APPENDIX I
Noise and Vibration Technical Memorandum

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MEMORANDUM

DATE: April 19, 2023

TO: Eric Lardy, City of Carlsbad, City Planner

FROM: Jason Lui, Associate/Senior Noise Specialist

SUBJECT: Noise and Vibration Technical Memorandum for the Three on Garfield Project in Carlsbad, California (LSA Project No. 20230874)

INTRODUCTION

LSA prepared this Noise and Vibration Technical Memorandum to evaluate the potential noise and vibration impacts and reduction measures associated with the Three on Garfield (project) in Carlsbad, San Diego County, California. This report is intended to satisfy the City of Carlsbad's (City) requirements and the California Environmental Quality Act (CEQA) for a project-specific noise and vibration impact analysis by examining the impacts of the proposed uses on the project site and evaluating the reduction measures that the project requires. All references cited in this memorandum are included in Attachment A.

Project Location

The 0.16-acre project site is at 2685, 2687, and 2689 Garfield Street in Carlsbad, San Diego County, California. The existing project site is currently developed with an attached three-unit residential air space condominium building. Regional access to the project site is provided by Interstate 5 and State Route 78. Local access to the project site is provided by Carlsbad Boulevard. The project location is shown in Figure 1 (all figures are provided in Attachment B of this document).

The project site is surrounded by residential units and open space. The project site is bounded to the east by a City-owned park with a historical building, to the south by a vacant lot and a parking lot, and to the west and north by a mix of single- and multifamily residential units.

Project Description

The proposed project would construct three attached, air-space condominium units to replace the existing condominium units on site. The proposed building would have a total of 5,118 square feet (sf). Two residential units will contain two bedrooms, while the third unit would feature three bedrooms. The units would range in size from 1,701 sf to 1,713 sf. Each unit would include an attached 2-car garage for a total of 6 parking spaces. In addition, 1 guest parking space would be provided along the building exterior on the north side of the site. Direct vehicular access to the proposed project site would continue to be provided via a full-access driveway on Beech Avenue. Figure 2 illustrates the project site plan.

Landscape would be installed throughout the common areas and along the driveway and will consist of various native/drought tolerant trees, shrubs, and groundcover species. Total landscape area would be 3,086 sf. In addition, 472 sf of rooftop area would be solar ready.

Construction would include demolition, site preparation, grading, and building construction activities. Construction of the proposed project is anticipated to commence in February 2025. Based on the preliminary grading plans, the project would require 233 cubic yards of soil cut, 93 cubic yards of fill, 140 cubic yards of export, and 434 cubic yards of remedial grading. Demolition, grading, and building activities would involve the use of standard earthmoving equipment such as large excavators, cranes, and other related equipment.

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, whereas 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 deemphasizes low and very high frequencies of sound similar to the human ear's de-emphasis of these frequencies. Decibels (dB), unlike the linear scale (e.g., inches or pounds), are measured on a logarithmic scale, which is a scale based on powers of 10.

For example, 10 decibels is 10 times more intense than 0 dB, 20 dB is 100 times more intense than 0 dB, and 30 dB is 1,000 times more intense than 0 dB. Thirty decibels (30 dB) represents 1,000 times as much acoustic energy as 0 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; however, line source noise in a relatively flat environment with absorptive vegetation decreases 4.5 dB for each doubling of distance.

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 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. 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.

Noise impacts can be described in three categories. The first category includes audible impacts that refer to increases in noise levels noticeable to humans. Audible increases in noise levels generally refer to a change of 3 dB or greater because this level has been found to be barely perceptible in exterior environments. The second category, potentially audible, refers to a change in the noise level between 1 dB and 3 dB. This range of noise levels has been found to be noticeable only in laboratory environments. The last category includes changes in noise levels of less than 1 dB, which are inaudible to the human ear. Only audible changes in existing ambient or background noise levels are considered potentially significant.

