3215 PORTER DRIVE PROJECT NOISE AND VIBRATION ASSESSMENT

Palo Alto, California

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INTRODUCTION

A two-story office building is proposed on a 1.67-acre site located at 3215 Porter Drive in Palo Alto, California. The site is currently undeveloped. The proposed office building would include a below-grade parking garage and a ground-level café. The total square footage of the proposed building would be 21,933 square feet. Access to the site would be provided via a driveway at the intersection of Porter Drive/Hanover Street and Hillview Avenue.

This report evaluates the project's potential to result in significant noise and vibration impacts with respect to applicable California Environmental Quality Act (CEQA) guidelines. The report is divided into three sections: 1) the Setting Section provides a brief description of the fundamentals of environmental noise and groundborne vibration, summarizes applicable regulatory criteria, and discusses the results of the ambient noise monitoring survey completed to document existing noise conditions; 2) the Plan Consistency Section discusses noise and land use compatibility utilizing policies in the City's General Plan (Comprehensive Plan) and applicable sections of the 2016 California Building Cal Green Code; and, 3) the Impacts and Mitigation Measures Section describes the significance criteria used to evaluate project impacts and provides a discussion of each project impact. In summary, no significant impacts were identified as a result of the construction or operation of the project.

SETTING

Fundamentals of Environmental Noise

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 (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* (L_{dn} or *DNL*) 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.

Effects of Noise

Sleep and Speech Interference

The thresholds for speech interference indoors are about 45 dBA if the noise is steady and above 55 dBA if the noise is fluctuating. Outdoors the thresholds are about 15 dBA higher. Steady noises of sufficient intensity (above 35 dBA) and fluctuating noise levels above about 45 dBA have been shown to affect sleep. Interior residential standards for multi-family dwellings are set by the State of California at 45 dBA L_{dn}. Typically, the highest steady traffic noise level during the daytime is about equal to the L_{dn} and nighttime levels are 10 dBA lower. The standard is designed for sleep and speech protection and most jurisdictions apply the same criterion for all residential uses. Typical structural attenuation is 12 to 17 dBA with open windows. With closed windows in good condition, the noise attenuation factor is around 20 dBA for an older structure and 25 dBA for a newer dwelling. Sleep and speech interference is therefore possible when exterior noise levels are about 57 to 62 dBA L_{dn} with open windows and 65 to 70 dBA L_{dn} if the windows are closed. Levels of 55 to 60 dBA are common along collector streets and secondary arterials, while 65 to 70 dBA is a typical value for a primary/major arterial. Levels of 75 to 80 dBA are normal noise levels at the first row of development outside a freeway right-of-way. In order to achieve an acceptable interior noise environment, bedrooms facing secondary roadways need to be able to have their windows closed; those facing major roadways and freeways typically need special glass windows.

Annoyance

Attitude surveys are used for measuring the annoyance felt in a community for noises intruding into homes or affecting outdoor activity areas. In these surveys, it was determined that the causes for annoyance include interference with speech, radio and television, house vibrations, and interference with sleep and rest. The L_{dn} as a measure of noise has been found to provide a valid correlation of noise level and the percentage of people annoyed. People have been asked to judge the annoyance caused by aircraft noise and ground transportation noise. There continues to be disagreement about the relative annoyance of these different sources. When measuring the percentage of the population highly annoyed, the threshold for ground vehicle noise is about 50 dBA L_{dn}. At a L_{dn} of about 60 dBA, approximately 12 percent of the population is highly annoyed. When the L_{dn} increases to 70 dBA, the percentage of the population highly annoyed increases to about 25 to 30 percent of the population. There is, therefore, an increase of about 2 percent per dBA between a L_{dn} of 60 to 70 dBA. Between a L_{dn} of 70 to 80 dBA, each decibel increase increases by about 3 percent the percentage of the population highly annoyed. People appear to respond more adversely to aircraft noise. When the L_{dn} is 60 dBA, approximately 30 to 35 percent of the population is believed to be highly annoyed. Each decibel increase to 70 dBA adds about 3 percentage points to the number of people highly annoyed. Above 70 dBA, each decibel increase results in about a 4 percent increase in the percentage of the population highly annoyed.

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 method is the Peak Particle Velocity (PPV). The PPV is defined as the maximum instantaneous positive or negative peak of the vibration wave. In this report, 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 or frequent intermittent vibration levels produce. The guidelines in Table 3 represent syntheses of vibration criteria for human response and potential damage to buildings resulting from construction vibration.

Construction activities can cause vibration that varies in intensity depending on several factors. The use of pile driving and vibratory compaction equipment typically generates the highest construction related groundborne vibration levels. Because of the impulsive nature of such activities, the use of the PPV descriptor has been routinely used to measure and assess groundborne vibration and almost exclusively to assess the potential of vibration to cause 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. 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 paint flaking or minimal extension of cracks in building surfaces; minor, including limited surface cracking; or major, that may threaten the structural integrity of the building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher. The damage criteria presented in Table 3 include several categories for ancient, fragile, and historic structures, the types of structures most at risk to damage. Most buildings are included within the categories ranging from “Historic and some old buildings” to “Modern industrial/commercial buildings”. 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.

The annoyance levels shown in Table 3 should be interpreted with care since vibration may be found to be annoying at 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.

TABLE 1 Definition of Acoustical Terms Used in this Report

Term	Definition
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 micro Pascals.
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.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Day/Night Noise Level, L_{dn} or DNL	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 pm and 7:00 am.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 pm to 10:00 pm and after addition of 10 decibels to sound levels measured in the night between 10:00 pm and 7:00 am.
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 Activities	Noise Level (dBA)	Common Indoor Activities
	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), California Department of Transportation, September 2013.

TABLE 3 Reaction of People and Damage to Buildings from Continuous or Frequent Intermittent Vibration Levels

Velocity Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.01	Barely perceptible	No effect
0.04	Distinctly perceptible	Vibration unlikely to cause damage of any type to any structure
0.08	Distinctly perceptible to strongly perceptible	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected
0.1	Strongly perceptible	Threshold at which there is a risk of damage to fragile buildings with no risk of damage to most buildings
0.25	Strongly perceptible to severe	Threshold at which there is a risk of damage to historic and some old buildings.
0.3	Strongly perceptible to severe	Threshold at which there is a risk of damage to older residential structures
0.5	Severe - Vibrations considered unpleasant	Threshold at which there is a risk of damage to new residential and modern commercial/industrial structures

Source: Transportation and Construction Vibration Guidance Manual, California Department of Transportation, September 2013.

Regulatory Background - Noise

The State of California, Santa Clara County, and the City of Palo Alto have established regulatory criteria that are applicable in this assessment. The State CEQA Guidelines, Appendix G, the California Building Code, the Santa Clara County Airport Land Use Commission Comprehensive Land Use Plan, and the City of Palo Alto Comprehensive Plan and Municipal Code are used to assess the potential significance of impacts related to the construction and operation of the project. A summary of the applicable regulatory criteria is provided below.

State CEQA Guidelines. 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) Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local General Plan or Noise Ordinance, or applicable standards of other agencies;

(b) Generation of excessive groundborne vibration or groundborne noise levels; or

(c) For a project located within the vicinity of a private airstrip or 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.

Pursuant to recent court decisions, the impacts of site constraints, such as exposure of the proposed project to excessive levels of noise and vibration, are not included in the Impacts and Mitigation Section of this report. These items are discussed in a separate section addressing the project's consistency with the policies set forth in the City's Comprehensive Plan.

CEQA does not define what noise level increase would be considered substantial. Typically, an increase in the L_{dn} noise level resulting from the project at noise sensitive land uses of 3 dBA or greater would be considered a significant impact when projected noise levels would exceed those considered acceptable for the affected land use. An increase of 5 dBA L_{dn} or greater would be considered a significant impact when projected noise levels would remain within those considered acceptable for the affected land use.

2016 California Building Cal Green Code. The State of California established exterior sound transmission control standards for new non-residential buildings, as set forth in the 2010 California Green Building Standards Code (Section 5.507.4.1 and 5.507.4.2). These standards were not altered in the 2016 revisions. Section 5.507 states that either the prescriptive (Section 5.507.4.1) or the performance method (Section 5.507.4.2) shall be used to determine environmental control at indoor areas. The prescriptive method is very conservative and not practical in most cases; however, the performance method can be quantitatively verified using exterior-to-interior calculations. For the purposes of this report, the performance method is utilized to determine consistency with the Cal Green Code. Both of the sections that pertain to this project are as follows:

> **5.507.4.1 Exterior noise transmission, prescriptive method.** Wall and roof-ceiling assemblies exposed to the noise source making up the building envelope shall meet a composite STC rating of at least 50 or a composite OITC rating of no less than 40, with exterior windows of a minimum STC of 40 or OITC of 30 when the building falls within the 65 dBA DNL noise contour of a freeway or expressway, railroad, industrial source or fixed-guideway noise source, as determined by the local general plan noise element.
>
> **5.507.4.2 Performance method.** For buildings located, as defined by Section 5.507.4.1, wall and roof-ceiling assemblies exposed to the noise source making up the building envelope shall be constructed to provide an interior noise environment attributable to exterior sources that does not exceed an hourly equivalent noise level ($L_{eq\ (1\text{-}hr)}$) of 50 dBA in occupied areas during any hour of operation.

