NOISE AND VIBRATION STUDY

1642 S. CENTRAL AVENUE APARTMENT PROJECT

CITY OF GLENDALE, CALIFORNIA

LSA

June 2020

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CITY OF GLENDALE, CALIFORNIA

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INTRODUCTION

This noise and vibration study has been prepared to evaluate the potential noise and vibration impacts and project features associated with the 1642 S. Central Avenue Apartment Project (proposed project) in Glendale, California. This analysis is intended to satisfy the City of Glendale (City) requirements for a project-specific noise and vibration impact analysis by examining the impacts of the proposed project on noise-sensitive uses in the project area and evaluating the necessary minimization measures that would be incorporated as part of the project design.

Project Description and Location

The proposed project is located at 1642 S. Central Avenue, south of S. Central Avenue and east of Gardena Avenue in the City of Glendale, California. The project will construct a five (5) story apartment building consisting of 31 units and 3,173 square feet (sf) of common space on top of one (1) subterranean parking level.

The regional location is illustrated on Figure 1, and the site plan is illustrated on Figure 2.

Existing Sensitive Land Uses in the Project Area

The project site is surrounded primarily by residential, commercial, and industrial development. The areas adjacent to the project site include the following uses:

- **North:** Existing industrial warehouse uses opposite S. Central Avenue, 65 feet away
- **East:** Existing Peak Auto Body repair shop, immediately adjacent
- **South:** Existing single-family homes, 60 feet away
- **West:** Existing parking lot associated with the Glendale Station opposite Gardena Avenue, 55 feet away