Physiological Effects of Noise

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 160–165 dBA will result in dizziness or loss of equilibrium. The ambient or background noise problem is widespread and generally more concentrated in urban areas than in outlying, less developed area. Table A lists definitions of acoustical terms, and Table B shows common sound levels and their sources.

Table A: Definitions of Acoustical Terms

Term	Definition
Decibel, dB	A unit of noise level 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 de-emphasizes the very-low-frequency 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_2, L_8, L_{50}, L_{90}	The fast A-weighted noise levels that are equaled or exceeded by a fluctuating sound level 2 percent, 8 percent, 50 percent, and 90 percent of a stated time period.
Equivalent Continuous Sound 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 dB to sound levels occurring in the evening from 7:00 p.m. to 10:00 p.m. and after the addition of 10 dB to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
Day/Night Average Noise Level, L_{dn}	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 10 dB to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
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 from 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 on its amplitude, duration, frequency, time of occurrence, and tonal or informational content, as well as the prevailing ambient noise level.

Source: *Handbook of Acoustical Measurement 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 as Compared to the Reference Level
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 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	Reference Level
Average Office	60	Quiet	½ as loud
Suburban Street	55	Quiet	—
Light Traffic; Soft Radio Music in Apartment	50	Quiet	¼ as loud
Large Transformer	45	Quiet	—
Average Residence without Stereo Playing	40	Faint	⅛ 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 Associates, Inc. (2004).

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. Although the perceptibility threshold is approximately 65 vibration velocity decibels (VdB), human response to vibration is not usually substantial unless the vibration exceeds 70 VdB. A vibration level that causes annoyance is well below the damage risk threshold for typical 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 (Transit Noise and Vibration Impact Assessment Manual [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, both construction of the project and freight train operations 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 (e.g., 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 velocity 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. The vibration velocity level in decibels is defined as the following:

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

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.

REGULATORY SETTING

Federal Guidelines

Federal Transit Administration

Vibration standards included in the FTA Transit Noise and Vibration Impact Assessment Manual (FTA 2018) were used in this analysis because the City of Carlsbad does not have vibration standards. Table C provides the criteria for assessing the potential for interference or annoyance from vibration levels in a building, while Table D lists the potential vibration building damage criteria associated with construction activities.

Table C: Interpretation of Vibration Criteria for Detailed Analysis

Land Use	Maximum L_v (VdB)[1]	Description of Use
Workshop	90	Vibration that is distinctly felt. Appropriate for workshops and similar areas not as sensitive to vibration.
Office	84	Vibration that can be felt. Appropriate for offices and similar areas not as sensitive to vibration.
Residential Day	78	Vibration that is barely felt. Adequate for computer equipment and low-power optical microscopes (up to 20X).
Residential Night and Operating Rooms	72	Vibration is not felt, but ground-borne noise may be audible inside quiet rooms. Suitable for medium-power microscopes (100X) and other equipment of low sensitivity.

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018).
[1] As measured in ⅓-octave bands of frequency over the frequency range 8 to 80 Hertz.
FTA = Federal Transit Administration VdB = vibration velocity decibels
L_v = velocity in decibels

Table D: Construction Vibration Damage Criteria

Building Category	PPV (in/sec)	Approximate L_V (VdB)[1]
Reinforced concrete, steel, or timber (no plaster)	0.50	102
Engineered concrete and masonry (no plaster)	0.30	98
Non-engineered timber and masonry buildings	0.20	94
Buildings extremely susceptible to vibration damage	0.12	90

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

[1] RMS vibration velocity in decibels (VdB) re 1 µin/sec.

