Appendix D: Noise Assessment

This Page Intentionally Left Blank

335 SOUTH WINCHESTER ENVIRONMENTAL NOISE AND VIBRATION ASSESSMENT

San José, California

March 26, 2019

Revised July 23, 2019

Prepared for:

Andrew Metzger
Circlepoint
46 S. First Street
San José, CA 95113

Prepared by:

Dana M. Lodico, PE, INCE Bd. Cert.

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality
429 E. Cotati Ave.
Cotati, CA 94931
(707) 794-0400

Project: 17-191

INTRODUCTION

The project proposes a commercial development comprised of 5 levels of commercial space and a level of below grade parking at 335 South Winchester Boulevard in San José, California. 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 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 noise and land use compatibility utilizing 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 provide a compatible project in relation to adjacent noise sources and land uses.

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* (*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 DNL. Typically, the highest steady traffic noise level during the daytime is about equal to the DNL 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 DNL with open windows and 65-70 dBA DNL 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, and 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 DNL 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 DNL. At a DNL of about 60 dBA, approximately 12 percent of the population is highly annoyed. When the DNL 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 DNL of 60-70 dBA. Between a DNL of 70-80 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 DNL 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. Perceptible vibration levels inside residences are attributed to the operation of heating and air conditioning systems, door slams and foot traffic. Construction activities, train operations, and street traffic are some of the most common external sources of vibration that can be perceptible inside residences.

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 and the City of San José have established regulatory criteria that are applicable in this assessment. The State CEQA Guidelines, Appendix G, are used to assess the potential significance of impacts pursuant to local General Plan policies, Municipal Code standards, or the applicable standards of other agencies. A summary of the applicable regulatory criteria is provided below.

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

(a) 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.

The impacts of the project on the surrounding land uses are addressed in the Noise Impacts and Mitigation Measures Section of the report. The impacts of site constraints such as exposure of the proposed project to excessive levels of noise and vibration are not considered under CEQA and are discussed in a separate section addressing Noise and Land Use Compatibility for consistency with the policies set forth in the City's General Plan.

2016 California Green Building Standards Code (Cal Green Code). The State of California established exterior sound transmission control standards for new non-residential buildings as set forth in the 2016 California Green Building Standards Code (Section 5.507.4.1 and 5.507.4.2). 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. 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 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.
>
> **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 San José General Plan. The Environmental Leadership Chapter in the Envision San José 2040 General Plan sets forth policies with the goal of minimizing the impact of noise on people through noise reduction and suppression techniques, and through appropriate land use policies in the City of San José. The following policies are applicable to the proposed project:

EC-1.1 Locate new development in areas where noise levels are appropriate for the proposed uses. Consider Federal, State, and City noise standards and guidelines as a part of new development review. Applicable standards and guidelines for land uses in San José include:

Exterior Noise Levels

- The City's acceptable exterior noise level objective is 70 dBA DNL or less for office buildings, business commercial, and professional offices (Table EC-1).

Table EC-1: Land Use Compatibility Guidelines for Community Noise in San José

LAND USE CATEGORY	EXTERIOR NOISE EXPOSURE (DNL IN DECIBELS (DBA)) 55 60 65 70 75 80
1. Residential, Hotels and Motels, Hospitals and Residential Care[1]	
2. Outdoor Sports and Recreation, Neighborhood Parks and Playgrounds	
3. Schools, Libraries, Museums, Meeting Halls, Churches	
4. Office Buildings, Business Commercial, and Professional Offices	
5. Sports Arena, Outdoor Spectator Sports	
6. Public and Quasi-Public Auditoriums, Concert Halls, Amphitheaters	

[1]Noise mitigation to reduce interior noise levels pursuant to Policy EC-1.1 is required.

Normally Acceptable:

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

Conditionally Acceptable:

- 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.

EC-1.2 Minimize the noise impacts of new development on land uses sensitive to increased noise levels (Categories 1, 2, 3 and 6) by limiting noise generation and by requiring use of noise attenuation measures such as acoustical enclosures and sound barriers, where feasible. The City considers significant noise impacts to occur if a project would:

- Cause the DNL at noise sensitive receptors to increase by five dBA DNL or more where the noise levels would remain "Normally Acceptable;" or

- Cause the DNL at noise sensitive receptors to increase by three dBA DNL or more where noise levels would equal or exceed the "Normally Acceptable" level.

EC-1.3 Mitigate noise generation of new nonresidential land uses to 55 dBA DNL at the property line when located adjacent to existing or planned noise-sensitive residential and public/quasi-public land uses.

EC-1.6 Regulate the effects of operational noise from existing and new industrial and commercial development on adjacent uses through noise standards in the City's Municipal Code.