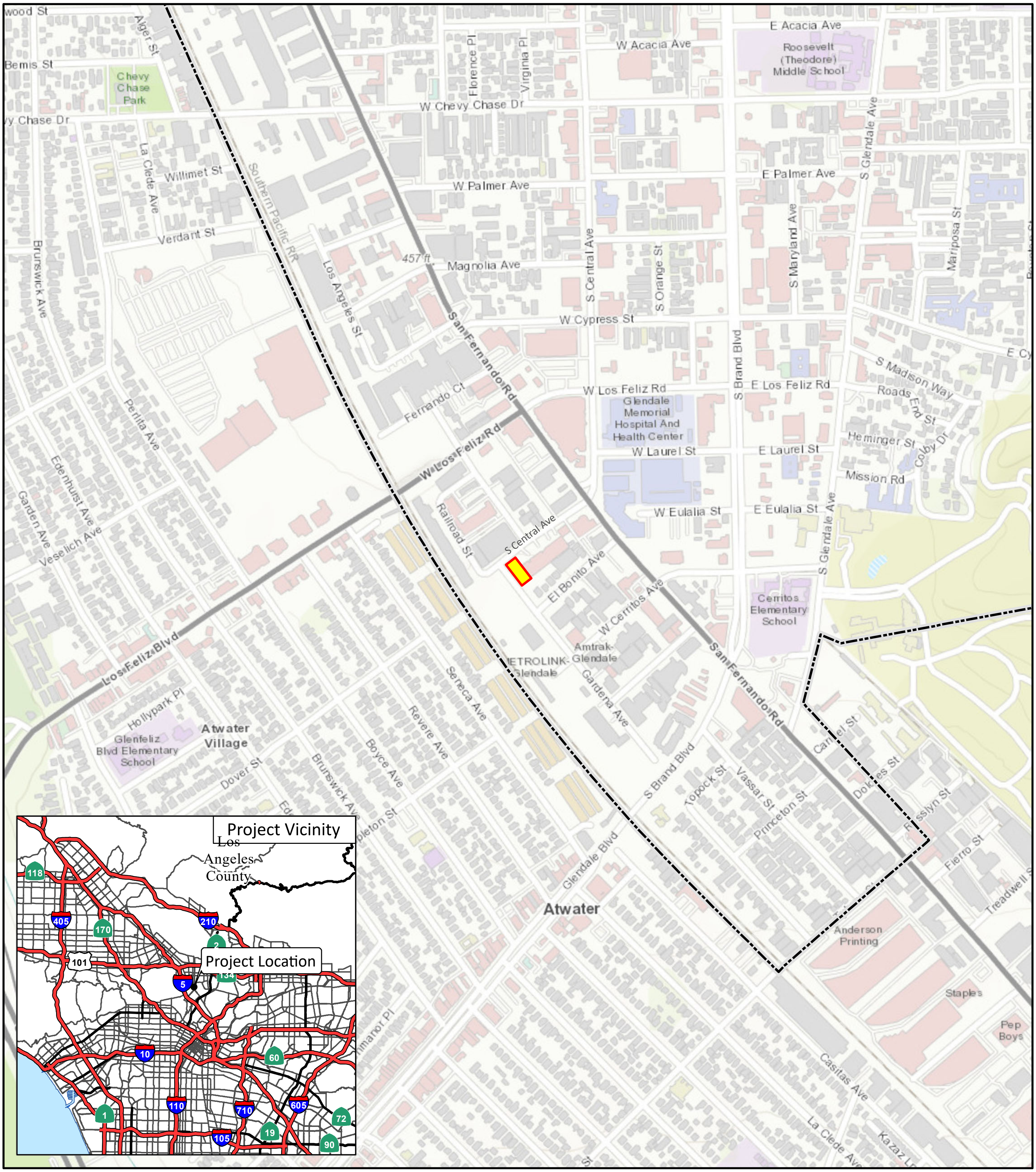

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FIGURE 1

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Project Site

City Boundary

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1642 S. Central Avenue

Project Location

SOURCE: ArcGIS Online Topographic Map

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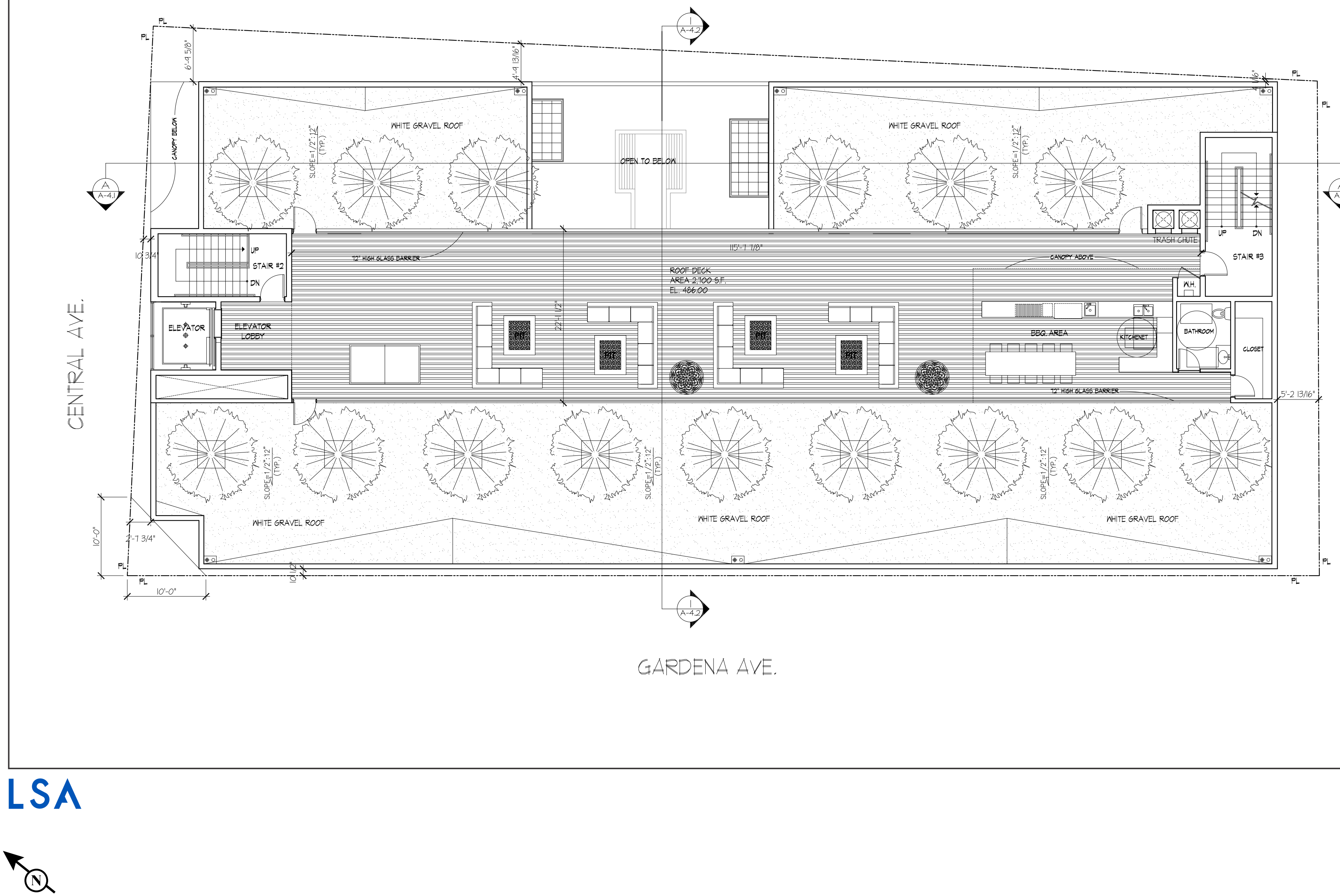

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FIGURE 2

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SOURCE: Alajajian Marcoosi Architects, Inc.

1642 S. Central Avenue

Site Plan

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CHARACTERISTICS OF SOUND

Noise is usually defined as unwanted sound. Noise consists of any sound that may produce physiological or psychological damage and/or interfere with communication, work, rest, recreation, and sleep.

To the human ear, sound has two significant characteristics: pitch and loudness. Pitch is generally an annoyance, while loudness can affect the ability to hear. Pitch is the number of complete vibrations, or cycles per second, of a wave resulting in the tone's range from high to low. Loudness is the strength of a sound that describes a noisy or quiet environment and is measured by the amplitude of the sound wave. Loudness is determined by the intensity of the sound waves combined with the reception characteristics of the human ear. Sound intensity refers to how hard the sound wave strikes an object, which in turn produces the sound's effect. This characteristic of sound can be precisely measured with instruments. The analysis of a project defines the noise environment of the project area in terms of sound intensity and its effect on adjacent sensitive land uses.

Measurement of Sound

Sound intensity is measured through the A-weighted scale to correct for the relative frequency response of the human ear. That is, an A-weighted noise level de-emphasizes low and very high frequencies of sound similar to the human ear's de-emphasis of these frequencies. Unlike linear units (e.g., inches or pounds), decibels are measured on a logarithmic scale representing points on a sharply rising curve.

For example, 10 decibels (dB) is 10 times more intense than 1 dB, 20 dB is 100 times more intense than 1 dB, and 30 dB is 1,000 times more intense than 1 dB. Thirty decibels (30 dB) represent 1,000 times as much acoustic energy as 1 dB. The decibel scale increases as the square of the change, representing the sound pressure energy. A sound as soft as human breathing is about 10 times greater than 0 dB. The decibel system of measuring sound gives a rough connection between the physical intensity of sound and its perceived loudness to the human ear. A 10 dB increase in sound level is perceived by the human ear as only a doubling of the loudness of the sound. Ambient sounds generally range from 30 dB (very quiet) to 100 dB (very loud).

Sound levels are generated from a source, and their decibel level decreases as the distance from that source increases. Sound dissipates exponentially with distance from the noise source. For a single-point source, sound levels decrease approximately 6 dB for each doubling of distance from the source. This drop-off rate is appropriate for noise generated by stationary equipment. If noise is produced by a line source (e.g., highway traffic or railroad operations) the sound decreases 3 dB for each doubling of distance in a hard site environment. Similarly, line sources with intervening absorptive vegetation or line sources that are located at a great distance to the receptor would decrease 4.5 dB for each doubling of distance, which is consistent with information provided in the Federal Highway Administration (FHWA) Highway Traffic Noise Prediction Model (FHWA RD-77-108).