The performance method, which establishes the acceptable interior noise level, is the method typically used when applying these standards.

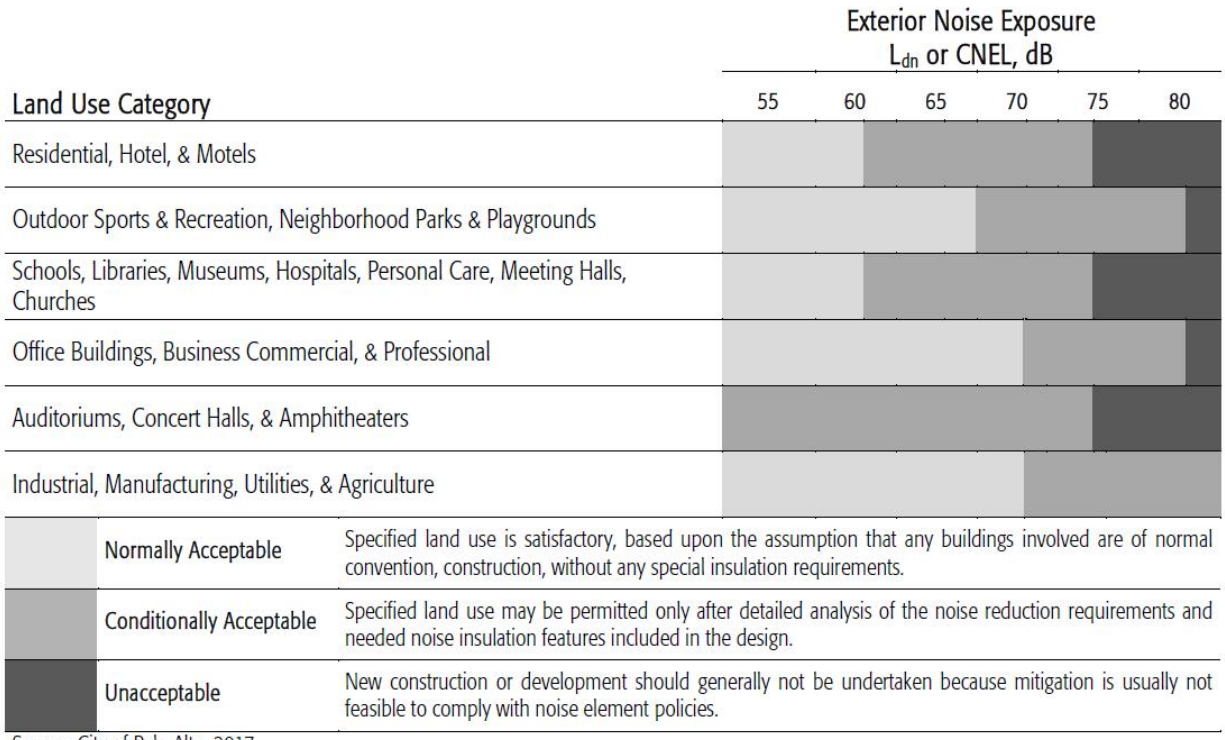
City of Palo Alto Comprehensive Plan 2030. Chapter 4 of the 2030 Comprehensive Plan (Natural Environment) discusses noise. The following goals and policies apply to the proposed project:

Goal N-6: An environment that minimizes the adverse impacts of noise.

Policy N-6.1 Encourage the location of land uses in areas with compatible noise environments. Use the guidelines in Table N-1 to evaluate the compatibility of proposed land uses with existing noise environments when preparing, revising, or reviewing development proposals.

Policy N-6.3 Protect the overall community and especially sensitive noise receptors, including schools, hospitals, convalescent homes, senior and child care facilities and public conservation land from unacceptable noise levels from both existing and future noise sources, including construction noise.

TABLE N-1 LAND USE COMPATIBILITY FOR COMMUNITY NOISE ENVIRONMENT



	Normally Acceptable	Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal convention, construction, without any special insulation requirements.
	Conditionally Acceptable	Specified land use may be permitted only after 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 Palo Alto, 2017.

Policy N-6.5 Protect residential and residentially-zoned properties from excessive and unnecessary noise from any sources on adjacent commercial or industrial properties.

Policy N-6.6 Apply site planning and architectural design techniques that reduce overall noise pollution and reduce noise impacts on proposed and existing projects within Palo Alto and surrounding communities.

Policy N-6.7 While a proposed project is in the development review process, the noise impact of the project on existing residential land uses, public open spaces and public conservation land should be evaluated in terms of the increase in existing noise levels for the potential for adverse community impact, regardless of existing background noise levels. If an area is below the applicable maximum noise guideline, an increase in noise up to the maximum should not necessarily be allowed.

Policy N-6.8 The City may require measures to reduce noise impacts of new development on adjacent properties through appropriate means including, but not limited to, the following:

- Orient buildings to shield noise sensitive outdoor spaces from sources of noise.
- Construct noise walls when other methods to reduce noise are not practical and when these walls will not shift similar noise impacts to another adjacent property.
- Screen and control noise sources such as parking lots, outdoor activities and mechanical equipment, including HVAC equipment.

- Increase setbacks to serve as a buffer between noise sources and adjacent dwellings.

- Whenever possible, retain fences, walls or landscaping that serve as noise buffers while considering design, safety and other impacts.

- Use soundproofing materials, noise reduction construction techniques, and/or acoustically-rated windows/doors.

- Include auxiliary power sources at loading docks to minimize truck engine idling.

- Control hours of operation, including deliveries and trash pickup, to minimize noise impacts.

Policy N-6.9 Continue to require applicants for new projects or new mechanical equipment in the Multifamily, Commercial, Manufacturing or Planned Community districts to submit an acoustical analysis demonstrating compliance with the Noise Ordinance prior to receiving a building permit.

Policy N-6.11 Continue to prioritize construction noise limits around sensitive receptors, including through limiting construction hours and individual and cumulative noise from construction equipment.

City of Palo Alto Municipal Code. The noise ordinance of the City of Palo Alto limits noise levels caused by stationary noise sources and construction on adjacent residential properties. The applicable portions of the noise code are as follows:

9.10.020 Definitions.

(d) "Local ambient" means the lowest sound level repeating itself during a six-minute period as measured with a precision sound level meter, using slow response and "A" weighting. The minimum sound level shall be determined with the noise source at issue silent, and in the same location as the measurement of the noise level of the source or sources at issue. However, for purposes of this chapter, in no case shall the local ambient be considered or determined to be less than: (1) Thirty (30) dBA for interior noise in Section 9.10.030(b); (2) Forty (40) dBA in all other sections. If a significant portion of the local ambient is produced by one or more individual identifiable sources which would otherwise be operating continuously during the six-minute measurement period and contributing significantly to the ambient sound level, determination of the local ambient shall be accomplished with these separate identifiable noise sources silent.

9.10.030 Residential property noise limits.

(b) No person shall produce, suffer or allow to be produced by any machine, animal, or device, or any combination of same, on residential property, a noise level more than six (6) dB above the local ambient at any point outside the property plane.

9.10.040 Commercial and industrial property noise limits. No person shall produce, suffer or allow to be produced by any machine or device, or any combination of same, on commercial or

industrial property, a noise level more than eight (8) dB above the local ambient at any point outside of the property plane.

9.10.060 Special Provisions. The special exceptions listed in this section shall apply, notwithstanding the provisions of Sections 9.10.030 through 9.10.050. Said exceptions shall apply only to the extent and during the hours specified in each of the following enumerated exceptions.

(a) General Daytime Exception. Any noise source which does not produce a noise level exceeding seventy (70) dBA at a distance of twenty-five feet under its most noisy condition of use shall be exempt from the provisions of Sections 9.10.030(a), 9.10.040 and 9.10.050(a) between the hours of eight a.m. and eight p.m. Monday through Friday, nine a.m. and eight p.m. on Saturday, except Sundays and holidays, when the exemption herein shall apply between ten a.m. and six p.m.

(b) Construction. Except for construction on residential property, construction, alteration and repair activities which are authorized by valid city building permit shall be prohibited on Sundays and holidays and shall be prohibited except between the hours of eight a.m. and six p.m. Monday through Friday, nine a.m. and six p.m. on Saturday provided that the construction, demolition or repair activities during those hours meet the following standards:

(1) No individual piece of equipment shall produce a noise level exceeding one hundred ten (110) dBA at a distance of twenty-five (25) feet. If the device is housed within a structure on the property, the measurement shall be made out-side the structure at a distance as close to twenty-five feet from the equipment as possible.

(2) The noise level at any point outside of the property plane of the project shall not exceed one hundred ten (110) dBA.

(3) The holder of a valid construction permit for a construction project in a non-residential zone shall post a sign at all entrances to the construction site upon commencement of construction, for the purpose of informing all contractors and subcontractors, their employees, agents, materialmen and all other persons at the construction site, of the basic requirements of this chapter.

(j) Emergency. Emergencies are exempt from this chapter.

Existing Noise Environment

The project site is located west of the intersection of Porter Drive/Hanover Street and Hillview Avenue in Palo Alto, California. Commercial buildings exist to the south and opposite Porter Drive/Hanover Street to the east. The Hanover Substation is located to the north. A parking lot bounds the site to the west.

