1919 O'FARRELL STREET NOISE AND VIBRATION ASSESSMENT

San Mateo, California

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INTRODUCTION

The project is located at 1919 O'Farrell Street in the Beresford Park neighborhood in the City of San Mateo. The project plans to redevelop a .71-acre site by demolishing an existing one-story office building to construct a four-story, 49-unit multi-family apartment community with subterranean parking.

This report evaluates the Project's potential to result in significant noise 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 vibration, summarizes applicable regulatory criteria, and discusses the results of the ambient noise monitoring survey completed to document existing noise conditions; 2) the General Plan Consistency section discusses land use compatibility utilizing noise policies in the City's General Plan; and, 3) 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, to reduce the impacts to less than significant.

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.

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 sounds 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.

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.

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.

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.

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 12-17 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 57-62 dBA L_{dn} with open windows and 65-70 dBA L_{dn} if the windows are closed. Levels of 55-60 dBA are common along collector streets and secondary arterials, while 65-70 dBA is a typical value for a primary/major arterial. Levels of 75-80 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 25-30 percent of the population. There is, therefore, an increase of about 2 percent per dBA between a L_{dn} of 60-70 dBA. Between a L_{dn} of 70-80 dBA, each additional decibel increases the percentage of the population highly annoyed by about 3 percent. People appear to respond more adversely to aircraft noise. When the L_{dn} is 60 dBA, approximately 30-35 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 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, April 2020.

Regulatory Background

The project would be subject to noise-related regulations, plans and policies established by the State of California and the City of San Mateo. Applicable planning documents include Appendix G of the CEQA Guidelines, the San Mateo General Plan, and the San Mateo Municipal Code. Regulations, plans, and policies presented within these documents form the basis of the significance criteria used to assess project impacts.

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;

(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.

Of these guidelines, items (a) and (b) are applicable to the proposed project. The project is not located in the vicinity of a public airport or private airstrip; therefore, checklist item (c) is not carried forward in this analysis.

2019 California Building Code, Title 24, Part 2. The current version of the California Building Code (CBC) requires interior noise levels attributable to exterior environmental noise sources to be limited to a level not exceeding 45 dBA L_{dn}/CNEL in any habitable room.

City of San Mateo General Plan: The Noise Element of the City of San Mateo General Plan sets forth goals and policies to control environmental noise and protect citizens from excessive noise exposure. The goals and policies relevant to this project are summarized below:

GOAL 1: Protect "noise sensitive" land uses from excessive noise levels.

POLICIES:

N 1.1: Interior Noise Level Standard. Require submittal of an acoustical analysis and interior noise insulation for all "noise sensitive" land uses listed in Table N-1 that have an exterior noise level of 60 dB (L_{dn}) or above, as shown on Figure N-1. The maximum interior noise level shall not exceed 45 dB (L_{dn}) in any habitable rooms.

N 1.2: Exterior Noise Level Standard. Require an acoustical analysis for new parks, play areas, and multi-family common open space (intended for the use and the enjoyment of residents) that have an exterior noise level of 60 dB (L_{dn}) or above, as shown on Figure N-1. Require an acoustical analysis that uses peak hour L_{eq} for new parks and play areas. Require a feasibility analysis of noise reduction measures for public parks and play areas. Incorporate necessary mitigation measures into residential project design to minimize common open space noise levels. Maximum exterior noise should not exceed 67 dB (L_{dn}) for residential uses and should not exceed 65 dB (L_{eq}) during the noisiest hour for public park uses.

GOAL 2: Minimize unnecessary, annoying and unhealthful noise.

POLICIES:

N 2.1: Noise Ordinance. Continue implementation and enforcement of City's existing noise control ordinance: (a) which prohibits noise that is annoying or injurious to neighbors of normal sensitivity, making such activity a public nuisance, and (b) restricts the hours of construction to minimize noise impact.

N 2.2: Minimize Noise Impact. Protect all "noise-sensitive" land uses listed in Tables N-1 and N-2 from adverse impacts caused by noise generated on-site by new developments. Incorporate necessary mitigation measures into development design to minimize noise impacts. Prohibit long-term exposure increases of 3 dB (L_{dn}) or greater at the common property line, excluding existing ambient noise levels.

N 2.3: Minimize Commercial Noise. Protect land uses other than those listed as "noise sensitive" in Table N-1 from adverse impacts caused by the on-site noise generated by new developments. Incorporate necessary mitigation measures into development design to minimize noise impacts. Prohibit new uses that generate noise levels of 65 dB (L_{dn}) or above at the property line, excluding existing ambient noise levels.

N 2.4: Traffic Noise. Recognize projected increases in ambient noise levels resulting from traffic increases. Promote the installation of noise barriers along highways where "noise-sensitive" land uses listed in Table N-1 are adversely impacted by unacceptable noise levels [60 dB (L_{dn}) or above]. Require adequate noise mitigation to be incorporated into the widening of SR 92 and US 101. Accept noise increases on El Camino Real at existing development, and require new multi-family development to provide common open space having a maximum exterior noise level of 67 dB (L_{dn}).