There are many ways to rate noise for various time periods, but an appropriate rating of ambient noise affecting humans also accounts for the annoying effects of sound. The equivalent continuous sound level (L_{eq}) is the total sound energy of time-varying noise over a sample period. However, the predominant rating scales for human communities in the State of California are the L_{eq} and Community Noise Equivalent Level (CNEL) or the day-night average noise level (L_{dn}) based on A-weighted decibels (dBA). CNEL is the time-varying noise over a 24-hour period, with a 5 dBA weighting factor applied to the hourly L_{eq} for noises occurring from 7:00 p.m. to 10:00 p.m. (defined as relaxation hours), and a 10 dBA weighting factor applied to noises occurring from 10:00 p.m. to 7:00 a.m. (defined as sleeping hours). L_{dn} is similar to the CNEL scale but without the adjustment for events occurring during the evening hours. CNEL and L_{dn} are within 1 dBA of each other and are normally interchangeable. The City uses the CNEL noise scale for long-term noise impact assessment.

Other noise rating scales of importance when assessing the annoyance factor include the maximum instantaneous noise level (L_{max}), which is the highest exponential time-averaged sound level that occurs during a stated time period. The noise environments discussed in this analysis for short-term noise impacts are specified in terms of maximum levels denoted by L_{max}, which reflects peak operating conditions and addresses the annoying aspects of intermittent noise. L_{max} is often used together with another noise scale or noise standards in terms of percentile noise levels in noise ordinances for enforcement purposes. For example, the L_{10} noise level represents the noise level exceeded 10 percent of the time during a stated period. The L_{50} noise level represents the median noise level (i.e., half the time the noise level exceeds this level, and half the time it is less than this level). The L_{90} noise level represents the noise level exceeded 90 percent of the time and is considered the background noise level during a monitoring period. For a relatively constant noise source, the L_{eq} and L_{50} are approximately the same.

The human perception of noise level increases can be described in three categories:

- **Inaudible/Not Perceptible:** Changes in noise levels of less than 1 dB are inaudible to the human ear and often referred to as not perceptible.

- **Potentially Audible/Barely Perceptible:** A potentially audible impact refers to a 1 to 3 dB change in noise levels. This range of noise levels has been found to be noticeable in low-noise environments.

- **Audible/Readily Perceptible:** An audible impact refers to a noticeable increase in noise for humans. Audible increases in noise levels generally refer to a change of 3 dB or greater because this level has been found to be readily perceptible in exterior environments. For reference, a 10 dB increase is experienced by humans as a doubling of sound or perceived to be twice as loud.

Only readily perceptible changes in existing ambient or background noise levels are considered potentially significant.

Physiological Effects of Noise

Exposure to prolonged high noise levels has been found to have effects on human health (Suter 1991; World Health Organization 1999), including physiological and psychological effects to humans. Physical damage to human hearing begins at prolonged exposure to noise levels higher than 85 dBA.

Exposure to high noise levels affects the entire system, with prolonged noise exposure in excess of 75 dBA increasing body tensions, thereby affecting blood pressure and functions of the heart and the nervous system. In comparison, extended periods of noise exposure above 90 dBA would result in permanent cell damage. When the noise level reaches 120 dBA, a tickling sensation occurs in the human ear, even with short-term exposure. This level of noise is called the threshold of feeling. As the sound reaches 140 dBA, the tickling sensation is replaced by the feeling of pain in the ear (the threshold of pain). A sound level of 160 to 165 dBA will result in dizziness or loss of equilibrium. The ambient or background noise problem is widespread and is generally more concentrated in urban areas than in outlying, less developed areas.

Table A lists definitions of acoustical terms, and Table B shows common sound levels and their sources.

Table A: Definitions of Acoustical Terms

Term	Definitions
Decibel, dB	A unit of measurement that denotes the ratio between two quantities that are proportional to power; the number of decibels is 10 times the logarithm (to the base 10) of this ratio.
Frequency, Hz	Of a function periodic in time, the number of times that the quantity repeats itself in 1 second (i.e., number of cycles per second).
A-Weighted Sound Level, dBA	The sound level obtained by use of A-weighting. The A-weighting filter deemphasizes the very low- and very high-frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. (All sound levels in this report are A-weighted, unless reported otherwise.)
L_{01}, L_{10}, L_{50}, L_{90}	The fast A-weighted noise levels that are equaled or exceeded by a fluctuating sound level 1%, 10%, 50%, and 90% of a stated time period.
Equivalent Continuous Noise Level, L_{eq}	The level of a steady sound that, in a stated time period and at a stated location, has the same A-weighted sound energy as the time-varying sound.
Community Noise Equivalent Level, CNEL	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 5 dBA to sound levels occurring in the evening from 7:00 PM to 10:00 PM and after the addition of 10 dBA to sound levels occurring in the night between 10:00 PM and 7:00 AM.
Day/Night Noise Level, L_{dn}	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 10 dBA to sound levels occurring in the night between 10:00 PM and 7:00 AM.
L_{max}, L_{min}	The maximum and minimum A-weighted sound levels measured on a sound level meter, during a designated time interval, using fast time averaging.
Ambient Noise Level	The all-encompassing noise associated with a given environment at a specified time; usually a composite of sound from many sources at many directions, near and far; no particular sound is dominant.
Intrusive	The noise that intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, 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 1991).