A noise monitoring survey was performed to document existing noise levels in the project vicinity beginning on Tuesday, November 12, 2019 and concluding on Thursday, November 14, 2019. The monitoring survey included two long-term (LT-1 and LT-2) noise measurements and two short-

term (ST-1 and ST-2) noise measurements. All measurement locations are shown in Figure 1. The existing noise environment in the project vicinity results primarily from local vehicular traffic. Aircraft associated with operations from the Palo Alto Airport and the Moffett Federal Airfield also affect the noise environment.

Long-term noise measurement LT-1 was made at the project site, approximately 25 feet west of the centerline of Porter Drive/Hanover Street. Hourly average noise levels typically ranged from 53 to 68 dBA L_{eq} during the day and from 46 to 61 dBA L_{eq} at night. The day-night average noise level on Thursday, November 13, 2019 was 64 dBA L_{dn}. The daily trend in noise levels at LT-1 is shown in Figures 2 through 4.

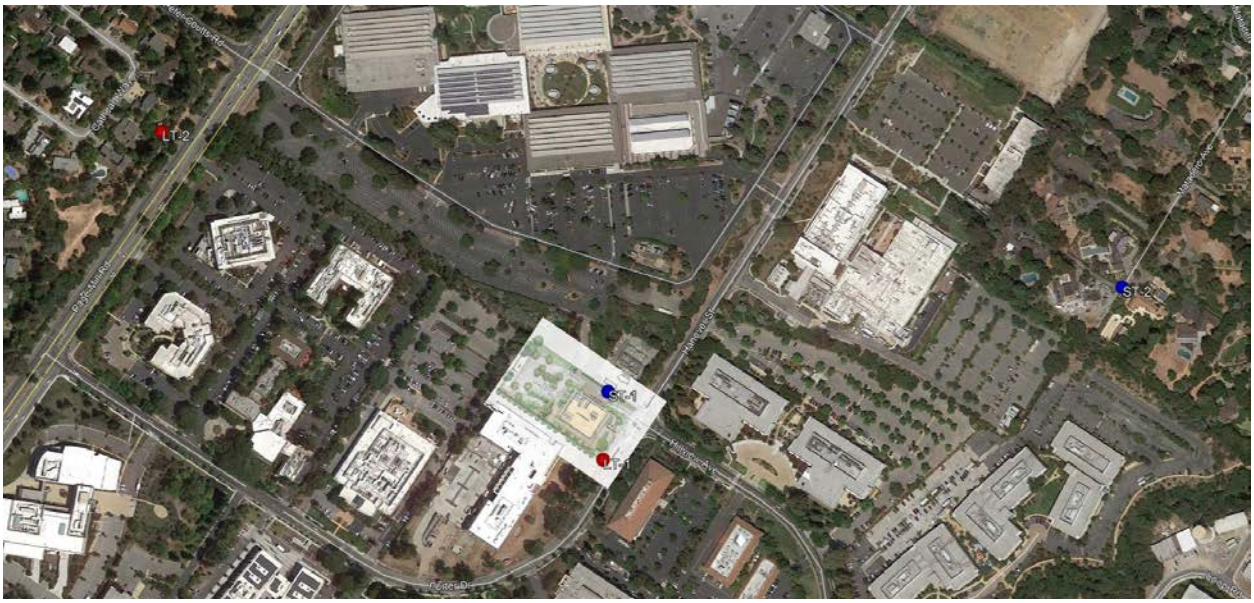
LT-2 was made along a walking path between the backyards of 1047 Cathcart Way and 1055 Cathcart Way. LT-2 was set back approximately 115 feet from the centerline of Page Mill Road. Hourly average noise levels typically ranged from 61 to 68 dBA L_{eq} during the day and from 51 to 65 dBA L_{eq} at night. The day-night average noise level on Thursday, November 13, 2019 was 67 dBA L_{dn}. The daily trend in noise levels at LT-2 is shown in Figures 5 through 7.

Short-term noise measurements were made over 10-minute periods, concurrent with the long-term noise data, on Thursday, November 14, 2019, between 10:00 a.m. and 10:30 a.m. in order to complete the noise survey. All short-term measurement results are summarized in Table 4.

ST-1 was made along the northernmost property line of the site near the Hanover Substation. In addition to the roadway traffic, a constant electrical hum was produced by the substation, resulting in constant noise levels of 50 to 52 dBA. During light passenger vehicle pass-bys, noise levels of 53 to 59 dBA were measured. Three buses passed the site in this 10-minute period generating noise levels of 57 to 58 dBA. A nearby leaf blower was also operating at the time of this measurement generating noise levels of 53 dBA. The 10-minute average noise level measured at ST-1 was 53 dBA $L_{eq(10\text{-}min)}$.

ST-2 was made at the end of Matadero Avenue. Vehicular traffic along Matadero Avenue generated noise levels of 59 to 62 dBA at ST-2, and two jets flew overhead during the measurement generating noise levels of 43 to 58 dBA. The 10-minute average noise level measured at ST-2 was 49 dBA $L_{eq(10\text{-}min)}$.

FIGURE 1 Noise Measurement Locations



Source: Google Earth 2019.