TABLE N-1
NOISE SENSITIVE LAND-USE COMPATIBILITY GUIDELINES FOR COMMUNITY NOISE ENVIRONMENTS[1]
Day-Night Average Sound Level (L_{dn}), Decibels

Land-Use Category	Normally Acceptable[2]	Conditionally Acceptable[3]	Normally Unacceptable[4]
Single-Family Residential	50 to 59	60 to 70	Greater than 70
Multi-Family Residential	50 to 59	60 to 70	Greater than 70
Hotels, Motels, and Other Lodging Houses	50 to 59	60 to 70	Greater than 70
Long-Term Care Facilities	50 to 59	60 to 70	Greater than 70
Hospitals	50 to 59	60 to 70	Greater than 70
Schools	50 to 59	60 to 70	Greater than 70
Multi-Family Common Open Space Intended for the Use and Enjoyment of Residents	50 to 67	--	Greater than 67

TABLE N-2
NOISE GUIDELINES FOR OUTDOOR ACTIVITIES
Average Sound Level (L_{eq}), Decibels

Land Use Category	Normally Acceptable[2]	Conditionally Acceptable[3]	Normally Unacceptable[4]
Parks, Playgrounds	50 to 65*	--	Greater than 65*

[1] These guidelines are derived from the California Department of Health Services, Guidelines for the Preparation and Content of the Noise Element of the General Plan, 2003. The State Guidelines have been modified to reflect San Mateo's preference for distinct noise compatibility categories and to better reflect local land-use and noise conditions. It is intended that these guidelines be utilized to evaluate the suitability of land-use changes only and not to determine cumulative noise impacts. Land uses other than those classified as being "noise sensitive" are exempt from these compatibility guidelines.

[2] Normally Acceptable – Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

[3] Conditionally Acceptable – New construction should be undertaken only after a detailed analysis of the noise reduction requirement is conducted and needed noise insulation features included in the design.

[4] Normally Unacceptable – New construction should be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.

* Average Sound Level (Leq) for peak hour.

City of San Mateo Municipal Code: The Noise Regulations of the San Mateo Municipal Code, Chapter 7.30 are set forth to protect the inhabitants of the City against all forms of nuisances.

Section 7.30.040 Maximum Permissible Sound Levels. It is unlawful for any person to operate or cause to be operated any source of sound at any location within the city or allow the creation of any noise on property owned, leased, occupied or otherwise controlled by such person, which causes the noise level when measured on any other property to exceed:

(1) The noise level standard for that property as specified in Table 7.30.040 for a cumulative period of more than thirty minutes in any hour;
(2) The noise level standard plus five dB for a cumulative period of more than fifteen minutes in any hour;
(3) The noise level standard plus ten dB for a cumulative period of more than five minutes in any hour;
(4) The noise level standard plus fifteen dB for a cumulative period of more than one minute in any hour; or
(5) The noise level standard or the maximum measured ambient level, plus twenty dB for any period of time.

If the measured ambient level for any area is higher than the standard set in Table 7.30.040, then the ambient shall be the base noise level standard for purposes of this section. In such cases, the noise levels for purposes of subsections (2) through (5) of this section shall be increased in five dB increments above the ambient.

Table 7.30.040: Noise Level Standards

Noise Zone	Time Period	Noise Level, dBA
Noise Zone 1	10 p.m.--7 a.m.	50
	7 a.m.--10 p.m.	60
Noise Zone 2	10 p.m.--7 a.m.	55
	7 a.m.--10 p.m.	60
Noise Zone 3	10 p.m.--7 a.m.	60
	7 a.m.--10 p.m.	65
Noise Zone 4	Anytime	70

Section 7.30.060 Special Provisions. Construction, alteration, repair, or land development activities authorized by a valid city permit shall be allowed at the following times:

- Weekdays: between 7:00 a.m. and 7:00 p.m.
- Saturdays: between 9:00 a.m. and 5:00 p.m.
- Sundays and Holidays: between 12:00 p.m. and 4:00 p.m.
- Or at other such hours as authorized or restricted by the permit, so long as they meet the following conditions:

    1. No individual piece of equipment shall produce a noise level exceeding 90 dBA at a distance of 25 feet. If the device is housed within a structure on the property, the measurement shall be made outside the structure at a distance as close to 25 feet as possible.

2. The noise level outside of any point outside the property plane of the project shall not exceed 90 dBA.

Existing Noise Environment

The project site, shown in Figure 1, is located south of SR 92. Existing uses in the vicinity of the project include multi-family residential uses bordering the site to the east with office and public use to the west and office and multi-family to the south. More distant single-family residences are located to the west and south.

FIGURE 1 Location of Project Site

Source: Google Earth, 2021.

Due to the COVID-19 pandemic, the traffic volumes along the surrounding roadways were reduced and not representative of typical conditions. Therefore, a noise monitoring survey was not completed to document ambient noise levels. Instead, the existing noise environment was determined through noise modeling and review of traffic noise contours provided in the Draft Environmental Impact Report completed for the City of San Mateo General Plan (DEIR)[1]. The DEIR identifies the project site is within the <75 dBA L_{dn} contour. The contours assume an at-grade roadway alignment with no intervening shielding.

[1] City of San Mateo, *General Plan Update Draft Environmental Impact Report*, July 2009, https://www.cityofsanmateo.org/DocumentCenter/View/5216/4_6-Noise

Traffic volumes for segments of SR 92 in the vicinity of the project site were obtained from Caltrans via the Traffic Census Program[2] and traffic volumes for O'Farrell Street were obtained from the project's traffic study, completed by Fehr Peers. These volumes were used to model traffic noise at the site and were validated using the contour distances specified in the DEIR. Traffic noise was modeled using Federal Highway Administration Traffic Noise Model 2.5 implemented in SoundPLAN 8.2. Sound PLAN is a three-dimensional noise modeling software that considers site geometry, the characteristics of noise sources, and shielding from structures, barriers, and terrain.

Based on review of General Plan contours and SoundPLAN noise modeling, the existing noise environment at the project site is characterized primarily by vehicular traffic along SR 92. The project site is located approximately 60 feet south of the centerline of SR 92. Existing noise levels would range from 75 to 77 dBA L_{dn} at the northern setback of the proposed project.