EC-1.7 Require construction operations within San José to use best available noise suppression devices and techniques and limit construction hours near residential uses per the City's Municipal Code. The City considers significant construction noise impacts to occur if a project located within 500 feet of residential uses or 200 feet of commercial or office uses would:

- Involve substantial noise generating activities (such as building demolition, grading, excavation, pile driving, use of impact equipment, or building framing) continuing for more than 12 months.
    - For such large or complex projects, a construction noise logistics plan that specifies hours of construction, noise and vibration minimization measures, posting or notification of construction schedules, and designation of a noise disturbance coordinator who would respond to neighborhood complaints will be required to be in place prior to the start of construction and implemented during construction to reduce noise impacts on neighboring residents and other uses.

City of San José Municipal Code. The City's Municipal Code contains a Zoning Ordinance that limits noise levels at adjacent properties. Chapter 20.30.700 states that sound pressure levels generated by any use or combination of uses on a property shall not exceed 55 dBA at any property line shared with land zoned for residential use and to 60 dBA at commercial property lines, except upon issuance and in compliance with a Conditional Use Permit. No specific limits are given for industrial property lines. This code is not explicit in terms of the acoustical descriptor associated with the noise level limit. Consistent with General Plan policy E.C.-1.3, a reasonable interpretation of this standard would identify the ambient base noise level criteria as the day/night noise level (DNL).

Chapter 20.100.450 of the Municipal Code establishes allowable hours of construction within 500 feet of a residential unit between 7:00 am and 7:00 pm Monday through Friday unless permission is granted with a development permit or other planning approval. No construction activities are permitted on the weekends at sites within 500 feet of a residence.

Regulatory Background – Vibration

The City of San Jos**é** has established vibration guidelines applicable to this analysis.

City of San José General Plan. The Environmental Leadership Chapter in the Envision San José 2040 General Plan sets forth policies to achieve the goal of minimizing vibration impacts on people, residences, and business operations in the City of San José. The following policies are applicable to the proposed project:

EC-2.3 Require new development to minimize vibration impacts to adjacent uses during demolition and construction. A vibration limit of 0.20 in/sec PPV will be used to minimize the potential for cosmetic damage at buildings of normal conventional construction.

Existing Noise Environment

The project site is located at 335 South Winchester Boulevard in San José, California. The site is currently occupied by Khanh's Restaurant and is bordered by a retail store to the north, a parking garage to the east across Winchester Boulevard, Chipotle Mexican Grill to the south, and single family residential land uses to the west.

A noise monitoring survey was performed at the project site beginning on Wednesday, September 26th, 2018 and concluding on Monday, October 1st, 2018. The monitoring survey included one long-term (LT-1) and one short-term (ST-1) noise measurement. Measurement locations are shown in Figure 1 and the daily trends in noise levels for the long-term measurement is shown in Appendix A. The noise environment at the site and at the nearby land uses results primarily from vehicular traffic along South Winchester Boulevard.