FIGURE 2 Daily Trend in Noise Levels at LT-1, Tuesday, November 12, 2019

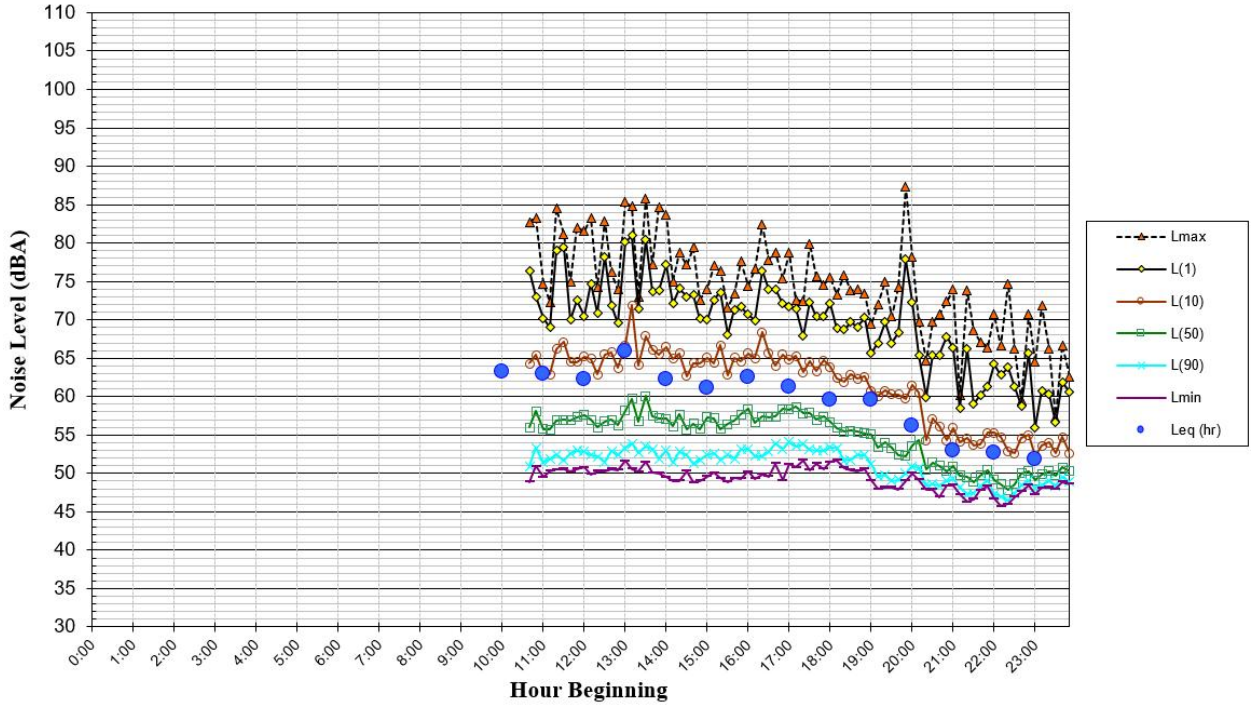


FIGURE 3 Daily Trend in Noise Levels at LT-1, Wednesday, November 13, 2019

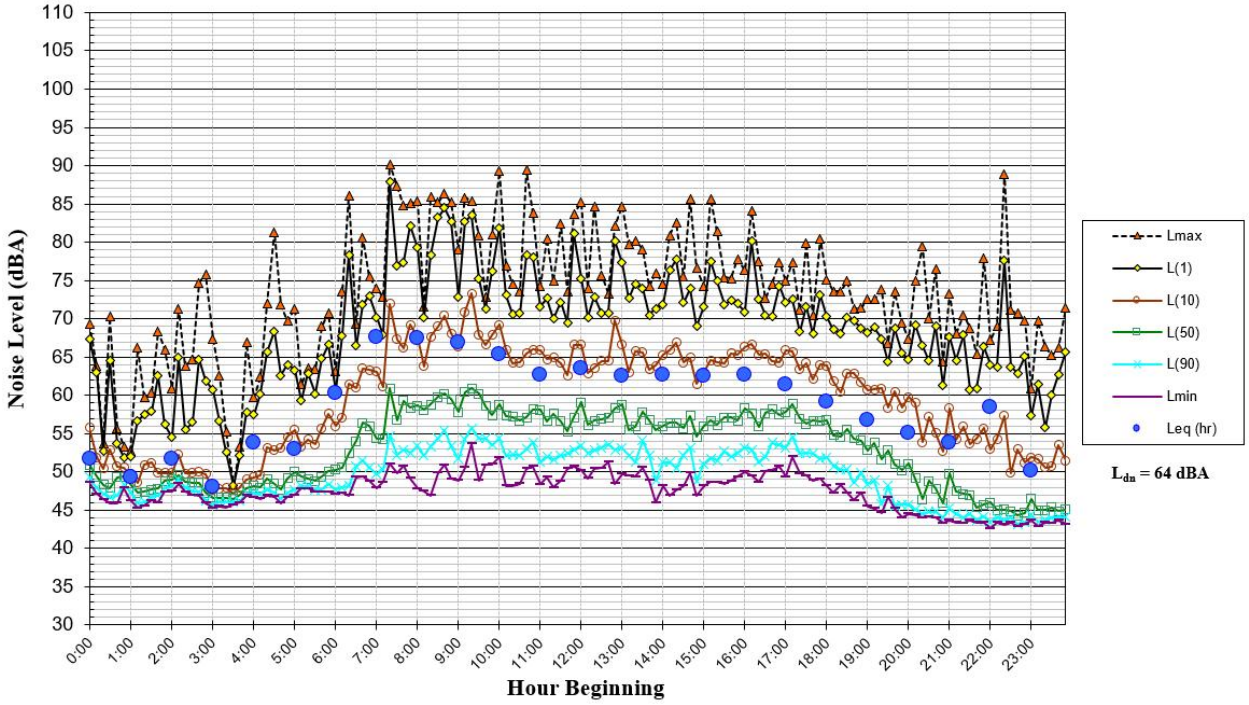


FIGURE 4 Daily Trend in Noise Levels at LT-1, Thursday, November 14, 2019

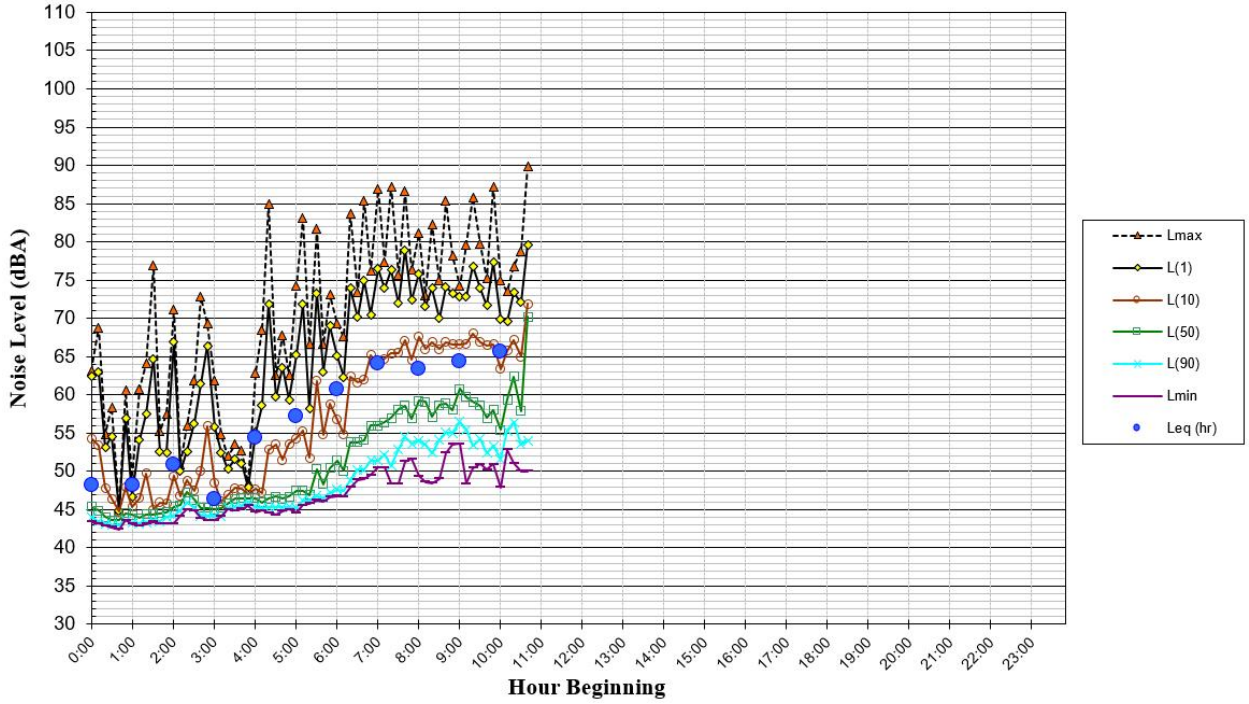


FIGURE 5 Daily Trend in Noise Levels at LT-2, Tuesday, November 12, 2019

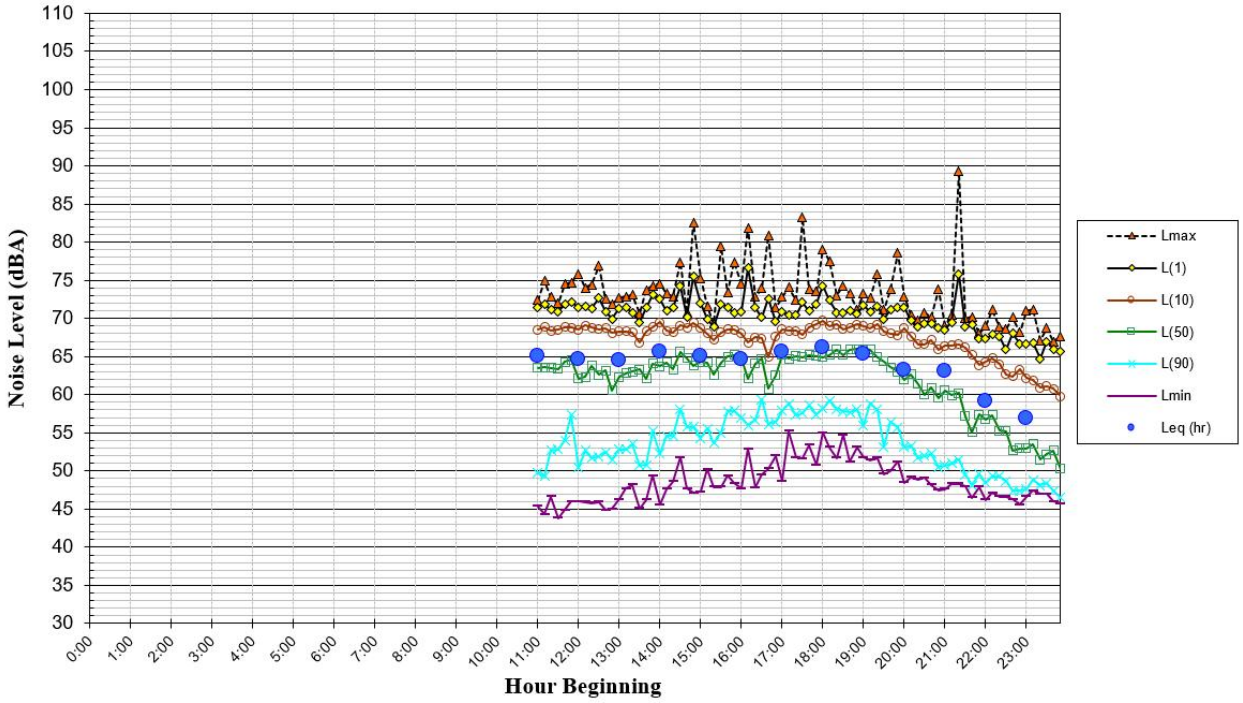


FIGURE 6 Daily Trend in Noise Levels at LT-2, Wednesday, November 13, 2019

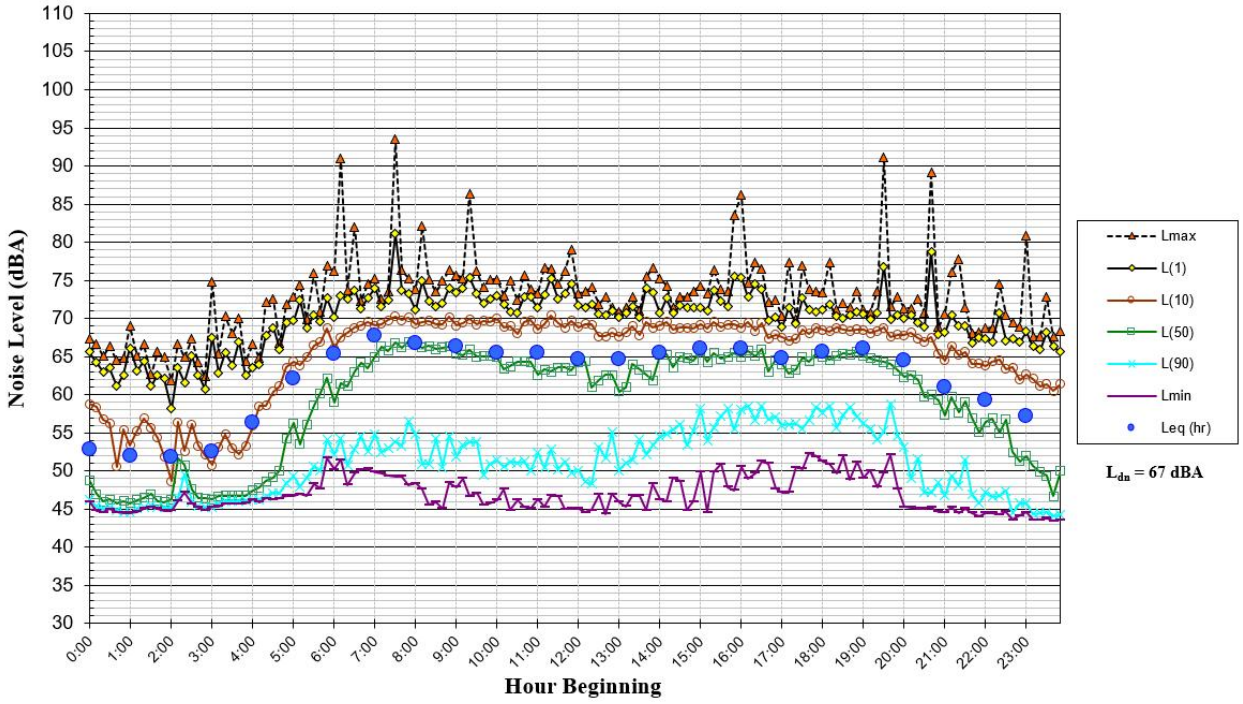


FIGURE 7 Daily Trend in Noise Levels at LT-2, Thursday, November 14, 2019

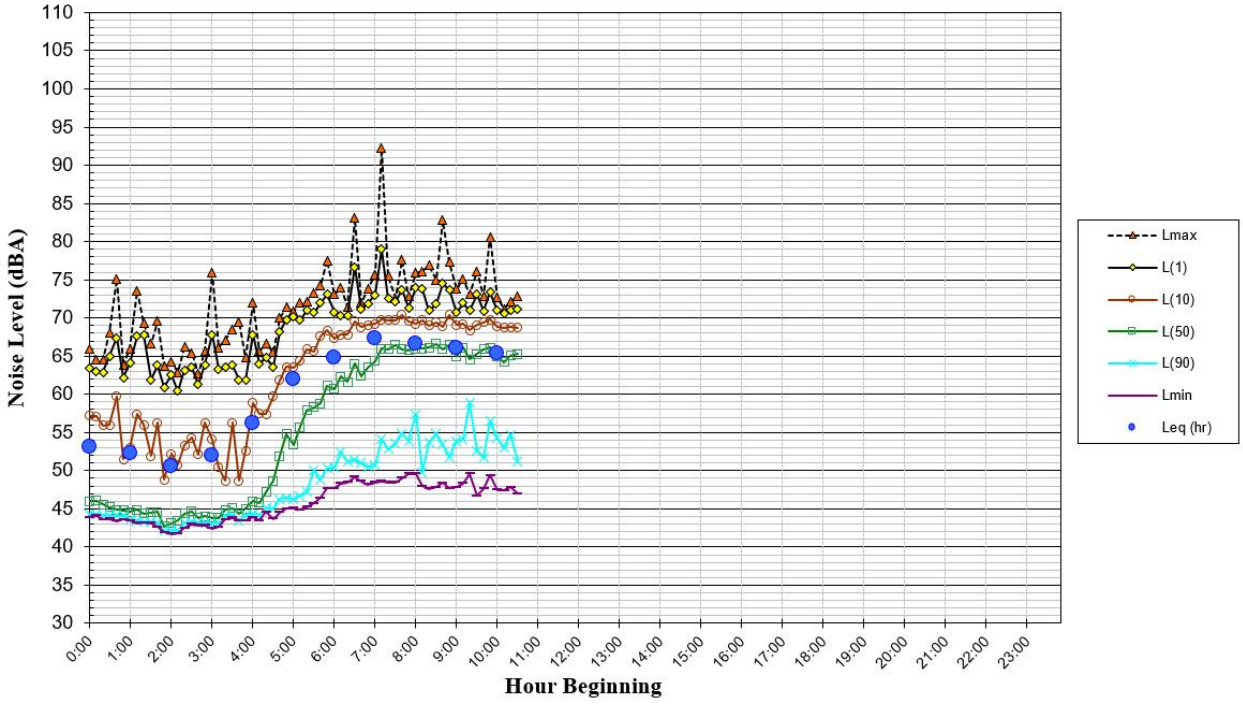


TABLE 4 Summary of Short-Term Noise Measurements (dBA)

Noise Measurement Location (Date, Time)	L_{max}	$L_{(1)}$	$L_{(10)}$	$L_{(50)}$	$L_{(90)}$	$L_{eq(10\text{-}min)}$
ST-1: ~125 feet west of the centerline of Porter Drive/Hanover Street (11/14/2019, 10:00-10:10 a.m.)	60	58	56	53	51	53
ST-2: End of Matadero Avenue (11/14/2019, 10:20-10:30 a.m.)	63	59	54	41	40	49

PLAN CONSISTENCY ANALYSIS

Noise and Land Use Compatibility

The City of Palo Alto has established a normally acceptable exterior noise threshold of 70 dBA L_{dn} for commercial office buildings. This standard would be enforced at the centers of common use outdoor areas and not at private balconies or decks. The performance method enforced in the Cal Green Code requires that interior noise levels be maintained at 50 dBA $L_{eq(1\text{-}hr)}$ or less during hours of operation at the nonresidential buildings when the building falls within the 65 dBA L_{dn} noise contour of a freeway or expressway, railroad, industrial source or fixed-guideway noise source, as determined by the local general plan noise element.

The future noise environment at the project site would continue to result primarily from vehicular traffic along the surrounding local roadways. A traffic report was completed for the proposed

project on July 11, 2019 by *Fehr & Peers.*[1] However, the traffic study did not include future traffic volumes. To estimate the worst-hour noise level under future conditions, it was assumed that an increase of 1 to 2% in traffic volumes could occur along Porter Drive/Hanover Street each year through 2040. These projections assume a standard rate of growth in the City but are conservative for built-out areas where growth is not forecasted. The total noise level increase at the project site would be 2 dBA L_{dn} above existing conditions for the year 2040. Therefore, the future noise levels would be 66 dBA L_{dn} at a distance of 25 feet from the centerline of Porter Drive/Hanover Street (LT-1).

Future Exterior Noise Environment

According to the site plan, an outdoor dining and seating area is shown on the ground level along the southern façade of the building, with setbacks from the centerline of the Porter Drive ranging from 70 to 245 feet. The future exterior noise levels would range from below 60 to 62 dBA L_{dn} at seating areas located along the perimeter of this outdoor space.