GENERAL PLAN CONSISTENCY ANALYSIS

Noise and Land Use Compatibility Thresholds

The Noise Element of the City of San Mateo General Plan sets forth goals and policies to control environmental noise and protect citizens from excessive noise exposure. The applicable policies were presented in detail in the Regulatory Background section and are summarized below for the proposed project:

- The City of San Mateo's "Normally Acceptable" exterior noise level objective is 59 dBA L_{dn} or less for residential land uses. Maximum exterior noise in multi-family outdoor activity areas intended for the use of residents should not exceed 67 dBA L_{dn}.

- The City of San Mateo's interior noise level limit is 45 dBA L_{dn} or less for residential land uses consistent with the requirements of the California Building Code.

Future Exterior Noise Environment

The future noise environment at the project site would continue to be dominated by vehicular traffic along SR 92. Secondary noise sources would include the occasional overhead aircraft and vehicle traffic along O'Farrell Street. Existing and future traffic conditions from the project's traffic study were compared to estimate future traffic noise levels in the project vicinity. For purposes of estimating the worst-case scenario, the cumulative plus project traffic scenario was used to estimate future peak hour noise levels on O'Farrell Street. A standard growth rate of 1% per year over the next 19 years was assumed on SR 92.

Future noise levels at the site are conservatively calculated to increase by up to 1 dBA by year 2040. Therefore, the future day-night average noise level would be up to 78 dBA L_{dn} at the northern facade of the proposed building.

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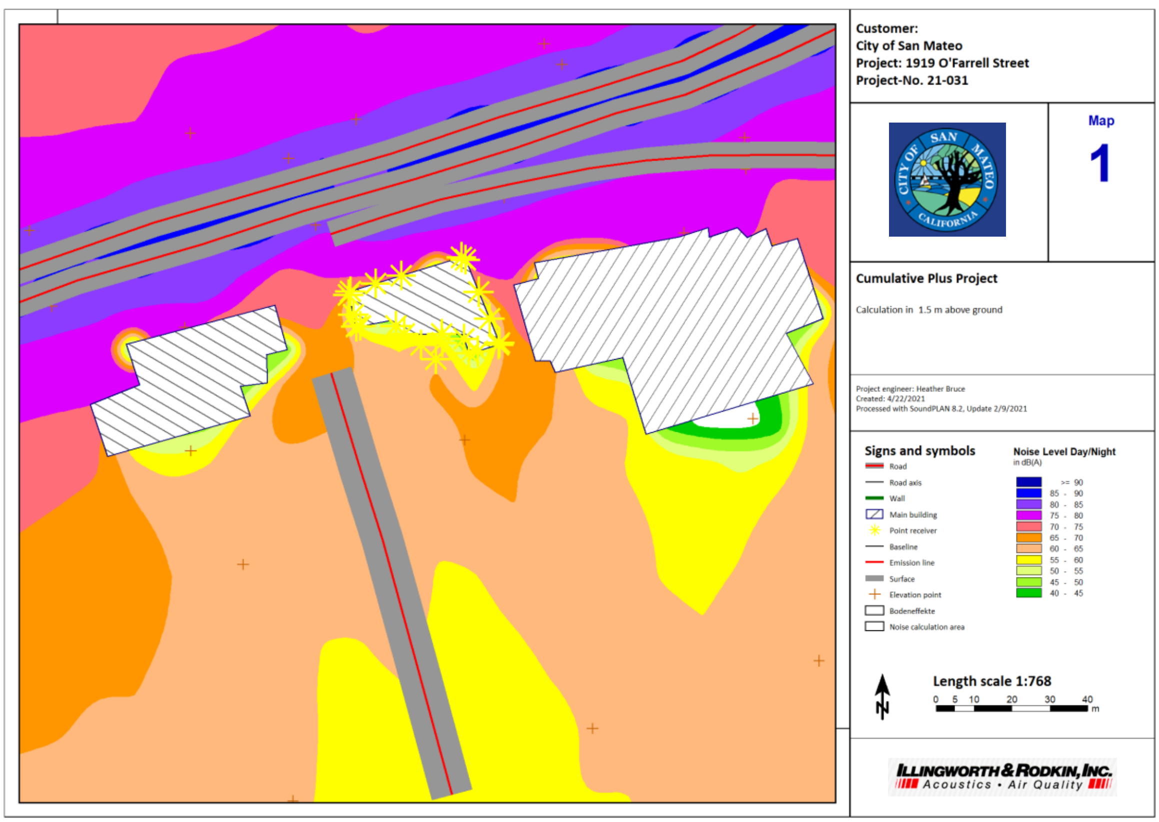
[2] Caltrans, *Traffic Census Program: 2019 Traffic Volumes: Route 92-98*, Accessed 4/7/2021, Available: https://dot.ca.gov/programs/traffic-operations/census

The site plan proposed an outdoor use activity area on the first floor. While private patios and balconies are proposed throughout the project site, these small outdoor spaces are not evaluated as outdoor activity areas sensitive to noise. Industry practice is to apply the exterior noise threshold to common outdoor use areas in multi-family projects because these are the areas that are frequently used by residents. Small decks and patios associated with multi-family residential land uses are normally used for the storage of bicycles, barbecues, etc., and are rarely used by residents for outdoor enjoyment, particularly when adjacent to transportation-related noise sources. Residents desiring a quiet outdoor use area normally choose to use an interior courtyard or rooftop deck for quiet outdoor enjoyment as opposed to a balcony overlooking a busy roadway.