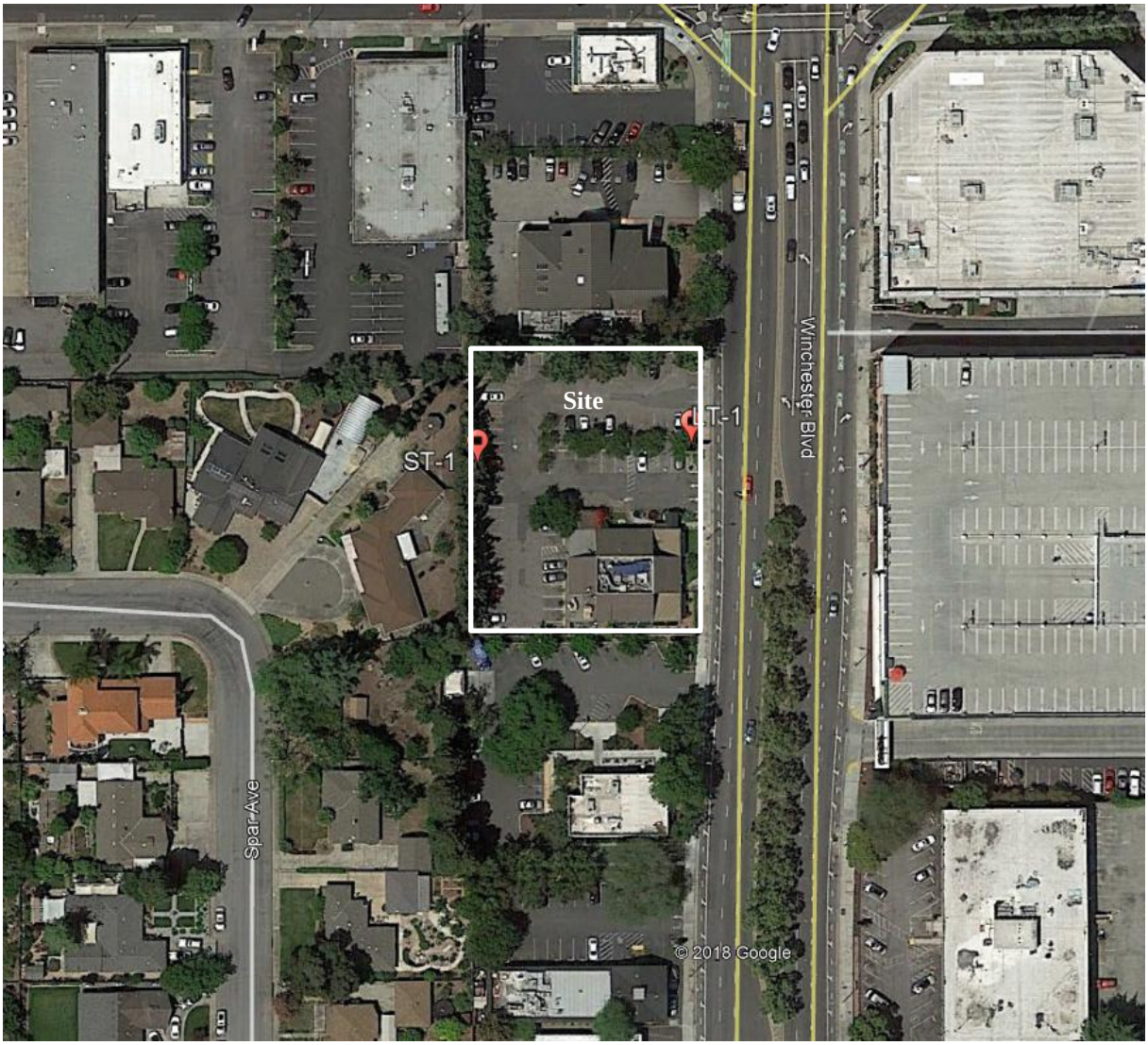
Long-term noise measurement LT-1 was made at a setback of about 60 feet from the centerline of South Winchester Boulevard. Weekday hourly average noise levels at this location ranged from 67 to 73 dBA L_{eq} during the day, and from 54 to 67 dBA L_{eq} at night. Weekend hourly average noise levels at this location ranged from 62 to 73 dBA L_{eq} during the day, and from 55 to 68 dBA L_{eq} at night. The day-night average noise level was 72 dBA DNL on Thursday, September 27th, 2018 and Friday, September 28th, 2018, 71 dBA DNL on Saturday, September 29th, 2018, and 70 dBA DNL on Sunday, September 30th, 2018. These results were approximately 1 dB higher than noise levels measured in 2016 as part of the noise study conducted by *Illingworth & Rodkin, Inc.* for the site located at 350 South Winchester Boulevard (directly across the street from the site).

Short-term noise measurement ST-1 was made at the setback of residences adjoining the site to the west, about 210 feet from the centerline of South Winchester Boulevard. The 10-minute average noise level measured at this location between 1:40 pm and 1:50 pm on Wednesday, September 27th, 2018 was 56 dBA L_{eq}. Table 4 summarizes the results of the short-term measurement.

TABLE 4 350 Winchester Blvd. Summary of Short-Term Noise Measurement Data

Noise Measurement Location	L_{max}	$L_{(1)}$	$L_{(10)}$	$L_{(50)}$	$L_{(90)}$	L_{eq}
ST-1: Residential setback, ~210 feet from centerline of South Winchester Boulevard (9/27/2018, 1:40 pm – 1:50 pm)	62	61	58	55	52	56

FIGURE 1 Noise Measurement Locations



GENERAL PLAN CONSISTENCY ANALYSIS

The impacts of site constraints such as exposure of the proposed project to excessive levels of noise are not considered under CEQA. This section addresses Noise and Land Use Compatibility for consistency with the policies set forth in the City's General Plan.

Noise and Land Use Compatibility

The Environmental Leadership Chapter in the Envision San José 2040 General Plan sets forth policies with the goal of minimizing the impact of noise on people through noise reduction and suppression techniques, and through appropriate land use policies in the City of San José. The applicable General Plan policies were presented in detail in the Regulatory Background section and are summarized below for the proposed project:

- The City's acceptable exterior noise level objective is 70 dBA DNL for proposed office and commercial uses (Table EC-1).