Table B: Common Sound Levels and Their Noise Sources

Noise Source	A-Weighted Sound Level in Decibels	Noise Environments	Subjective Evaluations
Near Jet Engine	140	Deafening	128 times as loud
Civil Defense Siren	130	Threshold of Pain	64 times as loud
Hard Rock Band	120	Threshold of Feeling	32 times as loud
Accelerating Motorcycle at a Few Feet Away	110	Very Loud	16 times as loud
Pile Driver; Noisy Urban Street/Heavy City Traffic	100	Very Loud	8 times as loud
Ambulance Siren; Food Blender	95	Very Loud	—
Garbage Disposal	90	Very Loud	4 times as loud
Freight Cars; Living Room Music	85	Loud	—
Pneumatic Drill; Vacuum Cleaner	80	Loud	2 times as loud
Busy Restaurant	75	Moderately Loud	—
Near Freeway Auto Traffic	70	Moderately Loud	—
Average Office	60	Quiet	One-half as loud
Suburban Street	55	Quiet	—
Light Traffic; Soft Radio Music in Apartment	50	Quiet	One-quarter as loud
Large Transformer	45	Quiet	—
Average Residence without Stereo Playing	40	Faint	One-eighth as loud
Soft Whisper	30	Faint	—
Rustling Leaves	20	Very Faint	—
Human Breathing	10	Very Faint	Threshold of Hearing
—	0	Very Faint	—

Source: Compiled by LSA (2017).

FUNDAMENTALS OF VIBRATION

Vibration refers to ground-borne noise and perceptible motion. Ground-borne vibration is almost exclusively a concern inside buildings and is rarely perceived as a problem outdoors, where the motion may be discernible, but without the effects associated with the shaking of a building there is less adverse reaction. Vibration energy propagates from a source through intervening soil and rock layers to the foundations of nearby buildings. The vibration then propagates from the foundation throughout the remainder of the structure. Building vibration may be perceived by occupants as the motion of building surfaces, the rattling of items sitting on shelves or hanging on walls, or a low-frequency rumbling noise. The rumbling noise is caused by the vibration of walls, floors, and ceilings that radiate sound waves. Annoyance from vibration often occurs when the vibration exceeds the threshold of perception by 10 dB or less. This is an order of magnitude below the damage threshold for normal buildings.

Typical sources of ground-borne vibration are construction activities (e.g., blasting, pile-driving, and operating heavy-duty earthmoving equipment), steel-wheeled trains, and occasional traffic on rough roads. Problems with both ground-borne vibration and noise from these sources are usually localized to areas within approximately 100 feet (ft) from the vibration source, although there are examples of ground-borne vibration causing interference out to distances greater than 200 ft (Federal Transit Authority [FTA] 2018). When roadways are smooth, vibration from traffic, even heavy trucks, is rarely perceptible. It is assumed for most projects that the roadway surface will be smooth enough that ground-borne vibration from street traffic will not exceed the impact criteria; however, construction of the project could result in ground-borne vibration that may be perceptible and annoying.

Ground-borne noise is not likely to be a problem because noise arriving via the normal airborne path will usually be greater than ground-borne noise.

Ground-borne vibration has the potential to disturb people and damage buildings. Although it is very rare for train-induced ground-borne vibration to cause even cosmetic building damage, it is not uncommon for construction processes such as blasting and pile-driving to cause vibration of sufficient amplitudes to damage nearby buildings (FTA 2018). Ground-borne vibration is usually measured in terms of vibration velocity, either the root-mean-square (RMS) velocity or peak particle velocity (PPV). The RMS is best for characterizing human response to building vibration, and PPV is used to characterize potential for damage. Decibel notation acts to compress the range of numbers required to describe vibration. Vibration velocity level in decibels is defined as:

$$L_v = 20 \log_{10} [V/V_{ref}]$$

where “L_v” is the vibration velocity in decibels (VdB), “V” is the RMS velocity amplitude, and “V_{ref}” is the reference velocity amplitude, or 1×10^{-6} inches/second (in/sec) used in the United States.

OVERVIEW OF THE EXISTING NOISE ENVIRONMENT

This section describes the existing noise environment in the project site vicinity. Noise monitoring was used to quantify existing noise levels at the project site. In the City, vehicle traffic is the primary source of noise. Other significant local noise sources include train pass-bys and stations operations, airport noise, industrial noise, and mechanical equipment noise.

The proposed project is located approximately 315 feet east of an existing rail corridor that carries both passenger trains (Amtrak and Metrolink) and freight trains (Union Pacific Railroad, formerly known as Southern Pacific Lines). Current passenger train operations have been reduced due to the current pandemic conditions, and are estimated to be approximately half of typical operations based information provided on the Metrolink website. This reduction in activity will be accounted for in the impacts section of this report. Furthermore, the rail corridor may include the future operations of the proposed California High-Speed Rail Project. These operations, while not captured in the existing noise measurements, will also be accounted for in the impacts section.

Existing Noise Level Measurements

To assess existing noise levels, LSA conducted two long-term noise measurements at the project site. The long-term noise measurements were recorded from June 9 through June 10, 2020. The long-term noise measurements captured data in order to calculate the hourly L_{eq} and CNEL at each location, which incorporate the nighttime hours. Sources that dominate the existing noise environment include traffic on adjacent roadways, train traffic on the existing rail line to the east, parking lot activities, and operations from the commercial and industrial uses. Noise measurement data collected is summarized in Table C and shown in Figure 3. Noise measurement sheets are provided in Appendix A.

Table C: Long-Term Noise Level Measurements

Location	Daytime Noise Levels[1] (dBA L_{eq})	Evening Noise Levels[2] (dBA L_{eq})	Nighttime Noise Levels[3] (dBA L_{eq})	Average Daily Noise Level (dBA CNEL)
LT-1: Western edge of the project site on Gardena Avenue.	62.1-70.7	59.2-63.0	48.4-63.4	67.0
LT-2: Northeast corner of the project site, across on S. Glendale Avenue.	61.4-68.4	57.7-63.9	48.0-64.7	66.3

Source: Compiled by LSA. (June 2020).
1 Daytime Noise Levels = noise levels during the hours of 7:00 a.m. to 7:00 p.m.
2 Evening Noise Levels = noise levels during the hours of 7:00 p.m. to 10:00 p.m.
3 Nighttime Noise Levels = noise levels during the hours of 10:00 p.m. to 7:00 a.m.
dBA = A-weighted decibels
CNEL = Community Noise Equivalent Level
L_{eq}=equivalent continuous sound level

Aircraft Related Noise Impacts

The project is approximately 7.25 miles (mi) southeast of Burbank Airport and 14.5 mi northeast of Los Angeles International Municipal Airport. The proposed project is located well outside the 65 dBA CNEL noise contours of these airports; therefore, noise-related impacts due to airport activities would not represents a significant source of existing noise.