The proposed courtyard would be located on the first floor. The courtyard would be shielded by the building itself from SR 92 to the north. Existing buildings would provide additional acoustic shielding to south and east. The center of the courtyard would be located approximately 100 feet from the centerline of O'Farrell Street to the west. At this distance, and assuming shielding from the proposed building, the future exterior noise levels at the proposed courtyard would be as high as 66 dBA L_{dn} which is "conditionally acceptable" and below the City's maximum exterior noise standard of 67 dBA L_{dn}. Figure 2 depicts the SoundPLAN modeling roadway noise exposure contour map for cumulative plus project conditions at the proposed project site.

FIGURE 2 Cumulative Plus Project SoundPLAN Roadway Noise Modeling Results



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Noise Insulation Features to Reduce Future Interior Noise Levels

The following noise insulation features shall be incorporated into the proposed project to reduce interior noise levels to 45 dBA L_{dn} or less:

- Provide a suitable form of forced-air mechanical ventilation, as determined by the local building official, for all residential and retail units, so that windows can be kept closed at the occupant's discretion to control interior noise and achieve the interior noise standards.

- Preliminary calculations indicate that residential units located along the northern building façade would require windows and doors with a minimum rating of 32 to 38 STC to meet the interior noise threshold of 45 dBA L_{dn}.

- Residential units located along the eastern façade would require windows and doors with minimum STC rating of 28 to 36 to meet the interior noise threshold of 45 dBA L_{dn}.

- Residential units located along the western façade would require windows and doors with minimum STC rating of 28 to 36 to meet the interior noise threshold of 45 dBA L_{dn}.

- A qualified acoustical specialist shall prepare a detailed analysis of interior residential noise levels resulting from all exterior sources during the design phase pursuant to requirements set forth in the State Building Code. The study will also establish appropriate criteria for noise levels inside the commercial spaces affected by environmental noise. The study will review the final site plan, building elevations, and floor plans prior to construction and recommend building treatments to reduce residential interior noise levels to 45 dBA L_{dn} or lower. Treatments would include, but are not limited to, sound-rated windows and doors, sound-rated wall and window constructions, acoustical caulking, protected ventilation openings, etc. The specific determination of what noise insulation treatments are necessary shall be conducted on a unit-by-unit basis during final design of the project. Results of the analysis, including the description of the necessary noise control treatments, shall be submitted to the City, along with the building plans and approved design, prior to issuance of a building permit.

The implementation of these noise insulation features would reduce interior noise levels to 45 dBA L_{dn} or less within residential units.

NOISE IMPACTS AND MITIGATION MEASURES

This section describes the significance criteria used to evaluate project impacts under CEQA, provides a discussion of each project impact, and presents mitigation measures, where necessary, to provide a compatible project in relation to adjacent land uses.

Significance Criteria

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

1. **Temporary or Permanent Noise Increases in Excess of Established Standards.** A significant impact would be identified if project construction or operations would result in a substantial temporary or permanent increase in ambient noise levels at sensitive receivers in excess of the local noise standards contained in the San Mateo General Plan or Municipal Code, as follows:

    a. <u>Operational Noise in Excess of Standards.</u> A significant noise impact would be identified if the project operations would generate noise levels that would exceed applicable noise standards presented in the San Mateo General Plan or Municipal Code.

    b. <u>Permanent Noise Increase.</u> A significant permanent noise increase would be identified if traffic generated by the project or project improvements/operations would substantially increase noise levels at sensitive receivers in the vicinity. The City of San Mateo defines a substantial increase to occur if the noise level increase is 3 dBA L_{dn} or greater.

    c. <u>Temporary Noise Increase.</u> A significant temporary noise increase would be identified if construction-related noise would result in noise levels exceeding the applicable noise standards presented in the San Mateo Municipal Code.

2. **Generation of Excessive Groundborne Vibration.** A significant impact would be identified if the construction of the project would generate excessive vibration levels. Groundborne vibration levels exceeding 0.3 in/sec PPV would have the potential to result in cosmetic damage to normal buildings (see Table 3).

Impact 1a: **Operational Noise in Excess of Established Standards.** Mechanical equipment operation would have the potential to exceed the applicable noise thresholds at existing noise-sensitive land uses in the project vicinity. **This is a less-than significant impact.**

Operational noise is limited to the levels specified in Table 7.30.040, adjusted for ambient conditions. Noise-sensitive uses in the site vicinity include multi-family residents along the eastern property line and commercial land use along the southern property line. Maximum permissible sound levels for residences would be that of Zone 1: 50 dBA between 10:00 p.m. and 7 a.m. and 60 dBA between 7:00 a.m. and 10:00 p.m. Maximum permissible sound levels for offices would be that of Zone 2: 55 dBA between 10:00 p.m. and 7 a.m. and 60 dBA between 7:00 a.m. and 10:00 p.m.

The project design is not far enough along at this point that mechanical equipment that will service the building have been selected. Generally, one HVAC unit will be provided per unit, and the current plans indicate that the mechanical equipment will be located within mechanical equipment wells at the rooftop level of the building which will cause most of the noise to be projected upward and away from neighboring properties.

Noise levels produced by a typical residential heat pump are approximately 56 dBA at 3 feet during operation. Noise levels produced by a typical residential air conditioning condenser are approximately 66 dBA at 3 feet during operation. Up to 4 mechanical units would be located on the roof of the four-story building proposed nearest the east boundary of the site and adjacent multi-family residential. Up to 4 mechanical units would be located on the roof of the four-story building proposed nearest the south boundary of the site and adjoining office building. Based on the above generic assumptions, mechanical equipment noise levels are calculated to be 35 to 45 dBA at the nearest noise sensitive land uses and would be below ambient noise levels and the limits established in the City's Municipal Code.