µin/sec = microinches per second
FTA = Federal Transit Administration
in/sec = inches per second
L_V = velocity in decibels
PPV = peak particle velocity
VdB = vibration velocity decibels
RMS = root-mean-square

Local Regulations

City of Carlsbad

General Plan Noise Element. The City's General Plan Noise Element (2015) has established noise standards from transportation and non-transportation sources and contains policies to meet the City's noise-related goals. The acceptable limits of noise for various land uses for both exterior and interior environments from transportation sources are shown in Table E. Table F show the noise standards from non-transportation noise sources, including, but not limited to, industrial facilities, automotive servicing, car washes, equipment yards, nightclubs, hotels, and shopping centers. These standards apply to the noise sources themselves, as measured at the edge of the property line; noise caused by motor vehicles traveling to and from the site is exempt from this standard. The applicable General Plan Noise Element policies for the proposed project are listed below.

Table E: City of Carlsbad Allowable Noise Exposure[1]

Land Use	Outdoor Activity Areas[2,3] (dBA CNEL)	Indoor Spaces (dBA CNEL)
Residential	60[4]	45
Motels, Hotels	65	45
Hospitals, Residential Care Facilities, Schools, Libraries, Museums, Churches, Day Care Facilities	55	45
Playgrounds, Parks, Recreation Uses	65	50
Commercial and Office Uses	65	50
Industrial Uses	70	65

Source: City of Carlsbad General Plan Noise Element, Table 5-2 (September 2015).

[1] Development proposed within the McClellan-Palomar Airport Area of Influence shall also be subject to the noise compatibility policies contained in the ALUCP.

[2] For non-residential uses, where an outdoor activity area is not proposed, the standard does not apply. Where the location of outdoor activity areas is unknown, the exterior noise level standard shall be applied to the property line of the receiving use.

[3] Where it is not possible to reduce noise in outdoor activity areas to the allowable maximum, levels up to 5 dB higher may be allowed provided that available exterior noise level reduction measures have been implemented and interior noise levels are in compliance with this table.

[4] An exterior noise exposure level of 65 dBA CNEL is allowable for residential uses in a mixed-use project and for residential uses within the McClellan-Palomar Airport Area of Influence, pursuant to the noise compatibility policies contained in the ALUCP.

ALUCP = Airport Land Use Compatibility Plan
CNEL = Community Noise Equivalent Level
dB = decibels
dBA = A-weighted decibels

Table F: Performance Standards for Non-Transportation Sources (as Measured at Property Line of Source/Sensitive Land Use)

Noise Level Descriptor	Daytime (7:00 a.m. to 10:00 p.m.)	Nighttime (10:00 p.m. to 7:00 a.m.)
Hourly L_{eq}, dB	55	45
Maximum Level, dB	75	65

Source: City of Carlsbad General Plan Noise Element, Table 5-3 (September 2015).
Note: Each of the noise levels specified above shall be lowered by 5 dB for simple-tone noises, noises consisting of speech or music, or recurring impulsive noises.
dB = decibels
L_{eq} = equivalent continuous sound level

Policy 5-P.5 **Noise Generation.** As part of development project approval, require that noise generated by a project does not exceed standards established in Table 5-3[1].

Policy 5-P.6 **Berms and Sound Walls.** Discourage the use of berms and sound walls for noise mitigation; rather, encourage the use of project design techniques such as increasing the distance between the noise source and the noise sensitive receiver and use non-noise sensitive structures (e.g., a garage) to shield noise sensitive areas. If a berm or wall is determined necessary to mitigate noise, discourage exclusive use of walls in excess of six feet in height and encourage use of natural barriers such as site topography or constructed earthen berms. When walls are determined to be the only feasible solution to noise mitigation, then the walls shall be designed to limit aesthetic impacts. When walls over six feet in height are necessary to mitigate noise, a berm/wall combination with heavy landscaping, a terraced wall heavily landscaped, or other similar innovative wall design technique shall be used to minimize visual impacts.