The two common use balconies are shown on the second level along the eastern and western building façades. The balcony located on the western façade would be shielded from traffic noise by the proposed building and would have future exterior noise levels below 70 dBA L_{dn}. The balcony along the eastern façade would be set back by approximately 95 feet. At this distance, the balcony at the front of the building would have future exterior noise levels of 60 dBA L_{dn}.

The outdoor use areas associated with the proposed office building are not expected to exceed the City's exterior noise level limit. Therefore, the proposed project is compatible with the future noise environment at the project site and additional noise control measures are not required.

Future Interior Noise Environment

The eastern building façade would be setback approximately 95 feet from the centerline of Porter Drive/Hanover Street. At this setback, future hourly average noise levels during daytime hours would range from 49 to 64 dBA $L_{eq(1\text{-}hr)}$, and a day-night average noise level of 60 dBA L_{dn} would be expected at the building exterior. Map N-6, Future Noise Contours, contained in the City of Palo Alto Comprehensive Plan[2] also indicates that the future exterior noise environment at the project site would be less than 60 dBA CNEL (essentially equivalent to L_{dn}). Exterior noise levels would be compatible with City of Palo Alto and State Building Code exterior noise requirements, therefore, the use of standard construction materials would be sufficient to maintain interior noise levels at acceptable levels. No additional noise control measures are required.

[1] Fehr & Peers, "Intersection Operations Evaluation for the Proposed Office Building at 3215 Porter Drive," July 11, 2019.
[2] City of Palo Alto, "City of Palo Alto Comprehensive Plan," November 13, 2017.

NOISE IMPACTS AND MITIGATION MEASURES

Significance Criteria

The following criteria were used to evaluate the significance of environmental noise resulting from the project:

- A significant noise impact would be identified if the project would generate a substantial temporary or permanent noise level increase over ambient noise levels at existing noise-sensitive receptors surrounding the project site and that would exceed applicable noise standards presented in the City of Palo Alto's Comprehensive Plan or Municipal Code at existing noise-sensitive receptors surrounding the project site.

    - During the allowable construction hours between 8:00 a.m. and 6:00 p.m. Monday through Friday and between 9:00 a.m. and 6:00 p.m. on Saturdays, no individual piece of equipment shall exceed 110 dBA at a distance of 25 feet or at a distance of 25 feet from the structure in which the equipment is enclosed. Further, 110 dBA shall not be exceeded at any point beyond the property plane of the construction site during allowable hours. For construction activities outside the allowable hours, noise levels shall not local ambient levels at residential properties by 6 dBA or at commercial properties by 8 dBA. During nighttime hours at residential land uses when occupants would be sleeping, a conservative noise level threshold of 50 dBA shall not be exceeded at residential land uses.