- The California Green Building Code limits interior noise levels within new non-residential land uses to an hourly equivalent noise level ($L_{eq\ (1\text{-}hr)}$) of 50 dBA in occupied areas during any hour of operation.

The project proposes ground floor retail with four floors of office uses above, and a single level of below grade parking. The future noise environment at the project site would continue to result primarily from traffic along the surrounding roadways and commercial activities including parking lot traffic, truck loading and circulation, and mechanical equipment associated with the adjacent commercial buildings. The eastern façade of the building would face South Winchester Boulevard.

Future Exterior Noise Environment

Balconies associated with the offices are proposed on the eastern and western façades of the building. Based on traffic volumes provided in the project's traffic study[1], future traffic noise levels are anticipated to increase by about 2 dBA over existing conditions. East facing balconies directly overlooking South Winchester Boulevard would be exposed to future noise levels of about 74 dBA DNL. This would be above the City's office/commercial exterior noise level objective of 70 dBA DNL or less. Due to the substantial shielding provided by the project building, the noise level exposure in the western facing balconies is calculated to be below 60 dBA DNL and would be considered acceptable with respect to the City's office/commercial exterior noise level objective (70 dBA DNL).

Due to the small size of the east facing balconies, it may not be desirable or practical to provide mitigation to reduce noise levels to meet the City's objective. To reduce noise levels in the east facing balconies to 70 dBA DNL or less, balconies should be relocated to locations that are partially or fully shielded from South Winchester Boulevard.

1 355 S. Winchester Boulevard Mixed Use Development, Transportation Impact Analysis, Hexagon Transportation Consultants, Inc., July 13, 2018.

Future Interior Noise Environment

Noise sensitive non-residential interior uses include retail on the first floor and office uses on the second through fifth floors. Commercial façades facing South Winchester Boulevard would be exposed to an exterior noise level of about 74 dBA DNL with worst-hour noise levels as high as 74 dBA L_{eq}. North and south facing façades would be exposed to exterior noise levels of 65 to 72 dBA DNL/L_{eq}, depending on their proximity to South Winchester Boulevard.

Interior noise levels would vary depending upon the design of the buildings (relative window area to wall area) and the selected construction materials and methods. Standard residential construction provides approximately 15 dBA of exterior-to-interior noise reduction, assuming the windows are partially open for ventilation. Standard construction with the windows closed provides approximately 20 to 25 dBA of noise reduction in interior spaces. Where exterior noise levels range from 65 to 75 dBA $L_{eq\text{-}hr}$, the inclusion of adequate forced-air mechanical ventilation can reduce interior noise levels to acceptable Cal Green Code standards by allowing occupants the option of closing the windows to control noise. Based on preliminary calculations, standard office/commercial construction with windows in the closed positions would be sufficient to comply with the Cal Green Code standard of 50 dBA $L_{eq\ (1\text{-}hr)}$ in occupied areas during any hour of operation.

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 noise sources and land uses.

Significance Criteria

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

- **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 José General Plan or Municipal Code, as follows:

    a. Operational Noise in Excess of Standards. A significant noise impact would be identified if on-site project operations (i.e., mechanical equipment or parking) would generate noise levels that would exceed 55 dBA DNL at adjacent residential property lines or 60 dBA DNL at adjacent commercial property lines.

    b. Permanent Noise Increase. A significant permanent noise increase would occur if project traffic resulted in an increase of 3 dBA DNL or greater at noise-sensitive land uses where existing or projected noise levels would equal or exceed the noise level considered satisfactory for the affected land use (60 dBA DNL for single-family residential areas) and/or an increase of 5 dBA DNL or greater at noise-sensitive land uses where noise levels would continue to be below those considered satisfactory for the affected land use.

    c. Temporary Noise Increase. A significant temporary noise impact would be identified if construction-related noise would occur outside of the hours specified in the Municipal Code or if construction noise levels were to exceed the City's construction noise limits at adjacent noise sensitive land uses.

- **Generation of Excessive Groundborne Vibration:** A significant impact would be identified if the construction of the project would expose persons to excessive vibration levels. Groundborne vibration levels exceeding 0.2 in/sec PPV would have the potential to result in cosmetic damage to normal buildings.

Impact 1: **Temporary or Permanent Noise Increases in Excess of Standards.** Project traffic would not result in substantial permanent noise level increase at existing noise-sensitive uses in the project vicinity. Construction activities and deliveries occurring during nighttime hours may exceed City noise level limits at nearby noise sensitive uses. Noise levels from mechanical equipment, parking, and construction activities would not exceed the noise limits. This is a **potentially significant impact**.

a. Permanent Noise from On-Site Operations

Noise generating on-site operational components of the project would include mechanical equipment and parking lot activities. Operational noise levels are limited to 55 dBA DNL at adjacent residential property lines or 60 dBA DNL at adjacent commercial property lines.