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Project Location

LT-1 Long-term Noise Monitor Location

FIGURE 3

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SOURCE: Google Earth, 2020

1642 S. Central Avenue

Noise Monitoring Locations

REGULATORY SETTING

This section describes the applicable noise and vibration standards for the proposed project. The project would be entirely within the City of Glendale. Noise in the City is regulated by the City's General Plan and Municipal Code.

Applicable Noise Standards

Noise Element of the General Plan

The noise standards specified in Table 2 of the City's General Plan Noise Element (shown in Table D of this document) are used as design standards to be used in the project design stage. Compliance with these standards should be incorporated by conditions of approval or environmental mitigation measures and evaluated as part of City Development Review and building permit plan check.

Table D: Interior and Exterior Noise Standards Energy Average (CNEL)

Land Use Categories		Energy Average (CNEL)	
Categories	**Uses**	**Interior**	**Exterior**
Residential	Single-Family	45[1]	65[2]
	Multi-Family	45[1]	65[3]
	Residential within Mixed Use	45[1]	—
Commercial	Hotel, Motel, Transient Lodging	45[1]	—
Institutional	Hospital, School Classroom, Church, Library	45	—
Open Space	Parks[4]	—	65

Source: City of Glendale Noise Element, Table 2 (2007).

[1] Interior environment excludes bathrooms, toilets, closets, and corridors.

[2] Applies to the outdoor environment limited to the private yard of single family residences (normally rear yard).

[3] Applies to the patio area where there is an expectation of privacy (i.e. not a patio area which also serves as, or is adjacent to, the primary entrance to the unit).

[4] Only applies to parks where peace and quiet are determined to be of prime importance, such as hillside open space areas open to the public. Generally would not apply to urban parks or active-use parks.

CNEL = Community Noise Equivalent Level

Municipal Code

Section 8.36.040 of the City's Municipal Code establishes the presumed noise standards. Table E provides the City's noise standard based on the noise zone, the location of the noise (exterior/interior), and the time period. Section 8.36.050 goes on to clarify the following:

- Where the actual ambient is less than the presumed ambient, the actual ambient shall control and any noise in excess of the actual ambient, plus 5 dBA, shall be a violation

- Where the actual ambient is equal to or more than the presumed ambient, the actual ambient shall control and any noise may not exceed the actual ambient by more than five dBA; however, in no event may the actual ambient exceed the presumed noise standards by five dBA.

Table E: Exterior and Interior Noise Standards (dBA L_{eq})

Land Use Type	Daytime (7:00 a.m. to 10:00 p.m.)	Nighttime (10:00 p.m. to 7:00 a.m.)
Exterior		
Cemetery and Residential (Single-Family and Duplex)	55	45
Residential (Multi-family, hotels, motels and transient lodgings)	60	-
Central Business District and Commercial	65	-
Industrial	70	-
Interior		
Residential	55	45

Source: City of Glendale, Municipal Code (2020).
dBA = A-weighted decibels
L_{eq} = equivalent continuous sound level

Section 8.36.080 of the City's Municipal Code Noise Ordinance states the following as it relates to construction activities:

It is unlawful for any person within a residential zone, or within a radius of 500 feet therefrom, to operate equipment or perform any outside construction or repair work on buildings, structures or projects within the city between the hours of 7:00 p.m. on one day and 7:00 a.m. of the next day or from 7:00 p.m. on Saturday to 7:00 a.m. on Monday or from 7:00 p.m. preceding a holiday, as designated in Chapter 3.08 of this code, to 7:00 a.m. following such holiday unless beforehand a permit therefor has been duly obtained from the building official. No permit shall be required to perform emergency work as defined in this chapter.

Federal Transit Administration

Given that the Municipal Code exempts construction activities and that no standard criteria for assessing construction noise impacts is provided, for the purposes of determining the significance of the noise increase experienced at noise-sensitive uses surrounding the project during construction, the guidelines within the FTA *Transit Noise and Vibration Impact Assessment Manual* (2018) are used in this analysis for construction noise impact identification. The general assessment criteria for construction noise identifies a 1-hour noise level of 90 dBA L_{eq} for residential uses during daytime hours and a 1-hour noise level of 100 dBA L_{eq} for commercial and industrial uses. This provides reasonable criteria for assessing construction noise impacts based on the potential for adverse community reaction when the noise criteria are exceeded.

Applicable Vibration Standards

Federal Transit Administration

The criteria for environmental impact from groundborne vibration are based on the maximum levels for a single event. Vibration standards included in the Federal Transit Administration's (FTA) *Transit Noise and Vibration Impact Assessment* (FTA 2018) are used in this analysis for groundborne vibration impacts on human annoyance, as shown in Table F. The criteria presented in Table F account for variation in project types, as well as the frequency of events, which differ widely among projects. It is intuitive that when there will be fewer events per day, it should take higher vibration levels to evoke the same community response. The frequency of events is accounted for in the criteria by distinguishing between projects with frequent and infrequent events, in which the term "occasional events" is defined as between 30 and 70 events per day.

Table F: Groundborne Vibration Impact Criteria for General Assessment

Land Use Category	Groundborne Vibration Impact Levels (VdB re 1 µin/sec)		
	Frequent[1] Events	Occasional[2] Events	Infrequent[3] Events
Category 1: Buildings where low ambient vibration is essential for interior operations.	65 VdB[4]	65 VdB[4]	65 VdB[4]
Category 2: Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB

Source: *Transit Noise and Vibration Impact Assessment* (FTA 2018).