Equipment is not anticipated for a project of this scale to make meeting the applicable noise limits with standard noise control measures difficult. However, during final design of the mechanical systems, the noise levels from the various pieces of equipment on the rooftop should be calculated to ensure compliance with Chapter 7.30.040 of the City's Municipal Code. This is a **less-than significant impact**.

Conditions of Approval Measure 1a: **None required.**

Impact 1b: **Permanent Noise Level Increase.** Project-generated traffic would not cause a permanent noise level increase at existing noise-sensitive land uses in the project vicinity. **This is a less-than-significant impact.**

A significant noise impact would occur if traffic generated by the project would increase noise levels at sensitive receptors by 3 dBA L_{dn} or more. For reference, existing traffic volumes would have to double for noise levels to increase by 3 dBA L_{dn}.

The traffic study prepared for the proposed project by Fehr Peers included peak turning movements for existing traffic volumes at the one affected intersection. Peak hour turning movements for project trips were also included. When these project trips were added to the existing traffic volumes, the existing plus project was calculated. By comparing the existing plus project to the existing traffic volumes, the permeant traffic noise increase attributable to the project was calculated to be 0 dBA L_{dn}. The traffic study included peak turning movements for cumulative traffic volumes and cumulative plus project. By comparing the cumulative plus project to the cumulative traffic volumes, the permeant traffic noise increase attributable to the project was calculated to be 0 dBA L_{dn}. The project would not result in the doubling of traffic, and therefore, the project would not result in a permanent noise increase of 3 dBA L_{dn} or more. This is a **less-than-significant impact**.

Conditions of Approval Measure 1b: **None required.**

Impact 1c: **Temporary Construction Noise.** Existing noise-sensitive land uses would be exposed to construction noise levels in excess of the significance thresholds. **This is a potentially significant impact**.

Section 7.30.060 of the City of San Mateo's Municipal Code limits construction to weekdays between 7:00 a.m. and 7:00 p.m., Saturdays between 9:00 a.m. and 5:00 p.m., and Sundays and holidays between 12:00 p.m. and 4:00 p.m. Additionally, the City specifies that no individual piece of equipment shall produce a noise level exceeding 90 dBA at a distance of 25 feet and that the noise level outside any point outside the property plane of the project shall not exceed 90 dBA.

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.

Project construction is anticipated to occur over a period of about 15 months and would include demolition of existing structures and pavement, site preparation, grading and excavation, trenching and foundations, building erection, and paving. The hauling of excavated materials and construction materials would generate truck trips on local roadways. Pile driving would not be used as a means of construction.

Construction activities would be carried out in stages. During each stage of construction, there would be a different mix of equipment operating, and noise levels would vary by stage and vary within stages, based on the amount of equipment in operation and the location at which the equipment is operating. Typical construction noise levels at a distance of 50 feet are shown in Tables 4 and 5. Table 4 shows the average noise level ranges by construction phase and Table 5 shows the average and maximum noise level ranges for different construction equipment. Most demolition and construction noise falls with the range of 80 to 90 dBA at 50 feet from the source. 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.

TABLE 4 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.

TABLE 5 Construction Equipment 50-foot Noise Emission Levels (dBA)

Equipment Category	L_{eq}[1,2,3]	L_{max}[1,2]		Equipment Category	L_{eq}[1,2,3]	L_{max}[1,2]
Air Hose	93	100		Horizontal Bore Drill	87	88
Air-Operated Post Driver	83	85		Impact Pile Driver	99	105
Asphalt Distributor Truck (Asphalt Sprayer)	-	70		Impact Wrench	68	72
Auger Drill	88	101		Jackhammer	91	95
Backhoe	76	84		Jig Saw	92	95
Bar Bender	66	75		Joint Sealer	-	74
Blasting (Abrasive)	100	103		Man Lift	72	73
Blasting (Explosive)	83	93		Movement Alarm	79	80
Chainsaw	79	83		Mud Recycler	73	74
Chip Spreader	-	77		Nail Gun	70	74
Chipping Gun	95	100		Pavement Scarifier (Milling Machine)	-	84
Circular Saw	73	76		Paving – Asphalt (Paver, Dump Truck)	-	82
Compactor (Plate)	-	75		Paving – Asphalt (Paver, MTV, Dump Truck)	-	83
Compactor (Roller)	82	83		Paving – Concrete (Placer, Slipform Paver)	87	91
Compressor	66	67		Paving – Concrete (Texturing/Curing Machine)	73	74
Concrete Batch Plant	87	90		Paving – Concrete (Triple Roller Tube Paver)	85	88
Concrete Grinder	-	97		Power Unit (Power Pack)	81	82
Concrete Mixer Truck	81	82		Pump	73	74
Concrete Pump Truck	84	88		Reciprocating Saw	64	66
Concrete Saw	85	88		Rivet Buster	100	107
Crane	74	76		Rock Drill	92	95
Directional Drill Rig	68	80		Rumble Strip Grinding	-	87
Drum Mixer	66	71		Sander	65	68
Dump Truck (Cyclical)	82	92		Scraper	-	92
Dump Truck (Passby)	-	73		Shot Crete Pump/Spray	78	87
Excavator	76	87		Street Sweeper	-	81
Flatbed Truck	-	74		Telescopic Handler (Forklift)	-	88
Front End Loader (Cyclical)	72	81		Vacuum Excavator (Vac-Truck)	86	87
Front End Loader (Passby)	-	71		Ventilation Fan	62	63
Generator	67	68		Vibratory Concrete Consolidator	78	80
Grader (Passby)	-	79		Vibratory Pile Driver	99	105
Grinder	68	71		Warning Horn (Air Horn)	94	99
Hammer Drill	72	75		Water Spray Truck	-	72
Hoe Ram	92	99		Welding Machine	71	72

Notes: [1] Measured at 50 feet from the construction equipment, with a "slow" (1 sec.) time constant.
[2] Noise levels apply to total noise emitted from equipment and associated components operating at full power while engaged in its intended operation.
[3] Equipment without average (L_{eq}) noise levels are non-stationary and best represented only by maximum instantaneous noise level (L_{max}).
Source: Project 25-49 Data, National Cooperative Highway Research Program, https://apps.trb.org/cmsfeed/trbnetprojectdisplay.asp?projectid=3889, October 2018

Construction of the project is planned to occur between the hours of 7:00 a.m. and 4:00 p.m., Monday through Friday, over a period of 15 months. A detailed list of equipment expected to be used during each phase of construction was provided and assessed for each phase of construction.