Mechanical Equipment Noise

Commercial office and retail buildings typically include various mechanical equipment such as air conditioners, exhaust fans, chillers, pumps, and air handling equipment. A generator is proposed for the below grade parking level. The most substantial noise-generating equipment would be exhaust fans and building air conditioning units. Based on the provided planning submission plan set, dated November 9, 2018, all mechanical equipment is proposed to be located within the basement level and in the center of the rooftop, behind a 10-foot high screen wall. The basement equipment would be located in the parking level, with intake and exhaust vents opening on the eastern side of the roof. Equipment located inside or in a fully enclosed room with a roof would not be anticipated to be audible at off-site locations.

Rooftop mechanical equipment noise levels for commercial office and retail buildings typically range from 60 to 70 dBA L_{eq} at a distance of 15 feet, assuming direct line-of-site between the receiver and the mechanical equipment. The rooftop equipment, as shown in the plans, would be located as close as about 85 feet from the nearest residential property line and 30 feet from the nearest commercial property line.

Not taking into account any noise reduction due to shielding, mechanical equipment would be anticipated to generate noise levels of 45 to 55 dBA L_{eq} at the residential property line and 54 to 64 dBA L_{eq} at the commercial property line. With equipment operating continuously throughout the daytime and nighttime hours, this would equate to 51 to 61 dBA DNL at the residential property line and 60 to 70 dBA DNL at the commercial property line. Noise levels from rooftop equipment, located behind a 10-foot high solid rooftop screen are anticipated to meet the City's 55 dBA DNL residential noise limit and 60 dBA DNL commercial noise limits at adjacent properties.

This is a **potentially significant** impact. Mitigation would be required.

Parking Lot and Truck Deliveries

The majority of parking would occur in the underground parking structure and would not be anticipated to be discernable from ambient at adjacent land uses. Six at-grade level accessible parking spaces and a loading space are proposed along the western side of the site, about 25 feet

from the shared residential property line. Noise sources in the at-grade parking lot would be similar and less frequent (due to the reduction in the number of spaces) than existing parking lot noise sources and would include the sounds of moving vehicles, the starting of engines, door slams, and human voices. Truck deliveries to the retail space would access the building from the center of the western side of the building, as close as 25 feet from the shared residential property line to the west. A 6-foot high sound wall is proposed along the shared property line. Maximum instantaneous noise levels generated by delivery trucks are generally in the range of 65 to 75 dBA L_{max} at a distance of 25 feet. It is anticipated that a maximum of 1 to 2 deliveries per day would occur. The proposed 6-foot high sound wall is calculated to reduce noise levels from sources located at heights of 5-feet or less above ground level by about 5 dBA. Residences adjacent to the site are exposed to existing ambient noise levels of about 59 dBA DNL with maximum noise levels in the range of 60 to 65 dBA L_{max}. Maximum instantaneous noise levels generated by truck deliveries could be 5 to 10 dBA above typical maximum instantaneous noise levels occurring at the adjacent residences. Assuming deliveries are restricted to daytime hours only, day-night average (DNL) noise levels at adjacent residences would not measurably increase with the introduction of occasional truck deliveries. This is a **potentially significant** impact.

Mitigation Measure 1a: The following mitigation measures shall be included in the project to reduce the impact to a less-than-significant level:

- Ensure that noise-generating activities, such as maintenance activities and loading/unloading activities, are limited to the hours of 7:00 am and 7:00 pm.

b. Permanent Noise Increases from Project Traffic

A significant permanent noise increase would be identified if traffic noise generated by the project would substantially increase noise levels at sensitive receivers in the vicinity. A substantial increase would occur if: a) the noise level increase is 5 dBA DNL or greater, with a future noise level of less than 60 dBA DNL, or b) the noise level increase is 3 dBA DNL or greater, with a future noise level of 60 dBA DNL or greater.

To determine the effect of the project-generated traffic on the nearby residences, AM and PM peak hour traffic volumes for the Existing + Project condition were compared to Existing traffic volumes. Traffic volumes were provided in the traffic study conducted for the project by Hexagon Transportation Consultants, Inc.[2] Based on these calculations, project traffic would result in traffic noise increases of less than 1 dBA L_{eq} along the roadway network. Day-night average (DNL) noise level increases would be anticipated to be similar. This increase would not typically be noticeable and would be below the 3 dBA and 5 dBA DNL thresholds of significance. This is a **less-than-significant** impact.