Municipal Code. Section 8.48.010 of the City's Municipal Code states that it shall be unlawful to operate equipment or perform any construction in the erection, demolition, alteration, or repair of any building or structure or the grading or excavation of land during the following hours:

a. After 6:00 p.m. on any day, and before 7:00 a.m., Monday through Friday, and before 8:00 a.m. on Saturday;

b. All day on Sunday; and

c. On any federal holiday

1 Table F of this document.

EXISTING SETTING

Overview of the Existing Noise Environment

The primary existing noise sources in the project area are transportation facilities. Traffic on Garfield Street, Beech Avenue, Ocean Street, and other local streets contribute to the ambient noise levels in the project vicinity. Noise from motor vehicles is generated by engines, interaction between tires and the road, and vehicle exhaust systems.

Land Uses in the Project Vicinity

Land uses surrounding the project site include:

- **Northwest:** Residential uses
- **Northeast:** Museum (Carlsbad Historical Society)
- **East:** Commercial uses
- **Southeast:** Church (Saint Michael's by the Sea Episcopal Church)
- **South:** Vacant land
- **West:** Residential uses

Existing Aircraft Noise

Oceanside Municipal Airport and McClellan-Palomar Airport are 3.9 miles north and 4.4 miles southeast of the project site, respectively. The project site is outside the 60 dBA CNEL noise impact zones for both airports based on the *Oceanside Municipal Airport Land Use Compatibility Plan* (San Diego County Airport Land Use Commission 2010) and McClellan-Palomar Airport in the McClellan-Palomar Airport Land Use Compatibility Plan (San Diego County Airport Land Use Commission 2011). Additionally, there are no private airstrips or heliports within 2 miles of the project site. Therefore, the project would not expose people residing or working in the project area to excessive aircraft-related noise levels, and this topic is not further discussed.

IMPACTS

Short-Term Construction Noise Impacts

Two types of short-term noise impacts would occur during project construction. The first type would be from construction crew commutes and the transport of construction equipment and materials to the project site and would incrementally raise noise levels on roadways leading to the project site. The pieces of construction equipment for construction activities would move on site, would remain for the duration of each construction phase, and would not add to the daily traffic volume in the project vicinity. Although there would be a relatively high single-event noise exposure potential causing intermittent noise nuisance (passing trucks at 50 ft would generate up to a maximum of 84 dBA), the effect on longer-term ambient noise levels would be small because the number of daily construction-related vehicle trips is small compared to existing daily traffic volume. Project construction would generate a maximum of 30 trips per day based on the California Emissions Estimator Model (CalEEMod) (Version 2022.1.0) results contained in Attachment B of the *Air Quality Technical Memorandum for the Three on Garfield Project* (LSA 2023). Carlsbad Boulevard, Beech Avenue, and Garfield Street would be used to access the project site and the maximum of 30 trips per day would be considered minimal compared to existing traffic volumes on the affected roadways, and the construction-related traffic noise increase would not be perceptible. Therefore, no short-term construction-related noise impacts associated with worker commutes and transport of construction equipment and material to the project site would occur, and no noise reduction measures would be required.

The second type of short-term noise impact is related to noise generated from construction activities. Construction is performed in discrete steps, each of which has its own mix of equipment and, consequently, its own noise characteristics. The proposed project anticipates demolition, site preparation, grading, building construction, paving, and architectural coating phases of construction. These various sequential phases change the character of the noise generated on a project site. Therefore, the noise levels vary 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. Table G lists the L_{max} recommended for noise impact assessments for typical construction equipment included in the *FHWA Highway Construction Noise Handbook* (2006), based on a distance of 50 ft between the equipment and a noise receptor.

Table G: Typical Construction Equipment Noise Levels

Equipment Description	Acoustical Usage Factor[1] (%)	Maximum Noise Level (L_{max}) at 50 ft[2]
Backhoe	40	80
Compactor (ground)	20	80
Compressor	40	80
Crane	16	85
Dozer	40	85
Dump Truck	40	84
Excavator	40	85
Flatbed Truck	40	84
Forklift	20	85
Front-End Loader	40	80
Grader	40	85
Impact Pile Driver	20	95
Jackhammer	20	85
Pavement Scarifier	20	85
Paver	50	85
Pickup Truck	40	55
Pneumatic Tools	50	85
Pump	50	77
Rock Drill	20	85
Roller	20	85
Scraper	40	85
Tractor	40	84
Welder	40	73