    - A significant permanent noise level increase would occur if project-generated traffic would result in: a) a noise level increase of 5 dBA L_{dn} or greater, with a future noise level of less than 60 dBA L_{dn}, or b) a noise level increase of 3 dBA L_{dn} or greater, with a future noise level of 60 dBA L_{dn} or greater.

    - A significant noise impact would be identified if the project would expose persons to or generate noise levels that would exceed applicable noise standards presented in the Comprehensive Plan.

- A significant impact would be identified if the construction of the project would generate excessive vibration levels surrounding receptors. Groundborne vibration levels exceeding 0.3 in/sec PPV would have the potential to result in cosmetic damage to normal buildings.

- A significant noise impact would be identified if the project would expose people residing or working in the project area to excessive aircraft noise levels.

Impact 1a: **Temporary Construction Noise.** Existing noise-sensitive land uses would be exposed to a temporary increase in ambient noise levels due to project construction activities. The incorporation of construction best management practices as project conditions of approval would result in a **less-than-significant** temporary noise impact.

Noise impacts resulting from construction depend upon the noise generated by various pieces of construction equipment, the timing and duration of noise-generating activities, and the distance between construction noise sources and noise-sensitive areas. Construction noise impacts primarily result when construction activities occur during noise-sensitive times of the day (e.g., early morning, evening, or nighttime hours), the construction occurs in areas immediately adjoining noise-sensitive land uses, or when construction lasts over extended periods of time.

Section 9.10.060(b) of the City of Palo Alto Municipal Code states that construction activities are permitted between the hours of 8:00 a.m. and 6:00 p.m. Monday through Friday and between 9:00 a.m. and 6:00 p.m. on Saturdays provided that no individual piece of equipment produces a noise level exceeding 110 dBA at a distance of 25 feet or noise levels of 110 dBA are exceeded anywhere outside the property plane. If the equipment is housed in a structure, the 110 dBA would be enforced at a distance of 25 feet from the structure. All construction activities are prohibited on Sundays and holidays.

The proposed project may require construction activities outside the allowable hours. For activities outside of the above hours, Section 9.10.040 of the Municipal Code states that any noise generated on commercial property shall not exceed ambient levels at residential properties by 6 dBA or at commercial properties by 8 dBA.

As discussed in the fundamentals section of this report, steady noises of sufficient intensity (above 35 dBA) and fluctuating noise levels above about 45 dBA would affect sleep. Assuming a 15 dBA exterior-to-interior reduction, which is typical for standard residential construction with windows open, sleep disturbance may result when exterior noise levels exceed 50 dBA L_{eq} for steady noises and 60 dBA L_{eq} for fluctuating noises. Therefore, if project construction occurs during nighttime hours between 10:00 p.m. and 7:00 a.m., a conservative threshold of 50 dBA L_{eq} shall also be enforced at residential land uses.

The existing land uses surrounding the project site consist of commercial land uses, which have ambient noise levels ranging from 53 to 68 dBA L_{eq} during daytime hours and from 46 to 61 dBA L_{eq} during nighttime hours. The nearest existing residences are located approximately 1,240 feet to the west of the project site and approximately 1,120 feet to the northeast of the project site. The ambient noise environment at the residences to the west are represented by measurements made at LT-2, which documented hourly average noise levels ranging from 61 to 68 dBA L_{eq} during daytime hours and from 51 to 65 dBA L_{eq} during nighttime hours. ST-2 was made at the residences to the northeast, with a daytime ambient noise level of 49 dBA L_{eq}. While nighttime noise levels were not measured at this location, nighttime noise levels are typically 10 dBA lower than daytime noise levels when traffic noise is the main noise source. Therefore, a nighttime noise level of 39 dBA L_{eq} is assumed for these residences.

Construction activities generate considerable amounts of noise, especially during earth-moving activities when heavy equipment is used. The highest maximum noise levels generated by project construction would typically range from about 80 to 90 dBA L_{max} at a distance of 50 feet from the noise source. A list of typical maximum instantaneous noise levels measured at 50 feet are provided in Table 5. Typical hourly average construction-generated noise levels for office buildings are about 78 to 89 dBA L_{eq} measured at a distance of 50 feet from the center of the site

during busy construction periods (e.g., earth moving equipment, impact tools, etc.), as shown in Table 6. Construction-generated noise levels drop off at a rate of about 6 dBA per doubling of the distance between the source and receptor. Shielding by buildings or terrain can provide an additional 5 to 10 dBA noise reduction at distant receptors.

To calculate the maximum instantaneous noise levels for each individual piece of equipment at 25 feet, 6 dBA should be added from each noise level in Table 5 since it would be half the distance. Since the proposed project would not require impact pile driving, the City's the 110 dBA threshold for individual pieces of equipment at 25 feet would not be exceeded.

TABLE 5 Construction Equipment 50-Foot Noise Emission Limits

Equipment Category	L_{max} Level (dBA)[1,2]	Impact/Continuous
Arc Welder	73	Continuous
Auger Drill Rig	85	Continuous
Backhoe	80	Continuous
Bar Bender	80	Continuous
Boring Jack Power Unit	80	Continuous
Chain Saw	85	Continuous
Compressor[3]	70	Continuous
Compressor (other)	80	Continuous
Concrete Mixer	85	Continuous
Concrete Pump	82	Continuous
Concrete Saw	90	Continuous
Concrete Vibrator	80	Continuous
Crane	85	Continuous
Dozer	85	Continuous
Excavator	85	Continuous
Front End Loader	80	Continuous
Generator	82	Continuous
Generator (25 KVA or less)	70	Continuous
Gradall	85	Continuous
Grader	85	Continuous
Grinder Saw	85	Continuous
Horizontal Boring Hydro Jack	80	Continuous
Hydra Break Ram	90	Impact
Impact Pile Driver	105	Impact
Insitu Soil Sampling Rig	84	Continuous
Jackhammer	85	Impact
Mounted Impact Hammer (hoe ram)	90	Impact
Paver	85	Continuous
Pneumatic Tools	85	Continuous
Pumps	77	Continuous
Rock Drill	85	Continuous
Scraper	85	Continuous
Slurry Trenching Machine	82	Continuous
Soil Mix Drill Rig	80	Continuous
Street Sweeper	80	Continuous
Tractor	84	Continuous
Truck (dump, delivery)	84	Continuous

Equipment Category	L_{max} Level (dBA)[1,2]	Impact/Continuous
Vacuum Excavator Truck (vac-truck)	85	Continuous
Vibratory Compactor	80	Continuous
Vibratory Pile Driver	95	Continuous
All other equipment with engines larger than 5 HP	85	Continuous

Notes:
[1] Measured at 50 feet from the construction equipment, with a "slow" (1 sec.) time constant.
[2] Noise limits apply to total noise emitted from equipment and associated components operating at full power while engaged in its intended operation.
[3]Portable Air Compressor rated at 75 cfm or greater and that operates at greater than 50 psi.

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

	Domestic Housing		Office Building, Hotel, Hospital, School, Public Works		Industrial Parking Garage, Religious Amusement & Recreations, Store, Service Station		Public Works Roads & Highways, Sewers, and Trenches	
	I	II	I	II	I	II	I	II
Ground Clearing	83	83	84	84	84	83	84	84
Excavation	88	75	89	79	89	71	88	78
Foundations	81	81	78	78	77	77	88	88
Erection	81	65	87	75	84	72	79	78
Finishing	88	72	89	75	89	74	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.

For a building of this size, project construction is expected to start in early August 2020 and be completed by mid-July 2021. Construction phases would include site preparation, grading/excavation, trenching/foundation, building exterior, building interior/architectural coating, and paving. An equipment list for the proposed project was not available at the time of this study, so the hourly average noise levels from Table 6 were used to estimate worst-hour construction conditions. The noise levels in Table 6 were propagated from the center of the project site to the nearest property lines of the surrounding noise-sensitive receptors. Table 7 summarizes the results of typical construction noise levels expected at the surrounding land uses during the various phases of project construction. The range in noise levels represents the minimum required equipment present at the site to all pertinent equipment. The noise levels shown in Table 7 for the commercial uses in the project vicinity assume no shielding from fences or intervening buildings; however, due to the distance and number of intervening buildings between the project site and the nearest residences, a conservative 10 dBA reduction in noise level was applied.

As stated above, the 110 dBA threshold for individual pieces of equipment would not be exceeded during the allowable construction hours. From the results in Table 7, temporary construction occurring at night between 6:00 p.m. and 8:00 a.m. on weekdays and between 6:00 p.m. and 9:00 a.m. on weekends would potentially expose the nearest residences to construction noise levels

exceeding 50 dBA L_{eq} and to noise levels 6 dBA or more above ambient conditions. Temporary construction would also potentially expose commercial uses to construction noise levels 8 dBA or more above ambient conditions. However, typical construction work occurring during nighttime hours would include minimal equipment, limiting excessive nighttime noise levels. Further, most commercial uses surrounding the site would only be occupied during daytime hours of operation. Assuming the surrounding commercial buildings to be vacant during nighttime construction hours, the use of minimal equipment would limit the nighttime noise to which the nearest residences would be exposed and would reduce the significance of this impact. Since total project construction is expected to last for a period of approximately 11.5 months, measures shall be implemented to reduce disruption and annoyance as much as possible at the surrounding residences.