2 355 S. Winchester Boulevard Mixed Use Development, Transportation Impact Analysis, Hexagon Transportation Consultants, Inc., July 13, 2018.

Mitigation Measure 1b: None Required.

c. Temporary Noise Increases from Project Construction

Chapter 20.100.450 of the City's Municipal Code establishes allowable hours of construction within 500 feet of a residential unit between 7:00 am and 7:00 pm Monday through Friday unless permission is granted with a development permit or other planning approval. Policy EC-1.7 of the City's General Plan states that for large or complex projects within 500 feet of residential land uses or within 200 feet of commercial land uses or offices involving substantial noise-generating activities lasting more than 12 months, a construction noise logistics plan that specifies hours of construction, noise and vibration minimization measures, posting or notification of construction schedules, and designation of a noise disturbance coordinator who would respond to neighborhood complaints will be required to be in place prior to the start of construction and implemented during construction to reduce noise impacts on neighboring residents and other uses.

The significance of temporary noise increases resulting from construction depend upon the noise levels generated by various pieces of construction equipment, the timing and duration of noise-generating activities, the distance between construction noise sources and noise-sensitive areas, and the presence of intervening shielding features such as buildings or terrain. 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.

Construction activities for individual projects are typically 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 5 and 6. Table 5 shows the average noise level ranges, by construction phase, and Table 6 shows the maximum noise level ranges for different construction equipment. Most demolition and construction noise falls with the range of 80 to 90 dBA at a distance of 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.

TABLE 5 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 6 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

Equipment Category	L_{max} Level (dBA)[1,2]	Impact/Continuous
Tractor	84	Continuous
Truck (dump, delivery)	84	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.

Source: Mitigation of Nighttime Construction Noise, Vibrations and Other Nuisances, National Cooperative Highway Research Program, 1999.

As shown in Tables 5 and 6, construction activities generate considerable amounts of noise, especially during earth-moving activities when heavy equipment is used. The highest noise levels are typically generated during grading, excavation, and foundation construction. The hauling of excavated materials and construction materials would generate truck trips on local roadways, as well. The erection of large buildings from steel structures could also cause considerable noise for fairly long durations. Specific project construction information is unavailable at this time; however, based on our knowledge of the construction of similar projects in San José, we anticipate that the construction of the proposed project would involve demolition of existing site improvements, site preparation, foundation work, and new building framing and finishing. Pile driving is not planned as a method of construction. We anticipate that construction would occur over a period exceeding 12 months.

Noise sensitive uses surround the site include a residence located 15 feet to the west of the shared property line, a retail building (DXL) located about 15 feet to the north, and a restaurant building located about 95 feet to the south. Construction would be located within 500 feet of residential land uses and within 200 feet of commercial land uses for a period of more than 12 months. This is a **potentially significant** impact**.**

Mitigation Measure 1c: Modification, placement, and operation of construction equipment are possible means for minimizing the impact on the 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 shall be limited to the hours between 7:00 am and 7:00 pm, Monday through Friday, unless permission is granted with a development permit or other planning approval. No construction activities are permitted on the weekends at sites within 500 feet of a residence.

- Construct solid plywood fences around ground level construction sites adjacent to operational businesses, hotels, and other noise-sensitive land uses.

- 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. Construct temporary noise barriers to screen stationary noise-generating equipment when located near adjoining sensitive land uses. Temporary noise barriers could reduce construction noise levels by 5 dBA.

- 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.

- Notify all adjacent business, residences, and other noise-sensitive land uses of the construction schedule, in writing, and provide a written schedule of "noisy" construction activities to the adjacent land uses and nearby residences.

- A temporary noise control blanket barrier could be erected, if necessary, along building façades facing construction sites. This mitigation would only be necessary if conflicts occurred which were irresolvable by proper scheduling. Noise control blanket barriers can be rented and quickly erected.

- 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 in it the notice sent to neighbors regarding the construction schedule.

Implementation of the above measures 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 temporary increase in ambient noise levels would be **less-than-significant**.

Impact 2: **Exposure to Excessive Groundborne Vibration due to Construction.** Residential and commercial buildings in the vicinity of the project site could be exposed to construction-related vibration levels exceeding 0.2 in/sec. PPVs. **This is a potentially significant impact.**

Policy EC-2.3 of the City of San José General Plan establishes a vibration limit of 0.08 in/sec PPV to minimize the potential for cosmetic damage to sensitive historic structures, and a vibration limit of 0.2 in/sec PPV to minimize damage at buildings of normal conventional construction. The vibration limits contained in this policy are conservative and designed to

provide the ultimate level of protection for existing buildings in San José. Demolition and construction activities required for construction often generate perceptible vibration levels and levels that could affect nearby structures when heavy equipment or impact tools (e.g. jackhammers, pile drivers, hoe rams) are used in the vicinity of nearby sensitive land uses. Building damage generally falls into three categories. 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.