Source: Table 9.1, FHWA Highway Construction Noise Handbook (FHWA 2006).
Note: The noise levels reported in this table are rounded to the nearest whole number.
[1] Usage factor is the percentage of time during a construction noise operation that a piece of construction equipment is operating at full power.
[2] Maximum noise levels were developed based on Specification 721.560 from the CA/T program to be consistent with the City of Boston, Massachusetts, Noise Code for the "Big Dig" project.
CA/T = Central Artery/Tunnel
FHWA = Federal Highway Administration
ft – foot/feet
L_{max} = maximum instantaneous noise level

Table H lists the anticipated construction equipment for each construction phase based on the CalEEMod (Version 2022.1.0) results contained in Attachment B of the *Air Quality Technical Memorandum for the Three on Garfield Project* (LSA 2023). Table H shows the combined noise level at 50 feet (ft) from all of the equipment in each phase as well as the L_{eq} noise level for each equipment at 50 ft based on the quantity, reference instantaneous maximum (L_{max}) noise level at 50 ft, and the acoustical usage factor. As shown in Table H, project construction noise levels would reach up to 86.6 dBA L_{eq} at a distance of 50 ft.

Table H: Summary of Project Construction Phase, Equipment, and Noise Levels

Construction Phase	Construction Equipment	Quantity	Reference Noise Level at 50 ft (dBA L_{max})	Acoustical Usage Factor[1] (%)	Noise Level at 50 ft (dBA L_{eq})	Combined Noise Level at 50 ft (dBA L_{eq})
Demolition	Concrete Saws	1	90	20	83	86.1
	Dozer	1	85	40	81	
	Front-End Loader	2	80	40	79	
Site Preparation	Grader	1	85	40	81	82.2
	Front-End Loaders	1	80	40	76	
Grading	Grader	1	85	40	81	84.7
	Dozer	1	85	40	81	
	Front-End Loader	1	80	40	76	
Building Construction	Crane	1	85	16	77	84.1
	Forklift	2	85	20	81	
	Front-End Loader	2	80	40	72	
Paving	Drum Mixer	4	80	20	79	86.6
	Paver	1	85	50	82	
	Roller	1	85	20	78	
	Front-End Loader	1	85	20	78	
Architectural Coating	Air Compressor	1	80	40	76	76.0

Source: Compiled by LSA (2023).

[1] The acoustical usage factor is the percentage of time during a construction noise operation that a piece of construction equipment operates at full power.

dBA = A-weighted decibels
ft = foot/feet
L_{eq} = equivalent continuous sound level
L_{max} = maximum instantaneous noise level

The closest residential property lines immediately northwest and west of the project site are approximately 50 ft and 35 ft from the center of the project site and may be subject to short-term construction noise reaching 86.6 dBA L_{eq} and 89.7 dBA L_{eq}, respectively, generated by project construction activities. Construction noise is temporary and would stop once project construction is completed. Compliance with the City's hours of construction pursuant to Section 8.48.010 of the City's Municipal Code would ensure construction-related noise would not be generated during the more sensitive nighttime hours. Therefore, no construction noise impacts would occur, and no noise reduction measures are required.

Short-Term Construction Vibration Impacts

This construction vibration impact analysis discusses the level of human annoyance using vibration levels in RMS (VdB) and assesses the potential for building damage using vibration levels in PPV (in/sec). Vibration levels calculated in RMS velocity are best for characterizing human response to building vibration, whereas vibration levels in PPV are best for characterizing damage potential.

Table I shows the reference vibration levels at a distance of 25 ft for each type of standard construction equipment from the Transit Noise and Vibration Impact Assessment Manual (FTA 2018). Outdoor demolition and site preparation for the proposed project is expected to require the use of a small rubber-tired bulldozer and loaded trucks, which would generate ground-borne vibration of up to 58 VdB (0.003 PPV [in/sec] and 86 VdB (0.076 PPV [in/sec]) when measured at 25 ft, respectively.