Project construction is expected to be completed in seven phases. Phase 1 is expected to start in January 2022 and would include demolition of the exiting site. Phase 2 is expected to start in January 2022 and would include site preparation. Phase 3 is expected to start in January 2022 and would include grading and excavation of the site. Phase 4 is expected to start in February 2022 and would include trenching and foundation of the site. Phase 5 is expected to start in April 2022 and would include building exterior. Phase 6 is expected to start in August 2022 and will include building interior and architectural coating. Phase 7 is expected to start June 2022 and will include paving.

A detailed list of equipment expected to be used during each phase was provided by the applicant. Federal Highway Administration's (FHWA's) Roadway Construction Noise Model (RCNM) was used to calculate the hourly average noise levels for each phase of construction, assuming every piece of equipment would operate simultaneously, which would represent the worst-case scenario. This construction noise model includes representative sound levels for the most common types of construction equipment and the approximate usage factors of such equipment that were developed based on an extensive database of information gathered during the construction of the Central Artery/Tunnel Project in Boston, Massachusetts (CA/T Project or "Big Dig"). The usage factors represent the percentage of time that the equipment would be operating at full power. Assuming all equipment for each stage would be operating simultaneously, which would represent the worst-case construction scenario, at 50 feet measured from the center of the Project site, hourly average noise levels would range from 70 to 85 dBA L_{eq} for Phases 1 through 7.

For overall construction noise levels, multiple pieces of equipment used simultaneously would add together creating a collective noise source. While every piece of equipment per stage of construction would likely be scattered throughout the site, the noise-sensitive receptors surrounding the site would be subject to the collective noise source generated by all equipment operating at once. Therefore, to assess construction noise impacts at the receiving property lines of noise-sensitive receptors during each phase of construction, the collective worst-case hourly average noise level for each stage was centered at the geometrical center of the active construction site and propagated to the nearest property line of the surrounding land uses.

Noise-sensitive uses surrounding the project site include multi-family residential uses approximately 100 feet from the center of construction to the east and approximately 150 feet to the south, offices approximately 70 feet to the south and approximately 130 feet to the west and public use approximately 150 feet to the west.

Hourly average and maximum construction noise levels at the project site for each construction phase, assuming all equipment operating simultaneously, are shown in Table 6 for each of the nearby noise sensitive land uses relative to the center of the active construction site. Construction-generated noise levels drop off at a rate of about 6 dBA per doubling of the distance between the source and receptor. Noise levels in shielded areas would be anticipated to be 5 to 20 dB lower.

TABLE 6 Calculated Construction Noise Levels at Nearby Land Uses

Phase of Construction	Total Work Days	Calculated Noise Levels (dBA)													
		Offices to the South		Multi-Family Residential to the East		Offices to the West		Multi-Family Residential to the South		Public Use to the South		Commercial to the Southwest		Single Family Residential to the Southwest	
		(70 ft)		(100 ft)		(130 ft)		(150 ft)		(150 ft)		(290 ft)		(575 ft)	
		L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
Demolition	8	76	86	73	83	71	81	69	80	63	74	64	74	55	65
Site Preparation	5	72	74	68	71	66	69	65	68	59	62	59	62	50	53
Grading/ Excavation	15	78	88	75	85	72	83	71	82	65	76	65	76	56	67
Trenching/ Foundation	20	73	81	70	78	68	76	66	75	60	69	61	69	52	60
Building Exterior	55	82	87	79	84	77	81	75	80	69	74	70	74	61	66
Building Interior/ Architectural Coating	60	67	70	64	67	62	65	61	63	55	57	55	58	46	49
Paving	2	79	86	76	83	73	80	72	79	66	73	66	73	58	65

Conditions of Approval Measure 1c: Modification, placement, and operation of construction equipment are possible means for minimizing the impact of construction noise on existing sensitive receptors. Construction equipment should be well-maintained and used judiciously to be as quiet as possible. Additionally, construction activities for the proposed project should include the following best management practices to reduce noise from construction activities near sensitive land uses:

- Construction activities, including truck traffic coming to and from the construction site for any purpose, shall be limited to the hours between 7:00 a.m. and 7:00 p.m., Monday through Friday, Saturdays between 9:00 a.m. and 5:00 p.m., and Sundays and Holidays between 12:00 p.m. and 4:00 p.m., in accordance with the City's Municipal Code, unless permission is granted with a development permit or other planning approval.

- Construction staging areas shall be established at locations that will create the greatest distance between the construction-related noise sources and noise-sensitive receptors nearest the project site during all project construction.

- Use of exceptionally loud equipment such as jackhammers and concrete saws within 35 feet of shared property lines shall be limited, as feasible.

- Equip all internal combustion engine-driven equipment with intake and exhaust mufflers that are in good condition and appropriate for the equipment.

- Unnecessary idling of internal combustion engines should be strictly prohibited.