Project construction activities, such as drilling, the use of jackhammers, rock drills and other high-power or vibratory tools, and rolling stock equipment (tracked vehicles, compactors, etc.) may generate substantial vibration in the immediate vicinity of project construction. Construction activities associated with the project would include demolition of existing site improvements, site preparation, foundation work, and new building framing and finishing. Pile driving is not planned as a method of construction.

Table 7 presents typical vibration levels from construction equipment at various distances from the construction equipment. Jackhammers typically generate vibration levels of 0.035 in/sec PPV, and drilling typically generates vibration levels of 0.09 in/sec PPV at 25 feet. Vibration levels would vary depending on soil conditions, construction methods, and equipment used.

Calculations were made to estimate vibration levels at distances of 15 feet from project construction, as well as distances of 35, 95, and 125 feet from the site to represent other nearby buildings. 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 Source Levels for Construction Equipment

Equipment		PPV at 15 ft. (in/sec)	PPV at 25 ft. (in/sec)	PPV at 35 ft. (in/sec)	PPV at 95 ft. (in/sec)	PPV at 125 ft. (in/sec)
Clam shovel drop		0.354	0.202	0.140	0.047	0.034
Hydromill (slurry wall)	in soil	0.014	0.008	0.006	0.002	0.001
	in rock	0.030	0.017	0.012	0.004	0.003
Vibratory Roller		0.368	0.210	0.145	0.048	0.036
Hoe Ram		0.156	0.089	0.061	0.020	0.015
Large bulldozer		0.156	0.089	0.061	0.020	0.015
Caisson drilling		0.156	0.089	0.061	0.020	0.015
Loaded trucks		0.133	0.076	0.052	0.018	0.013
Jackhammer		0.061	0.035	0.024	0.008	0.006
Small bulldozer		0.005	0.003	0.002	0.001	0.001

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

The nearest structures to project construction include a residences located 15 feet west of the shared property line and about 35 feet west of the proposed building location, a retail building located about 15 feet north of the shared property line, a restaurant building located about 95 feet south of the shared property line, and a parking garage located about 125 feet east of the shared property line. There are no historic structures in the vicinity of the project site.

As indicated in Table 7, at a distance of 15 feet, groundborne vibration levels from construction could reach 0.368 in/sec PPV, with the majority of construction below the 0.2 in/sec PPV threshold. Heavy vibration generating construction equipment, including vibratory rollers and clam shovel drops, would have the potential to produce vibration levels of 0.2 in/sec PPV or more within about 25 feet of construction. Existing structures located within 25 feet of the project site include one residence to the west and one retail structure to the north (DXL).

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 2 presents the damage probability as reported in USBM RI 8507 and reproduced by Dowding assuming a maximum vibration level of 0.37 in/sec PPV. As shown on Figure 2, these studies have found no observations of "threshold damage" (referred to as cosmetic damage elsewhere in this report), "minor damage", or "major damage" at vibration levels below 0.5 in/sec PPV. Based on these data, no cosmetic or structural damage would be anticipated, assuming a maximum vibration level of 0.5 in/sec PPV or less.

Construction of the project could generate vibration levels exceeding the General Plan threshold of 0.2 in/sec PPV at one residence to the west and a retail structure to the north (DXL), located within 25 feet of the project site. This is a **potentially significant** impact.

In other surrounding areas where vibration would not be expected to cause structural 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.

Mitigation Measure 2: The implementation of the following measures would reduce the vibration impact to a less-than-significant level at adjacent structures:

- Where possible, prohibit operation of earth-moving equipment or other heavy vibration-generating equipment within distances of 25 feet of adjacent structures.

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.

- A list of all heavy construction equipment to be used for this project and the anticipated time duration of using the equipment that is known to produce high vibration levels (clam shovel drops, vibratory rollers, hoe rams, large bulldozers, caisson drillings, loaded trucks, jackhammers, etc.) shall be submitted by the contractor.

- A construction vibration plan shall be implemented to document conditions at all structures located within 25 feet of construction prior to, during, and after vibration generating construction activities. All plan tasks shall be undertaken under the direction of a licensed Professional Structural Engineer in the State of California and be in accordance with industry accepted standard methods. The construction vibration plan should be implemented to include the following tasks:

    - Identification of sensitivity to groundborne vibration of all structures located within 25 feet of heavy construction.