1 Frequent events are defined as more than 70 events per day.
2 Occasional events are defined as between 30 and 70 events per day.
3 Infrequent events are defined as fewer than 30 events per day.
4 This criterion limit is based on levels that are acceptable for most moderately sensitive equipment, such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.

µin/sec = microinches per second
dB = decibels
VdB = vibration velocity decibels

Table G lists the potential vibration building damage criteria associated with construction activities, as suggested in the *Transit Noise and Vibration Impact Assessment* (FTA 2018).FTA guidelines show that a vibration level of up to 0.5 in/sec PPV) is considered safe for buildings consisting of reinforced concrete, steel, or timber (no plaster), and would not result in any construction vibration damage. For a non-engineered timber and masonry building, the construction building vibration damage criterion is 0.2 in/sec in PPV.

Table G: Construction Vibration Damage Criteria

Building Category	PPV (in/sec)
Reinforced concrete, steel, or timber (no plaster)	0.50
Engineered concrete and masonry (no plaster)	0.30
Non-engineered timber and masonry buildings	0.20
Buildings extremely susceptible to vibration damage	0.12

Source: *Transit Noise and Vibration Impact Assessment* (FTA 2018).

in/sec = inches per second
PPV = peak particle velocity

IMPACT ASSESSMENT

Short-Term Construction Impacts

Construction noise and vibration impacts from the proposed project would be associated with demolition of the existing structures on-site and construction of the new apartment building.

Short-Term Off-Site Construction Noise Impacts

Short-term noise impacts would be associated with demolition of the existing structures, excavation, grading, and construction of the proposed project. Construction-related short-term noise levels would be higher than existing ambient noise levels in the vicinity of the project site, but would no longer occur once construction of the proposed project is completed.

Two types of short-term noise impacts could occur during construction of the proposed project. The first type of short-term construction noise would result from transport of construction equipment and materials to the project site and construction worker commutes. These transportation activities would incrementally raise noise levels on access roads leading to the site. It is expected that larger trucks used in equipment delivery would generate higher noise impacts than trucks associated with worker commutes. The single-event noise from equipment trucks passing at a distance of 50 feet from a sensitive noise receptor would reach a maximum level of 84 dBA L_{max}. However, the pieces of heavy equipment for grading and construction activities would be moved on site just one time and would remain on site for the duration of each construction phase. This one-time trip, when heavy construction equipment is moved on and off site, would not add to the daily traffic noise in the project vicinity. The total number of daily vehicle trips would be minimal when compared to existing traffic volumes on the affected streets, and the long-term noise level change associated with these trips would not be perceptible. Therefore, equipment transport noise and construction-related worker commute impacts would be short term and would not result in a significant off-site noise impact.

The second type of potential short-term noise impact is related to noise generated during demolition, site preparation, grading, building construction, and paving. Construction is completed in discrete steps, each of which has its own mix of equipment and consequently its own noise characteristics. These various sequential phases would change the character of the noise generated on the site and therefore the noise levels surrounding the site as construction progresses. Despite the variety in the type and size of construction equipment, similarities in the dominant noise sources and patterns of operation allow construction-related noise ranges to be categorized by work phase.

The site preparation and grading phase, which includes excavation and grading of the site, tends to generate the highest noise levels because earthmoving equipment are the noisiest construction equipment. Additionally, this phase would be the longest of the phases expected to occur near the project site boundary. The three loudest pieces of equipment during this phase are estimated to include an excavator, grader, and dozer. Typical operating cycles for these types of construction equipment may involve 1 or 2 minutes of full-power operation followed by 3 or 4 minutes at lower power settings.

In addition to the reference maximum noise level, the usage factor provided in Table H is utilized to calculate the hourly noise level impact for each piece of equipment based on the following equation:

$$L_{eq}(equip) = E.L. + 10\log(U.F.) - 20\log\left(\frac{D}{50}\right)$$

where: *L_{eq}(equip)* = L_{eq} at a receiver resulting from the operation of a single piece of equipment over a specified time period

E.L. = noise emission level of the particular piece of equipment at a reference distance of 50 ft

U.F. = usage factor that accounts for the fraction of time that the equipment is in use over the specified period of time

D = distance from the receiver to the piece of equipment

Each piece of construction equipment operates as an individual point source. Utilizing the following equation, a composite noise level can be calculated when multiple sources of noise operate simultaneously:

$$Leq\ (composite) = 10 * \log_{10}\left(\sum_{1}^{n} 10^{\frac{Ln}{10}}\right)$$

Consistent with FTA guidance, utilizing the equations from the methodology above and the reference information in Table H, the composite noise level of the two loudest pieces of equipment during construction, typically the concrete saw and tractor/truck, as required by the FTA criteria, would be 85.5 dBA L_{eq} at a distance of 50 ft from the construction area.

Once composite noise levels are calculated, reference noise levels can then be adjusted for distance using the following equation:

$$Leq\ (at\ distance\ X) = Leq\ (at\ 50\ feet) - 20 * \log_{10}\left(\frac{X}{50}\right)$$

In general, this equation shows that doubling the distance would decrease noise levels by 6 dBA, while halving the distance would increase noise levels by 6 dBA.

Table H: Typical Maximum Construction Equipment Noise Levels (L_{max})

Type of Equipment	Acoustical Usage Factor	Suggested Maximum Sound Levels for Analysis (dBA L_{max} at 50 ft)
Air Compressor	40	80
Backhoe	40	80
Cement Mixer	50	80
Concrete/Industrial Saw	20	90
Crane	16	85
Excavator	40	85
Forklift	40	85
Generator	50	82
Grader	40	85
Loader	40	80
Pile Driver	20	101
Paver	50	85
Roller	20	85
Rubber Tire Dozer	40	85
Scraper	40	85
Tractor	40	84
Truck	40	84
Welder	40	73

Source: FHWA. *Highway Construction Noise Handbook* (August 2006).
dBA = A-weighted decibel(s)
FHWA = Federal Highway Administration
ft = foot/feet
L_{max} = maximum instantaneous noise level

It is expected that the average noise levels during the construction of the project at the nearest noise-sensitive use, the existing single-family homes to the south, would be 76.5 dBA L_{eq} based on an average distance of 140 ft from the center of construction activities. While construction-related short-term noise levels have the potential to be higher than existing ambient noise levels in the project area under existing conditions, the noise impacts would no longer occur once project construction is completed and construction-related noise impacts would remain below the 90 dBA L_{eq} 1-hour construction noise level criteria established by the FTA for residential uses.