- Locate stationary noise-generating equipment, such as air compressors or portable power generators, as far as possible from sensitive receptors and property lines. If they must be located within 35 feet of receptors and property lines, adequate muffling (with barriers or enclosures where feasible and appropriate) shall be used to reduce noise levels at the adjacent sensitive receptors.

- Utilize "quiet" air compressors and other stationary noise sources where technology exists.

- Control noise from construction workers' radios to a point where they are not audible at existing residences bordering the project site.

- The contractor shall prepare a detailed construction plana 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.

- Designate a "disturbance coordinator" who would be 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. Conspicuously post a telephone number for the disturbance coordinator at the construction site and include it in the notice sent to neighbors regarding the construction schedule.

Implementation of the above best management practices would reduce construction noise levels emanating from the site, limit construction hours, and minimize disruption and annoyance. With the implementation of these measures and recognizing that noise generated by construction activities would occur over a temporary period, the impact would be **less-than-significant**.

Impact 2: Exposure to Excessive Groundborne Vibration due to Construction. Groundborne vibration from project construction is not anticipated to result in structural of cosmetic damage to nearby structures. **This is a potentially significant impact.**

The City of San Mateo does not specify a construction vibration limit. For structural damage, the California Department of Transportation recommends a conservative vibration limit of 0.08 in/sec PPV for ancient buildings, 0.3 in/sec PPV for older residential structures, and 0.5 in/sec PPV for new residential and modern commercial/industrial structures, which typically consists of buildings constructed from the 1990s (see Table 3). There are no historic or ancient structures in the project vicinity. For the purposes of this study, groundbourne vibration levels exceeding the conservative 0.3 in/sec PPV would have the potential to result in a significant vibration impact.

Construction of the project may generate perceptible vibration when heavy equipment or impact tools (jackhammers, hoe rams) are used. Construction activities would include demolition, site preparation, grading and excavation, trenching and foundation, building (exterior), interior/architectural coating, and paving. Pile driving, which can result in higher groundborne vibration levels, is not anticipated as a method of construction.

Table 7 presents vibration levels from construction equipment at the reference distance of 25 feet and levels calculated at distances representing the nearest adjacent residential and office structures. Vibration levels are highest close to the source, and then attenuate with increasing distance at the rate $(D_{ref}/D)^{1.1}$, where D is the distance from the source in feet and D_{ref} is the reference distance of 25 feet.

TABLE 7 Vibration Levels for Construction Equipment at Various Distances

Equipment		PPV at 25 ft. (in/sec)	PPV at 10 ft. (in/sec)	PPV at 20 ft. (in/sec)	PPV at 55 ft. (in/sec)
Clam shovel drop		0.202	**0.553**	0.258	0.085
Hydromill (slurry wall)	in soil	0.008	0.022	0.010	0.003
	in rock	0.017	0.047	0.022	0.007
Vibratory Roller		0.210	**0.575**	0.268	0.088
Hoe Ram		0.089	0.244	0.114	0.037
Large bulldozer		0.089	0.244	0.114	0.037
Caisson drilling		0.089	0.244	0.114	0.037
Loaded trucks		0.076	0.208	0.097	0.032
Jackhammer		0.035	0.096	0.045	0.015
Small bulldozer		0.003	0.008	0.004	0.001

Source: Transit Noise and Vibration Impact Assessment, United States Department of Transportation, Office of Planning and Environment, Federal Transit Administration, October 2018 as modified by Illingworth & Rodkin, Inc., September 2020.

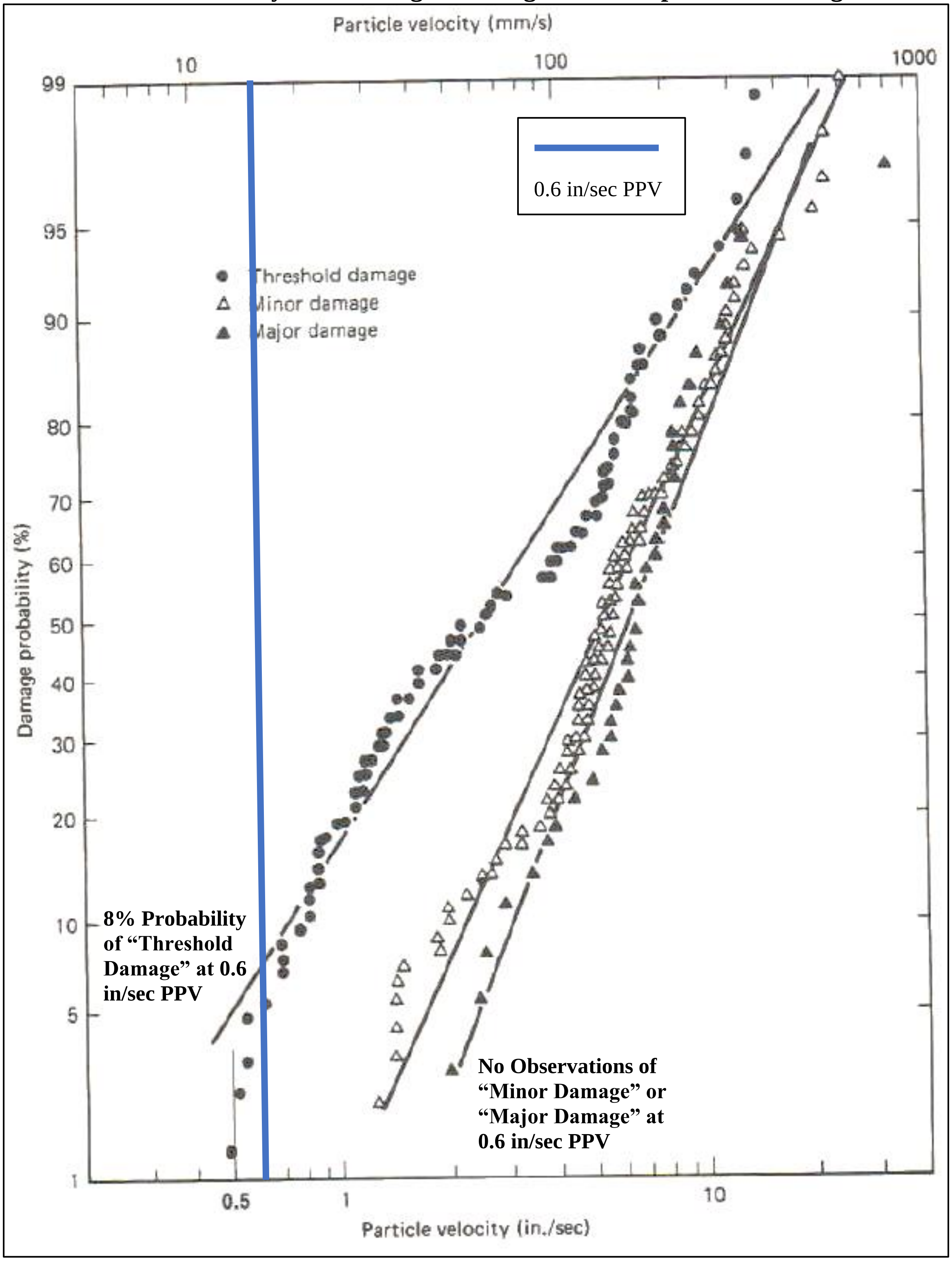
Worst-case scenario vibration levels would occur when equipment would be used near the shared property lines; therefore, vibration levels were calculated from the project's boundary lines to the nearest buildings surrounding the site. The closest structures to the project site are residences located at 1950 Elkhorn Ct., which are approximately 10 feet from the site to the east, and the office buildings located at 1941 O'Farrell Street, which are approximately 10 feet to the south, and at 1900 O'Farrell Street, which are approximately 55 feet to the west.