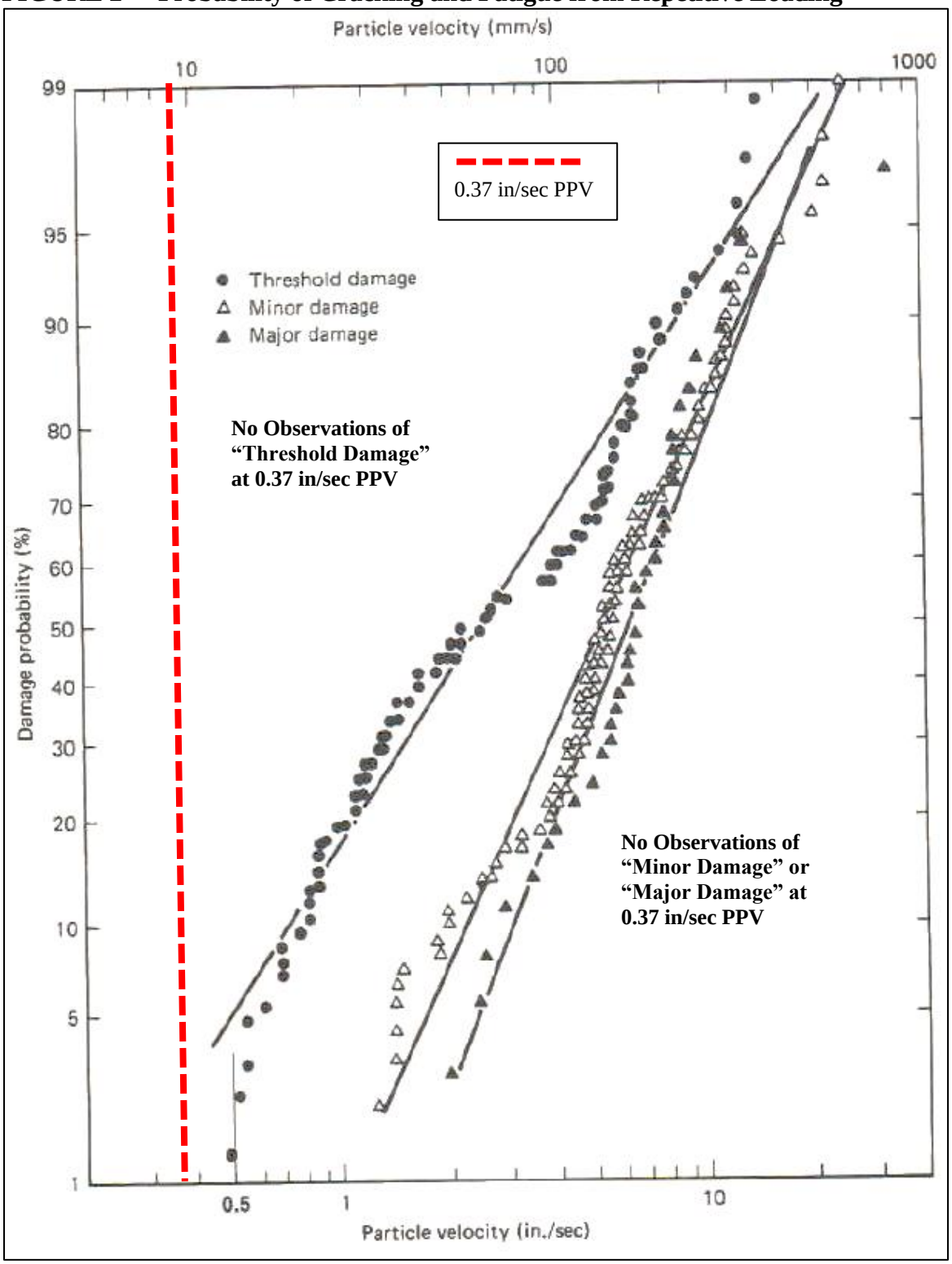
    - Performance of a photo survey, elevation survey, and crack monitoring survey for each structure of normal construction within 25 feet of construction activities identified as sources of high vibration levels. Surveys shall be performed prior to any construction activity and after project completion, and shall include internal and external crack monitoring in structures, settlement, and distress, and shall document the condition of foundations, walls and other structural elements in the interior and exterior of said structures.

    - Designate a person responsible for registering and investigating claims of excessive vibration. The contact information of such person shall be clearly posted on the construction site.

    - Conduct a post-survey on the structure where either monitoring has indicated high levels or complaints of damage. Make appropriate repairs in accordance with the Secretary of the Interior's Standards where damage has occurred as a result of construction activities.

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

FIGURE 2 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., June 2018.