Compliance with the City's Noise Ordinance would ensure that construction noise does not disturb the residential and sensitive office uses during hours when ambient noise levels are likely to be lower (i.e., at night). Although construction noise would be higher than the ambient noise in the project vicinity, construction noise would cease to occur once project construction is completed. In addition to compliance with appropriate construction times, the following best business practices would implement measures during construction to reduce noise impacts to the greatest extent feasible:

Prior to issuance of demolition permits, the General Manager of the Glendale (City) Department of Building and Safety, or designee, shall verify that all construction plans include notes stipulating the following:

- Grading and construction contractors shall use equipment that generates lower vibration levels, such as rubber-tired equipment rather than metal-tracked equipment.
- Construction haul truck and materials delivery traffic shall avoid residential areas whenever feasible.
- The construction contractor shall place noise- and vibration-generating construction equipment and locate construction staging areas away from sensitive uses whenever feasible.
- The construction contractor shall use on-site electrical sources to power equipment rather than diesel generators where feasible.
- All residential units located within 500 feet of the construction site shall be sent a notice regarding the construction schedule. A sign legible at a distance of 50 feet shall also be posted at the construction site. All notices and the signs shall indicate the dates and durations of construction activities, as well as provide a telephone number for the "noise disturbance coordinator."

Short-Term Off-Site Construction Vibration Impacts

Groundborne vibration from construction activity would be mostly low to moderate. While there is currently limited information regarding vibration source levels, to provide a comparison of vibration levels expected for a project of this size, a small bulldozer, as shown in Table I, would generate approximately 0.003 PPV in/sec or 58 VdB of groundborne vibration when measured at 25 feet, based on the *Transit Noise and Vibration Impact Assessment* (FTA 2018).

As shown in Table G, it would take a minimum of 0.3 in/sec in PPV to have the potential to result in building damage to structures constructed of concrete and masonry buildings and 0.2 in/sec PPV to cause any potential building damage to non-engineered timber and masonry buildings. Table I further shows the PPV values and vibration levels (in terms of VdB) from other construction vibration sources at 25 feet from construction vibration sources for comparison purposes.

Table I: Vibration Source Amplitudes for Construction Equipment

Equipment	Reference PPV/L_V at 25 ft	
	PPV (in/sec)	L_V (VdB)[1]
Large Bulldozer	0.089	87
Loaded Trucks	0.076	86
Jackhammer	0.035	79
Small Bulldozer	0.003	58

Source: *Transit Noise and Vibration Impact Assessment* (FTA 2006).
[1] RMS VdB re 1 µin/sec.
µin/sec = microinches per second
ft = feet
FTA = Federal Transit Administration
in/sec = inches per second
L_V = velocity in decibels
PPV = peak particle velocity
RMS = root-mean-square
VdB = vibration velocity in decibels

The distance to the nearest buildings for vibration impact analysis is measured between the nearest off-site buildings and the project boundary (assuming the construction equipment would be used at or near the project boundary) because vibration damage impacts occur at the buildings. The formula for vibration transmission is provided below:

$$PPV_{equip} = PPV_{ref} \times (25/D)^{1.5}$$

The closest buildings to the proposed construction activities are the existing auto body shop located immediately adjacent to the east and existing single-family residences 65 feet to the south.

It is assumed that all activities associated with demolition of the existing buildings and construction of the new buildings within 5 feet of any existing nearby buildings would be carried out using hand tools and any large equipment such as a dump truck to carry debris away would remain more than 5 feet from the existing buildings.

Utilizing the equations above, it is expected that vibration levels generated by small bulldozers and other similar equipment that would be as close as 5 feet would approach 0.034 in/sec in PPV. At a distance of 65 feet at the existing single-family uses to the south, vibration levels would approach 0.001 in/sec in PPV. It is expected that with the incorporation of standard construction best practices such as the use of hand tools as equipment for the demolition work that would occur within 5 feet of existing structures, building damage would not occur.

The closest sensitive uses to the project site, which are subject to annoyance, are the single-family homes to the south approximately 65 feet from construction activity. To assess the potential vibration levels related to annoyance, the estimated vibration impacts are propagated for distance. Based on the following formula for vibration transmission (FTA 2018), a vibration level at 50 feet is 9 VdB lower than at 25 feet, a vibration level at 100 feet is 18 VdB lower than at 25 feet, and a vibration level at 400 feet is 36 VdB lower than at 25 feet.

$$LvdB\ (D) = LvdB\ (25\ ft) - 30\ Log\ (D/25)$$

Utilizing the information in Table I, the operation of typical construction equipment would generate groundborne vibration levels of up to 46 VdB. Based on the standards provided in Table F, this level of groundborne vibration is well below the threshold of distinctly perceptible, which is approximately 72 VdB for frequent events at uses where people sleep and would not exceed the FTA vibration threshold for human annoyance at the nearest sensitive use.

Long-Term Off-Site Noise Impacts

The proposed project would have HVAC equipment. The greatest noise impact related to HVAC operations would occur at the existing single-family homes located south of the proposed project. The site plan identifies 28 HVAC units that would vary in distance from 70 feet to 190 feet from the closest single-family home façade. To be conservative, it was assumed that all units would be in operation simultaneously at the average distance to the receptor of 130 feet.

Research of several manufacturers' (e.g., Trane) technical data revealed that that there are residential air conditioners with noise levels with an approximate range from 57 to 75 LwA (sound power level) or 42.3 to 60.3 dBA L_{eq} when measured at a distance of 5 ft.