With the incorporation of the following construction best management practices as part of the conditions of approval, this would be a less-than-significant impact.

Construction Best Management Practices

- Construction will be limited to the hours of 7:00 a.m. to 6:00 p.m. Monday through Friday and between 9:00 a.m. and 6:00 p.m. on Saturdays for any on-site or off-site work within 300 feet of any residential unit.

- Limit nighttime construction work to interior finishing work only. During nighttime construction hours, windows and doors shall be closed to minimize noise. Examples of allowable interior finishing work includes: drywall, finish carpentry, painting, plumbing, electrical, etc.

- The contractor shall use “new technology” power construction equipment with state-of-the-art noise shielding and muffling devices. All internal combustion engines used on the project site shall be equipped with adequate mufflers and shall be in good mechanical condition to minimize noise created by faulty or poorly maintained engines or other components.

- The unnecessary idling of internal combustion engines shall be prohibited.

- Staging areas and stationary noise-generating equipment shall be located as far as possible from noise-sensitive receptors such as residential uses (a minimum of 200 feet).

- The surrounding neighborhood shall be notified early and frequently of the construction activities.

- A “noise disturbance coordinator” shall be designated to respond to any local complaints about construction noise. The disturbance coordinator would determine the cause of the noise complaints (e.g., beginning work too early, bad muffler, etc.) and institute reasonable measures warranted to correct the problem. A telephone number for the disturbance coordinator would be conspicuously posted at the construction site.

- Utilize ‘quiet’ models of air compressors and other stationary noise sources where technology exists.

- Equip all internal combustion engine-driven equipment with mufflers, which are in good condition and appropriate for the equipment.

- Construct temporary noise barriers, where feasible, to screen stationary noise-generating equipment when located within 200 feet of adjoining sensitive land uses. Temporary noise barrier fences would provide a 5 dBA noise reduction if the noise barrier interrupts the line-of-sight between the noise source and receptor and if the barrier is constructed in a manner that eliminates any cracks or gaps.

- If stationary noise-generating equipment must be located near receptors, adequate muffling (with enclosures where feasible and appropriate) shall be used. Any enclosure openings or venting shall face away from sensitive receptors.

- Ensure that generators, compressors, and pumps are housed in acoustical enclosures.

- Locate cranes as far from adjoining noise-sensitive receptors as possible.

- During final grading, substitute graders for bulldozers, where feasible. Wheeled heavy equipment are quieter than track equipment and should be used where feasible.

- Substitute nail guns for manual hammering, where feasible.

- Substitute electrically-powered tools for noisier pneumatic tools, where feasible.

- 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 adjacent residential land uses so that construction activities can be scheduled to minimize noise disturbance.

The implementation of these measures would reduce construction noise levels emanating from the site, minimizing disruption and annoyance. With the implementation of these controls, as well as the Municipal Code limits on allowable construction hours, and considering that construction is temporary, the impact would be reduced to a less-than-significant level.

Mitigation Measure 1a: No further mitigation required.

TABLE 7 Estimated Construction Noise Levels at the Property Lines of the Surrounding Receptors

Phase	Estimated Noise Levels at Nearby Land Uses, dBA L_{eq}				
	South Comm. (80ft)	**West Comm. (190ft)**	**East Comm. (245ft)**	**West Res. (1,240ft)**	**Northeast Res. (1,120ft)**
	L_{eq}	**L_{eq}**	**L_{eq}**	**L_{eq}**	**L_{eq}**
Ground Clearing	80 dBA	72 dBA	70 dBA	46 dBA	47 dBA
Excavation	75 to 85 dBA	67 to 77 dBA	65 to 75 dBA	41 to 51 dBA	42 to 52 dBA
Foundations	74 dBA	66 dBA	64 dBA	40 dBA	41 dBA
Erection	71 to 83 dBA	63 to 75 dBA	61 to 73 dBA	37 to 49 dBA	38 to 50 dBA
Finishing	71 to 85 dBA	63 to 77 dBA	61 to 75 dBA	37 to 51 dBA	38 to 52 dBA

Impact 1b: **Permanent Noise Level Increase.** The proposed project is not expected to cause a substantial permanent noise level increase at the existing residential land uses in the project vicinity. **This is a less-than-significant impact.**

A significant impact would occur if the permanent noise level increase due to project-generated traffic at noise-sensitive receptors was 3 dBA L_{dn} or greater where noise levels would exceed 60 dBA L_{dn} or was 5 dBA L_{dn} or greater where noise levels would remain at or below 60 dBA L_{dn}. Existing noise levels measured in the project area exceed 60 dBA L_{dn}; therefore, a significant impact would occur if the project would increase the existing noise environment of existing noise-sensitive receptors by 3 dBA L_{dn}. For reference, a 3 dBA L_{dn} noise increase would be expected if the project would double existing traffic volumes along a roadway.

The traffic study prepared for the proposed project[1] included existing plus project traffic volumes. When these volumes were compared to the existing traffic volumes, a noise level increase due to project-generated traffic was estimated to be less than 1 dBA L_{dn} or less along the roadway segments in the project vicinity. Therefore, the traffic expected as a result of the proposed project would not result in a permanent noise increase at the existing noise-sensitive receptors in the project vicinity. This is a less-than-significant impact.

Mitigation Measure 1b: **None required.**

Impact 1c: **Noise Levels in Excess of Standards.** The proposed project could generate noise in excess of standards established in the City's Comprehensive Plan at the nearby sensitive receptors. The incorporation of mitigation measures to reduce operational noise levels as project conditions of approval would result in a **less-than-significant** noise impact.

Section 9.10.040 of the Municipal Code states that any noise generated at the project site shall not exceed ambient levels at residential properties by 6 dBA or at commercial properties by 8 dBA.

Mechanical Equipment Noise

The roof plan for the proposed office building shows a 4,300-square foot PV array for solar power. While solar power equipment would be audible within a few feet, the noise is typically a low hum, and would not be audible from the ground level of the building. The roof plan also shows a mechanical enclosure, which would house two variable refrigerant flow outdoor units (Multi V5 with LG Red, combination unit model ARUM408DTE5 24 to 34 tons), a direct drive upblast centrifugal roof exhaust fan (Greenheck, model CUE-240-B-VGD), a centrifugal utility fan – backward inclined wheel (Greenheck, model USF-336-BI), an energy recovery ventilator (Greenheck, model ERVe-45-30L), and air conditioning unit (Greenheck, model MSX-118-H32). The noise level information provided by the manufacturers are summarized in Table 8.

TABLE 8 Summary of Mechanical Equipment Source Levels Provided by Manufacturers

Equipment	Label on Site Plan	Source Level at a Distance of 5 feet, dBA
Variable Refrigerant Flow Outdoor Units	HP-1 or HP-2	63 to 66 dBA
Direct Drive Upblast Centrifugal Roof Exhaust Fan	EF-1	74 dBA
Centrifugal Utility Fan – Backward Inclined Wheel	EF-2	67 dBA (inlet) 68 dBA (outlet)
Energy Recovery Ventilators	ERV-1	61 dBA (supply) 58 (exhaust)
Air Conditioning Unit	MUA-1	64 dBA

This analysis assumes that each piece of equipment summarized in Table 8 would operate simultaneously, representing the worst-case scenario. While the mechanical enclosure is likely to provide some shielding for the mechanical equipment, the type of material, thickness of the material, and absorptive properties were unavailable. For purposes of assessing the worst-case scenario, the mechanical enclosure is assumed to provide no shielding. Based on the noise sources summarized in Table 8 and the roof plan provided at the time of this study, a SoundPLAN (version 8.1) model was created for the proposed project equipment.

Table 9 summarizes the distances from the mechanical enclosure to the nearest receptor property line and the mechanical equipment noise estimated at that distance. For each receptor, the daytime and nighttime ambient noise levels are also summarized. Due to the distance between the source and receptor and the intervening buildings, a conservative 10 dBA reduction was applied to both of the residential receptors.

TABLE 9 Summary of Mechanical Equipment Noise Levels Calculated at Each Surrounding Receptor Property Line

Receptor (Distance from Mechanical Enclosure to Property Line)	Ambient Noise Levels, L_{eq}, dBA		Estimated Mechanical Equipment Noise Levels, L_{eq}, dBA
	Daytime	Nighttime	
Commercial Use, south (80 feet)	53 to 68 dBA	46 to 61 dBA	34 dBA
Commercial Use, east (160 feet)			35 dBA
Commercial Use, west (230 feet)			<30 dBA
Commercial Use, northeast (190 feet)			<30 dBA

Receptor (Distance from Mechanical Enclosure to Property Line)	Ambient Noise Levels, L_{eq}, dBA		Estimated Mechanical Equipment Noise Levels, L_{eq}, dBA
	Daytime	Nighttime	
Residential Use, west (1,490 feet)	61 to 68 dBA	51 to 65 dBA	<30 dBA
Residential Use, northeast (1,225 feet)	49 dBA	39 dBA	<30 dBA

The results of the modeling summarized in Table 9 show that noise levels generated by equipment on the rooftop of the proposed building would not exceed the ambient noise levels at residential uses by 6 dBA and would not exceed ambient noise levels at commercial uses by 8 dBA. Further, the mechanical enclosure would provide additional shielding for the equipment and further reduce noise levels. This would result in a less-than-significant impact.