As indicated in Table 7, the worst-case vibration levels at the structures to the south and east would be up to 0.575 in/sec PPV, which would potentially exceed the California Department of Transportation's recommended limit of 0.3 in/sec PPV. All other surrounding structures would be subject to vibration levels below 0.3 in/sec PPV.

A study completed by the US Bureau of Mines has analyzed the effects of blast-induced vibration on buildings in USBM RI 8507,[3] and these findings have been applied to vibrations emanating from construction equipment on buildings.[4] Figure 3 presents the damage probability, as reported in USBM RI 8507 and reproduced by Dowding, assuming a maximum vibration level of 0.6 in/sec PPV.

[3] Siskind, D.E., M.S. Stagg, J.W. Kopp, and C.H. Dowding, Structure Response and Damage Produced by Ground Vibration form Surface Mine Blasting, RI 8507, Bureau of Mines Report of Investigations, U.S. Department of the Interior Bureau of Mines, Washington, D.C., 1980.
[4] Dowding, C.H., Construction Vibrations, Prentice Hall, Upper Saddle River, 1996.

FIGURE 3 Probability of Cracking and Fatigue from Repetitive Loading



Source: Dowding, C.H., Construction Vibrations, Prentice Hall, Upper Saddle River, 1996 as modified by Illingworth & Rodkin, Inc., April 2021.

As shown on Figure 3, these studies indicate an approximate 8% probability of "threshold damage" (referred to as cosmetic damage elsewhere in this report) at vibration levels of 0.6 in/sec PPV or less and no observations of "minor damage" or "major damage" at vibration levels of 0.6 in/sec PPV or less. Based on these data, cosmetic or threshold damage would be manifested in the form of hairline cracking in plaster, the opening of old cracks, the loosening of paint or the dislodging of loose objects. However, minor damage (e.g., hairline cracking in masonry or the loosening of plaster) or major structural damage (e.g., wide cracking or shifting of foundation or bearing walls) to the residential and office structures adjacent to the site would not be anticipated to occur assuming a maximum vibration level of 0.6 in/sec PPV.

The nearest buildings located on the adjoining properties to the south and east are as close as 10 feet from the shared property line. At this distance, vibration levels would be as high as 0.553 to 0.575 in/sec PPV when heavy equipment is dropped, or vibratory rollers are used within 25 feet of the buildings.

While most construction work would occur throughout the site where vibration levels would be reduced to levels below 0.3 in/sec PPV, construction-generated vibration levels for the proposed project occurring near the eastern and southern boundaries of the site could potentially result in cosmetic damage (e.g. hairline cracks in plaster, opening of old cracks, etc.) at existing structures adjacent to the site. Additionally, construction vibration would be perceptible to the occupants of the adjacent buildings. This is a **potentially significant impact**.

By 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 and residences, perceptible vibration can be kept to a minimum. To address the potential impacts related to vibration, the project will implement conditions of approval measure 2.

Conditions of Approval Measure 2: The following measures are recommended to reduce vibration impacts from construction activities to a less-than-significant impact:

- The use of vibratory rollers and clam shovel drops should be prohibited.
- Limit the use of hoe rams, large bulldozers, and caisson drilling. Place operating equipment on the construction site as far as possible from vibration-sensitive receptors.
- Use smaller equipment to minimize vibration levels below the limits.
- Select demolition methods not involving impact tools.
- Avoid dropping heavy objects or materials near vibration sensitive locations.

Implementation of these measures would reduce the impact to a **less-than-significant** level.