Utilizing the equation below, a composite level of 46.5 dBA L_{eq} at the nearest building façade to the south.

$$Leq\ (at\ distance\ 100\ feet) = (Number\ of\ Units * 10^{\frac{Leq(at\ 5\ feet)}{10}}) - 20 * \log_{10}\left(\frac{100}{5}\right)$$

Additionally, the proposed screening walls would provide an additional reduction from the HVAC units. With the noise reduction associated with distance and additional reduction from screening walls, HVAC noise levels will be below the existing quietest nighttime ambient noise levels of 48.4 dBA L_{eq}. No mitigation is required.

Long-Term On-Site Noise Impacts

Exterior Noise Level Assessment

Based on monitoring results shown in Table C, noise levels at the project site currently approach 67 dBA CNEL. In order to account for the decrease in activity associated with the current pandemic, for purposes of this analysis, it is estimated that the primary sources of noise in the project vicinity, including the rail line to the west and associated parking lot activities, are currently about 50 percent of t typical operations. With a doubling of operations, it is expected that noise levels would be 3 dBA higher, resulting in a level of 70 dBA CNEL.

In addition to the existing noise sources, the project site would be potentially impacted by the future California High Speed Rail (CAHSR) operations. The results of the noise model presented in the Burbank to Los Angeles Project Section EIR/EIS (California Rail Authority 2020) indicates that noise levels experienced at the project site due to CAHSR operations would approach 64 dBA CNEL.

The combination of the exiting sources of noise with the future CAHSR operations would result in an exterior noise level of 71 dBA CNEL at the project site. As described in Table D above, exterior noise standards are only applicable to private areas at which privacy is expected. While the proposed project does not have any such areas, for reporting purposes, the rooftop desk would be considered a gathering space that may benefit from lower noise levels. The proposed 6 foot high glass barrier around the perimeter of the roof deck would reduce noise levels by approximately 7 dBA CNEL to a a level of 64 dBA CNEL. While measures to reduce exterior noise levels are not required; the project must demonstrate compliance with the interior noise standard of 45 dBA CNEL.

Interior Noise Assessment

Based on a review of the architectural plans from the proposed project (Alajajian Marcoosi Architects Inc. 2020), the noise sensitive rooms would have a means of mechanical ventilation; therefore, the interior noise assessment assumes a windows-and-doors-closed condition. Using the architectural plans for the proposed project, LSA conducted interior noise calculations for the bedrooms facing west toward Gardena Avenue and the existing rail corridor. INSUL, a software program for predicting interior noise environments from wall construction and window selections, was used to assess a standard exterior-to-interior noise level reduction for the proposed project. Based on a discussion with the project architect, the assumed minimum specifications for the proposed wall assembly, which would have an STC rating of 41, are as follows:

- 7/8-inch stucco exterior
- Single layer of 5/8-inch plywood
- 2-inch by 6-inch wood studs, 16 inches off center, filled with a minimum of 3.5-inch thick fiberglass insulation
- Single layer of 5/8-inch Type-X gypsum board

At this time, the specific window supplier has yet to be chosen; therefore, this information references Milgard Windows for comparison purposes. Utilizing a window with an STC rating of 33, the INSUL model indicates that a reduction of approximately 28 dBA can be expected. Given the proximity to a number of noise sources, it is recommended that all sliding glass doors and windows have a minimum rating of STC-33.

Summary of Recommendations

Based on the analysis above, the City should verify that final design plans reflect the following measures in order for all exterior and interior noise sensitive spaces to comply with the City's noise standards:

- Standard building construction requirements shall consist of wall construction with a minimum rating of STC-41 as described above and windows and glass doors throughout the building at sensitive rooms shall meet a minimum STC rating of STC-33.

Also, the plans must indicated the following best business practices related to construction activities to minimize noise impact and avoid potential vibration damage:

- Grading and construction contractors shall use equipment that generates lower vibration levels, such as rubber-tired equipment rather than metal-tracked equipment.
- Construction haul truck and materials delivery traffic shall avoid residential areas whenever feasible.
- The construction contractor shall place noise- and vibration-generating construction equipment and locate construction staging areas away from sensitive uses whenever feasible.
- The construction contractor shall use on-site electrical sources to power equipment rather than diesel generators where feasible.

- All residential units located within 500 feet of the construction site shall be sent a notice regarding the construction schedule. A sign legible at a distance of 50 feet shall also be posted at the construction site. All notices and the signs shall indicate the dates and durations of construction activities, as well as provide a telephone number for the “noise disturbance coordinator.”

- Heavy equipment similar to that of bulldozers shall not be used within 5 feet of any existing neighboring structure.

REFERENCES

Alajajian Marcoosi Architects Inc. June 2020. Roadway Apartments at 1642 S. Central Avenue Plans.

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APPENDIX A

NOISE MONITORING FIELD SHEETS

Noise Measurement Survey – 24 HR

Project Number: SSG2001
Project Name: 1642 S. Central Ave Apt Proj

Test Personnel: Corey Knips
Equipment: Larson Davis Spark 706RC

Site Number: LT-1 Date: 6/9/20

Time: From 11:00 AM To 11:00 AM

Site Location: 1642 Central Avenue, in tree along Gardena Avenue.

Primary Noise Sources: Light traffic on Gardena Avenue and Central Avenue, Glendale train station – very light activity compared to normal schedule.

Location Photo:

Noise Measurement Survey – 24 HR

Project Number: SSG2001
Project Name: 1642 S. Central Ave Apt Proj

Test Personnel: Corey Knips
Equipment: Larson Davis Spark 706RC

Site Number: LT-2 Date: 6/9/20

Time: From 11:00 AM To 11:00 AM

Site Location: 1642 Central Avenue, in tree along Central Avenue.

Primary Noise Sources: Light traffic on Gardena Avenue and Central Avenue, Glendale train station – very light activity compared to normal schedule.

Location Photo: