65 dBA L_{eq} and the average hourly nighttime noise levels ranging from 49 to 61 dBA L_{eq}. The Community Noise Equivalent Level (CNEL) for the 92-hour measurement period at position LT-2 was 64 dBA.

Chart 2: Measured Noise Levels at LT-2



Short term (10-minute duration) noise measurements were made between 4:30 and 4:50 p.m. on Friday, November 30th, 2018 on the project site at two positions, the first at approximately 280 feet from the centerline of Ellis Street (and over 1,100 south of Highway 101), which is the approximate northern extent of the proposed residential buildings, and the second at 50 feet from the centerline of Ellis Street, which is the setback of the proposed residential use closest to this roadway. The measurements were conducted simultaneously with measurements at LT-1 and LT-2 to determine the noise exposure at the closest residential uses to Highway 101and Ellis Street. The results of the simultaneous measurements at long-term and the short-term sites are shown in Table 4.

Table 4: Summary of Short-Term Noise Measurement Data, dBA

Noise Measurement Location	Time	L_{max}	$L_{(1)}$	$L_{(10)}$	$L_{(50)}$	$L_{(90)}$	L_{eq}	CNEL
LT-1: Approximately 350 ft from the centerline of Ellis Street	4:30-4:40 pm (11/30/2018)	66	59	57	55	54	55	**62**
ST-1: Approximately 280 ft from the centerline of Ellis Street	4:30-4:40 pm (11/30/2018)	66	61	57	53	52	55	**62**[1]
LT-2: Approximately 30 ft from the centerline of Ellis Street	4:50-5:00 pm (11/30/2018)	80	74	67	62	53	64	**64**
ST-2: Approximately 50 ft from the centerline of Ellis Street	4:50-5:00 pm (11/30/2018)	78	72	65	60	52	62	**62**[2]

[1] The CNEL at ST-1 is approximated by correlation to the corresponding measurement at LT-1
[2] The CNEL at ST-2 is approximated by correlation to the corresponding measurement at LT-2

A review of the data in Table 5 indicates that the noise exposure at the proposed residential uses closest to Ellis Street and Highway 101 would be characterized by a CNEL of 62 dBA. Considering these results, we would also estimate the environmental noise levels at the outdoor use areas on the northern portion of the site to be characterized by a CNEL of 63 dBA.

FUTURE NOISE ENVIRONMENT

The future noise environment on the project site due to external sources such as area traffic and adjacent recreational, residential and office/industrial uses is expected to remain largely the same. However, to conduct a conservative analysis, this study assumes that under future conditions, traffic on area local area roadways would increase by 1% to 2% in volume per year as a result of general growth throughout the City and that a similar increase in activities at the surrounding recreational and office/industrial uses would also occur. Considering this, the noise environment on the project site under future conditions would be approximately 1 decibel higher than existing noise levels. This increase would result in a CNEL level of 63 dBA at the residential facades closest to Ellis Street and Highway 101 and a CNEL of 64 dBA at the outdoor use areas on the northern portion of the site.

SIGNIFICANCE CRITERIA

Appendix G of the CEQA Guidelines states that a project would normally be considered to result in significant noise impacts if noise levels conflict with adopted environmental standards or plans or if noise generated by the project would substantially increase existing noise levels at sensitive receivers over a permanent or temporary basis. A conflict with the local standards or ordinances would be identified for a proposed land use if this use would be exposed to noise levels exceeding established guidelines or standards for noise and land use compatibility. A substantial permanent noise increase would occur if the noise level increase resulting from the project is 4 dBA CNEL as established by the Petaluma General Plan. A substantial temporary noise level increase would occur where noise from construction activities exceeds 60 dBA L_{eq} and the ambient noise environment by at least 5 dBA L_{eq} at adjacent land uses in the project vicinity for a period of one year or more. Vibration levels generated during demolition or construction activities would be significant if they cause cosmetic or structural damage to adjacent buildings.