Truck Loading and Unloading

The site plan shows the loading zone for the proposed project to be along the northern façade, facing the substation. While specific uses for the proposed building have not been determined, smaller delivery trucks or vender trucks are expected for a building of this size. Delivery times and frequency of deliveries were not provided at the time of this study; however, it is assumed that these deliveries would occur during daytime hours between 7:00 a.m. and 10:00 p.m.

Vendor delivery trucks typically generate maximum noise levels of 60 to 65 dBA L_{max} at a distance of 50 feet. Low speed truck noise results from a combination of engine, exhaust, and tire noise, as well as the intermittent sounds of back-up alarms and releases of compressed air associated with truck/trailer air brakes. The noise levels produced by backup alarms can vary depending on the type and directivity of the sound, but maximum noise levels are typically between 65 to 75 dBA L_{max} at a distance of 50 feet. Assuming a typical delivery would take about 15 to 20 minutes, the hourly average noise level from a delivery would be 68 dBA L_{eq} at a distance of 50 feet.

For each surrounding land use, Table 10 summarizes the distances from the center of the loading zone to the property lines of the surrounding land uses, the ambient noise levels during daytime hours, and the estimated truck delivery noise levels at the receptor property lines. For the commercial property to the south of the project site, the proposed building would break the line-of-sight to the loading zone; therefore, a conservative 10 dBA reduction was applied. This same conservative reduction was also applied to the distant residential receptors that would also be shielded by intervening buildings.

TABLE 10 Summary of Truck Delivery Noise Levels Calculated at Each Surrounding Receptor Property Line

Receptor (Distance from Center of Loading Zone to Property Line)	Ambient Noise Levels, L_{eq}, dBA	Estimated Truck Delivery Noise Levels, L_{eq}, dBA
	Daytime	
Commercial Use, south (140 feet)	53 to 68 dBA	49 dBA

Receptor (Distance from Center of Loading Zone to Property Line)	Ambient Noise Levels, L_{eq}, dBA Daytime	Estimated Truck Delivery Noise Levels, L_{eq}, dBA
Commercial Use, east (190 feet)		56 dBA
Commercial Use, west (250 feet)		54 dBA
Commercial Use, northeast (200 feet)		56 dBA
Residential Use, west (1,510 feet)	61 to 68 dBA	<30 dBA
Residential Use, northeast (1,200 feet)	49 dBA	30 dBA

Noise due to truck deliveries would not exceed the ambient noise levels at residential uses by 6 dBA and would not exceed ambient noise levels at commercial uses by 8 dBA. This would result in a less-than-significant impact.

Parking Lot Noise

Surface parking and garage parking are proposed for this project. The total number of surface parking spots would be 32, while 38 additional spots would be located within the parking below grade parking garage.

Noise associated with parking would include vehicular circulation, engines, door slams, car alarms, and human voices. Noise sources occurring within the parking garage are not anticipated to be audible outside of the parking garage. The surface parking would be located adjacent to a parking lot with about 200 spaces. The 32 additional parking spaces for this project would, therefore, be similar in character to the existing noise environment. The 32 additional parking spaces would not result in a noise level increase of more than 1 dBA in the immediate vicinity and would not be audible at the residential land uses more than 1,000 feet away. This is a less-than-significant impact.

Mitigation Measure 1c: None required.

Impact 2: Exposure to Excessive Groundborne Vibration due to Construction. Construction-related vibration levels resulting from activities are not expected to exceed 0.3 in/sec PPV at the surrounding sensitive land uses. **This is a less-than-significant impact.**

The construction of the project may generate perceptible vibration when heavy equipment or impact tools (e.g. jackhammers, hoe rams) are used. Construction activities would include site demolition, preparation work, foundation work, and new building framing and finishing. The proposed project is not expected to require pile driving, which can cause excessive vibration.

The California Department of Transportation recommends a vibration limit of 0.5 in/sec PPV for buildings structurally sound and designed to modern engineering standards in order to reduce the potential for cosmetic damage to structures. Cosmetic damage is defined as hairline cracking in plaster, the opening of old cracks, the loosening of paint or the dislodging of loose objects. A vibration limit of 0.3 in/sec PPV has been used for buildings that are found to be structurally sound but where structural damage is a major concern (see Table 3 above for further explanation). For historical buildings or buildings that are documented to be structurally weakened, a conservative limit of 0.08 in/sec PPV is often used to provide the highest level of protection.

No historical buildings or buildings that are documented to be structurally weakened adjoin the project site. Groundborne vibration levels exceeding 0.3 in/sec PPV at nearby buildings would have the potential to result in a significant vibration impact because such levels would be capable of cosmetically damaging adjacent buildings. Cosmetic damage (also known as threshold damage) is defined as hairline cracking in plaster, the opening of old cracks, the loosening of paint or the dislodging of loose objects. Minor damage is defined as hairline cracking in masonry or the loosening of plaster. Major structural damage is defined as wide cracking or the shifting of foundation or bearing walls.

Construction vibration levels would vary depending on soil conditions, construction methods, and equipment used. Table 11 presents typical vibration levels from construction equipment at the reference distance of 25 feet. Calculations were also made to estimate vibration levels at the nearest residential and commercial structures surrounding the site. Vibration levels are highest close to the source, and then attenuate with increasing distance at the rate $\left({}^{D_{ref}}/_{D}\right)^{1.1}$, where D is the distance from the source in feet and D_{ref} is the reference distance of 25 feet. Project-generated vibration levels would fall below the 0.3 in/sec PPV threshold when construction activities producing the highest vibration levels (e.g., vibratory roller) are 20 feet or more from the project site. Since all off-site structures are 25 feet or more from the project site boundaries, neither cosmetic, minor, or major damage would occur at these conventional buildings.

At these locations, and in other surrounding areas where vibration would not be expected to cause cosmetic damage, vibration levels may still be perceptible. However, as with any type of construction, this would be anticipated and would not be considered significant, given the intermittent and short duration of the phases that have the highest potential of producing vibration (use of jackhammers and other high-power tools). By use of administrative controls, such as notifying neighbors of scheduled construction activities and scheduling construction activities with the highest potential to produce perceptible vibration during hours with the least potential to affect nearby businesses, perceptible vibration can be kept to a minimum. This would be a less-than-significant impact.

TABLE 11 Vibration Source Levels for Construction Equipment

Equipment		PPV at 25 ft. (in/sec)	Vibration Levels at Nearest Surrounding Building Façades (in/sec PPV)				
			South Comm. (25ft)	East Comm. (120ft)	West Comm. (250ft)	West Res. (1,315ft)	NE Res. (1,185ft)
Clam shovel drop		0.202	0.202	0.036	0.016	0.003	0.003
Hydromill (slurry wall)	in soil	0.008	0.008	0.001	0.001	0.000	0.000
	in rock	0.017	0.017	0.003	0.001	0.000	0.000
Vibratory Roller		0.210	0.210	0.037	0.017	0.003	0.003
Hoe Ram		0.089	0.089	0.016	0.007	0.001	0.001
Large bulldozer		0.089	0.089	0.016	0.007	0.001	0.001
Caisson drilling		0.089	0.089	0.016	0.007	0.001	0.001
Loaded trucks		0.076	0.076	0.014	0.006	0.001	0.001
Jackhammer		0.035	0.035	0.006	0.003	0.000	0.001
Small bulldozer		0.003	0.003	0.001	0.000	0.000	0.000

Source: Transit Noise and Vibration Impact Assessment, United States Department of Transportation, Office of Planning and Environment, Federal Transit Administration, May 2006 and modified by Illingworth & Rodkin, Inc., November 2019.

Mitigation Measure 2: None required.

Impact 3: Excessive Aircraft Noise. The project site is located more than two miles from a public airport or public use airport and would not expose people residing or working in the project area to excessive aircraft noise levels. **This is a less-than-significant impact.**

The Palo Alto Airport is a general aviation airport located approximately 3.7 miles northeast of the project site. The project site lies well-outside the 55 dBA CNEL 2022 noise contour for the airport, according to the Palo Alto Airport Comprehensive Land Use Plan[3] amended in November 2016 (see Figure 8). This means that future exterior noise levels due to aircraft from Palo Alto Airport would be below 55 dBA CNEL/L_{dn} at the project site. Further, the project site is more than 5 miles from the Moffett Federal Airfield and more than 11 miles from Norman Y. Mineta San José International Airport. The project site would be well-outside the 60 dBA CNEL noise contours for each of these nearby airports. Therefore, the proposed project would be compatible with the City's exterior noise standards for aircraft noise. This would be a less-than-significant impact.

Mitigation Measure 3: None required.

[3] Santa Clara County Airport Land Use Commission, "Palo Alto Airport Comprehensive Land Use Plan Santa Clara County," prepared by Walter B. Windus, PE, amended November 16, 2016.

FIGURE 8 2022 CNEL Noise Contours for Palo Alto Airport Relative to Project Site