Table I: Vibration Source Amplitudes for Construction Equipment

Equipment	Reference PPV/L_V at 25 ft	
	PPV (in/sec)	L_V (VdB)[1]
Pile Driver (Impact), Typical	0.644	104
Pile Driver (Sonic), Typical	0.170	93
Vibratory Roller	0.210	94
Hoe Ram	0.089	87
Large Bulldozer	0.089	87
Caisson Drilling	0.089	87
Loaded Trucks[2]	**0.076**	**86**
Jackhammer	0.035	79
Small Bulldozer[2]	**0.003**	**58**

Sources: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018), Table 7-4.

1 RMS vibration velocity in decibels (VdB) is 1 µin/sec.

2 Equipment shown in **bold** is expected to be used on site.

3 Rubber-tire bulldozer.

µin/sec = micro-inches per second
ft = foot/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 decibels

The greatest vibration levels are anticipated during the site preparation and grading phase. All other phases are expected to result in lower vibration levels. 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 impacts normally occur within the buildings. An exception to this would be the location of loaded trucks due to the small project site. Loaded trucks would be limited to on-street parking along Garfield Street and Beech Avenue and would not operate on the project site.

The formulae for vibration transmission are provided below.

$$L_v dB (D) = L_v dB (25 \text{ ft}) - 30 \text{ Log } (D/25)$$

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

Table J lists the projected vibration levels from various construction equipment expected to be used on the project site from the center of the project site to the nearest buildings in the project vicinity. As shown in Table J, the residential buildings to the northwest and west would experience an average vibration level of up to 87 VdB and 84 VdB, respectively. These vibration levels would have the potential to result in annoyance, because vibration levels would exceed the FTA community annoyance threshold of 78 VdB for daytime residences (refer to Table C). However, vibration generated from project construction activities is temporary and would stop once project construction is completed.

Also, Table J shows that the museum building would experience an average vibration level of up to 69 VdB. This vibration level would not result in annoyance, because vibration levels would not exceed the FTA community annoyance threshold of 84 VdB for uses that are not as sensitive to vibration.

Table J: Potential Construction Vibration Annoyance

Land Use	Direction	Equipment/ Activity	Reference Vibration Level (VdB) at 25 ft	Distance to Structure (ft)[1]	Vibration Level (VdB)
Residence	Northwest	Loaded trucks	86	24[1]	87
		Small bulldozers	58	52[2]	48
Museum	Northeast	Loaded trucks	86	94[1]	69
		Small bulldozers	58	148[2]	35
Residence	West	Loaded trucks	86	30[1]	84
		Small bulldozers	58	37[2]	53

Source: Compiled by LSA (2023).

Note: The FTA-recommended annoyance threshold of 84 VdB for offices (and other similar areas not as sensitive to vibration) and 78 VdB for daytime residences were used to assess potential construction vibration annoyance.

[1] Distance from the on-street parking area along Garfield Street and Beech Avenue to the building structure, because loaded trucks would be limited to the on-street parking area due to the small project site.

[2] Distance from the center of the project site to the building structure.

ft = foot/feet
VdB = vibration velocity decibels
FTA = Federal Transit Administration

Similarly, Table K lists the projected vibration levels from various construction equipment expected to be used on the project site at the project construction boundary to the nearest buildings in the project vicinity. As shown in Table K, the residential buildings to the northwest and west would experience a vibration level of up to 0.081 in/sec (PPV). This vibration level would not have the potential to result in building damage, because the residential buildings would be constructed equivalent to non-engineered timber and masonry, and vibration levels would not exceed the FTA vibration damage threshold of 0.20 in/sec (PPV).