NOISE IMPACTS AND MITIGATION MEASURES

Impact 1: **Exterior Residential Noise and Land Use Compatibility.** Residential uses developed on the project site would be exposed to noise levels considered "normally acceptable" for such multifamily residential uses.
This is does not conflict with local standards or ordinances

The area traffic noise sources and adjacent school, and residential uses were not found to result noise levels at the site perimeter or elsewhere on the site, which exceed acceptable noise levels for the proposed multi-family residential uses. As discussed above the future exterior noise levels on the project site are expected to be characterized by a CNEL of less than 65 dBA. Therefore, the site noise environment would be considered "normally acceptable" by the City's General Plan for the proposed multifamily residential use of the site and is found to be compatible with site noise environment.

Mitigation Measure 1: None Required.

Impact 2: **Project Operational Noise Generation** Noise due to the use and occupation of the project residences on adjacent noise sensitive uses is not expected to significantly increase or alter the existing noise environment at these uses.
This is a less-than-significant impact.

The proposed project would place new multifamily residential uses adjacent to existing multifamily residential and educational uses. The occupation and use of the proposed residences is expected to result in noises typically associated with residential development, such as voices of the new residents, home maintenance activities, barking dogs and children. Though the noise environment may change noticeably in some areas due to the occupation of the new residences, the noise associated with the proposed residences is considered compatible with the adjacent multifamily residential and educational land uses and therefore is not judged to result in a noise impact.

Mitigation Measure 2: None Needed

Impact 3: **Project-Generated Traffic Noise.** The proposed project would not substantially increase noise levels on a permanent basis at noise sensitive uses in the vicinity. **This is a less-than-significant impact.**

A significant impact would be identified if traffic generated by the project would substantially increase noise levels at sensitive receivers in the vicinity. A substantial increase would occur if the project traffic on area roadways where to result in a noise level increase of 4 dBA CNEL or greater. A traffic report for the project was not reviewed for this project, however, to cause a 4 dBA increase in noise along either Ellis Street, the project would have to generate enough traffic to increase current roadway volumes by over 150%. Given the size of the project and the current amount of traffic on Ellis Street from the surrounding residential and educational uses this is not considered possible.

Mitigation 3: None Required.

Impact 4: **Exposure to Construction Generated Groundborne Vibration.** Residences in the vicinity of the project site are not expected to be exposed to perceptible vibration levels from construction activities. **This is a less-than-significant impact.**

Construction activities would include site preparation work such as grading and the installation of utilities, foundation work, and new building framing. Construction techniques that generate the highest vibration levels, such as impact or vibratory pile driving, are not expected at this project. Construction activities would generally occur at distances of 40 to 100 feet from the nearest residential units, but activities near the northern project perimeter could occur at distances of as close as 20 feet from existing residential units.

For structural damage, the California Department of Transportation uses a vibration limit of 0.5 in/sec, PPV for buildings structurally sound and designed to modern engineering standards.

Project construction activities such as drilling, the use of jackhammers, rock drills and other high-power or vibratory tools, and rolling stock equipment (tracked vehicles, compactors, etc.) may generate substantial vibration in the immediate vicinity. Building framing, exterior and interior finishing, and landscaping activities are not anticipated to be sources of substantial vibration. Construction activities may extend over an entire construction season, but construction vibration would not be substantial for most of this time except during vibration generating activities (as discussed above).

Table 5 presents vibration source levels for typical construction equipment at a distance of 25 feet. Jackhammers typically generate vibration levels of 0.035 in/sec PPV, drilling typically generates vibration levels of 0.09 in/sec PPV, and vibratory rollers generate vibration levels of 0.21 in/sec PPV at a distance of 20 feet. Vibration levels would vary depending on soil conditions, construction methods, and equipment used. At distances of 20 feet or greater, construction activities would be well below the 0.50 in/sec PPV damage criteria.

TABLE 5: Vibration Source Levels for Construction Equipment[1]

Equipment		PPV at 20 ft. (in/sec)
Clam shovel drop		0.25
Hydromill (slurry wall)	in soil	0.008
	in rock	0.02
Vibratory Roller		0.26
Hoe Ram		0.11
Large bulldozer		0.11
Caisson drilling		0.11
Loaded trucks		0.10
Jackhammer		0.04
Small bulldozer		0.004

Though vibration due to project construction is not be expected to cause structural damage, vibration levels during construction may still be perceptible. However, as with any type of construction, this is anticipated and would not be considered significant given the intermittent and short duration of the phases that have the highest potential of producing vibration (jackhammers and vibratory rollers). By use of administrative controls such as notifying adjacent land uses of scheduled construction activities and scheduling construction activities with the highest potential to produce perceptible vibration to hours with least potential to affect nearby residences, perceptible vibration can be kept to a minimum and as such would not result in a significant impact with respect to perception.

Mitigation Measure 4: None Required

Impact 5: Construction Noise. Noise levels generated by project construction activities would temporarily elevate ambient noise levels at sensitive land uses in the vicinity. Major noise generating construction activities would be limited to less than one construction season or less. **This is a less-than-significant impact.**

Construction of the project would generate noise and would temporarily increase noise levels at adjacent residential receivers. Noise impacts resulting from construction depend on the noise generated by various pieces of construction equipment operating on site, the timing and duration of noise generating activities, and the distance between construction noise sources and noise sensitive receptors. Construction of the project would involve site improvements, such as the removal of existing structures and pavement, establishment of utilities and foundations, building erection, paving, and landscaping. The hauling of excavated material and construction materials would also generate truck trips on local roadways. Construction activities are typically carried out in stages. During each stage of construction, there would be a different mix of equipment operating. Construction noise levels would vary by stage and vary within stages based on the amount of equipment in operation and location where the equipment is operating. Typical construction noise levels at a distance of 50 feet are shown in Table 6, which gives the average noise level ranges by construction phase. Most demolition and construction noise is in the range of 80 to 90 dBA at a distance of 50 feet from the source.

[1] PPV at 20 feet calculated based on data from the Transit Noise and Vibration Impact Assessment, United States Department of Transportation, Office of Planning and Environment, Federal Transit Administration, May 2006.

TABLE 6: Typical Ranges of L_{eq} Construction Noise Levels at 50 Feet, dBA

Construction Stage	Domestic Housing		Public Works Roads & Highways, Sewers, & Trenches	
	I	II	I	II
Ground Clearing	83	83	84	84
Excavation	88	75	88	78
Foundations	81	81	88	88
Erection	81	65	79	78
Finishing	88	72	84	84
I - All pertinent equipment present at site, **II -** Minimum required equipment present at site.				

Source: U.S.E.P.A., Legal Compilation on Noise, Vol. 1, p. 2-104, 1973.

The nearest noise sensitive uses will be 20 to 40 feet from the closest project construction activities. Average noise levels at this distance of typical construction activity at this site would range from 83 to 96 dBA during busy construction periods. These noise levels drop off at a rate of about 6 dBA per doubling of distance between the noise source and receptor. The adjacent, existing, apartment would, therefore be intermittently exposed to high levels of noise during periods of nearby construction. Typically, significant noise impacts do not result when standard construction noise control measures are enforced at the project site and when the duration of the noise generating construction period is limited to one construction season (typically one year) or less. Noise generated by major construction activities is not expected to result in noise levels exceeding 60 dBA L_{eq} and the ambient noise environment by 5 dBA L_{eq} for a period of greater than one year.

The following standard controls are assumed to be included in the project:

- Pursuant to the Municipal Code, restrict noise-generating activities at the construction site or in areas adjacent to the construction site to the hours between 7:00 a.m. and 10:00 p.m., Monday through Friday and 9:00 a.m. to 10:00 p.m. on Saturday, Sunday and State, Federal or Local Holidays.
- Equip all internal combustion engine driven equipment with intake and exhaust mufflers that are in good condition and appropriate for the equipment.
- Locate stationary noise generating equipment (e.g., compressors) as far as possible from adjacent residential receivers.
- Acoustically shield stationary equipment located near residential receivers with temporary noise barriers.
- Utilize "quiet" air compressors and other stationary noise sources where technology exists.
- The contractor shall prepare a detailed construction plan identifying the schedule for major noise-generating construction activities. The construction plan shall identify a procedure for coordination with the owner/occupants of nearby noise sensitive residential land uses so that construction activities can be scheduled to minimize noise disturbance.
- Designate a "disturbance coordinator" responsible for responding to any complaints about construction noise. The disturbance coordinator will determine the cause of the noise complaint (e.g., bad muffler, etc.) and will require that reasonable measures be implemented to correct the problem.

With the implementation of these controls, and the limited duration of the noise generating construction period, the substantial temporary increase in ambient noise levels associated with construction activities would be less-than-significant.

Mitigation Measure 5: **No additional measures required**