Table K: Potential Construction Vibration Damage

Land Use	Direction	Equipment/ Activity	Reference Vibration Level at 25 ft	Distance to Structure (ft)	Vibration Level
			PPV (in/sec)		PPV (in/sec)
Residence	Northwest	Loaded trucks	0.076	24[1]	0.081
		Small bulldozers	0.003	5[2]	0.034
Museum	Northeast	Loaded trucks	0.076	94[1]	0.010
		Small bulldozers	0.003	110[2]	0.000
Residence	West	Loaded trucks	0.076	30[1]	0.058
		Small bulldozers	0.003	5[2]	0.034

Source: Compiled by LSA (2023).

Note: The FTA-recommended building damage threshold is 0.20 PPV [in/sec]) at the receiving non-engineered timber and masonry building.

[1] Distance from the on-street parking area along Garfield Street and Beech Avenue to the building structure, because loaded trucks would be limited to the on-street parking area due to the small project site.

[2] Distance from the project construction boundary to the building structure.

ft = foot/feet
FTA = Federal Transit Administration
in/sec = inches per second
PPV = peak particle velocity
VdB = vibration velocity decibels

Also, Table K shows that the museum building would experience a vibration level of up to 0.010 in/sec (PPV). This vibration level would not have the potential to result in building damage, because the museum building would be constructed equivalent to non-engineered timber and masonry and vibration levels would not exceed the FTA vibration damage threshold of 0.20 in/sec (PPV). Therefore, no construction vibration impacts during project construction would occur. No vibration reduction measures are required.

Long-Term Traffic Noise Impacts

The proposed project would replace the existing three residential units and would not generate any additional project trips. No project-related traffic noise increases would result. Therefore, no traffic noise impacts from project-related traffic on off-site sensitive receptors would occur. No noise reduction measures are required.

Long-Term Stationary Noise Impacts

The proposed project would have the same number of HVAC units as the existing development and noise generated from the new HVAC units would be similar to the existing HVAC units. As a result, the new HVAC units would not result in a perceptible noise increase. Therefore, no noise impacts from project operations would occur, and no noise reduction measures are required.

Long-Term Vibration Impacts

The proposed project would not generate vibration. In addition, vibration levels generated from project-related traffic on Garfield Street, Beech Avenue, and Carlsbad Boulevard would be the same as the existing condition because the project would not generate any additional project trips. Also, vibration levels generated from traffic are unusual for on-road vehicles because the rubber tires and suspension systems of on-road vehicles provide vibration isolation. Therefore, no vibration impacts from project-related operations would occur, and no vibration reduction measures are required.

REGULATORY COMPLIANCE MEASURE

The following measure would minimize construction noise.

- The construction contractor shall limit construction activities to between the hours of 7:00 a.m. and 6:00 p.m. from Monday through Friday and between the hours of 8:00 a.m. and 6:00 p.m. on Saturday pursuant to Section 8.48.010 of the City's Municipal Code (City of Carlsbad 2023). Construction is prohibited outside these hours and any time on Sunday and federal holidays.

REDUCTION MEASURES

Short-Term Construction Noise Impacts

No noise reduction measures are required.

Short-Term Construction Vibration Impacts

No vibration reduction measures are required.

Aircraft Noise Impacts

No noise reduction measures are required.

Long-Term Traffic Noise Impacts

No noise reduction measures are required.

Long-Term Stationary Noise Impacts

No noise reduction measures are required.

Long-Term Vibration Impacts

No vibration reduction measures are required.

Attachments: A: References
B: Figures

ATTACHMENT A

REFERENCES

City of Carlsbad. 2015. *General Plan, Noise Element*. September 22. Website: https://www.carlsbadca.gov/home/showpublisheddocument/3426/637434861102600000 (accessed April 2023).

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ATTACHMENT B

FIGURES

LEGEND

Project Location

0 1000 2000

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FIGURE 1

3 on Garfield Project

Project Location and Vicinity

SOURCE: USGS 7.5' Quad - *San Luis Rey* (1975), *Oceanside* (1975), CA

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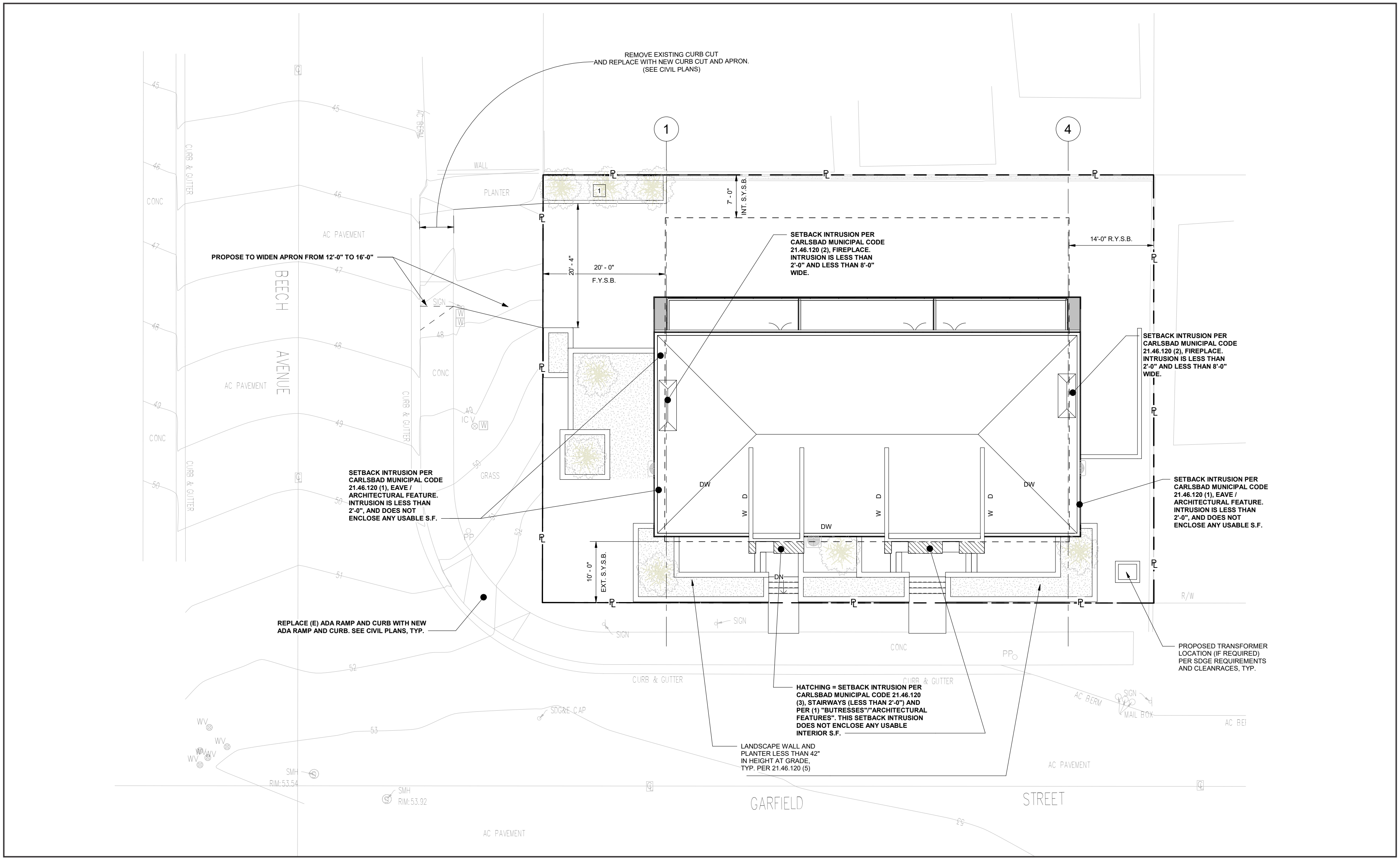

LSA

FIGURE 2

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SOURCE: BGI Architecture

3 on Garfield Project
Site Plan

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