Noise Impact Analysis

For
Columbia Heights Project

Located in
Riverside County, California

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I. Executive Summary

A. Construction Noise

Existing sensitive receptors that may be affected by construction noise include single-family residential land uses located north, south and west of the project site and a memory care center located north of the project site. The FTA construction noise threshold would be exceeded during the grading phase, the building phase, and the paving phase. This impact is potentially significant. Implementation of the following mitigation measures presented below would reduce construction noise impacts to less than significant. Best management practices listed below the mitigation measures are not required to achieve noise levels below the standard. They are provided to further minimize construction noise impacts if desired.

Mitigation Measure 1

Equip all large bulldozers, tractors, loaders and backhoes, pavers and paving equipment with mufflers that provide at least 10 dB in noise emission reduction or otherwise show that they do not exceed their noise emission reference levels shown in Table 8 minus 10 dB. For example, the contractor would need to show that bulldozers onsite do not exceed a sound level of 72 dB Lmax at a distance of 50 feet. This can be done by submitting sound specifications from the manufacturer or by field measurement.

Mitigation Measure 2

Limit construction hours of operation to between the hours of 6:00 AM and 6:00 PM during the months of June through September, and 7:00 AM and 6:00 PM during the months of October through May."

Recommended Best Management Practices

The following Best Management Practices (BMPs) can be implemented to further reduce noise at sensitive receptors.

1. Equip all construction equipment, fixed or mobile, with properly operating and maintained mufflers, consistent with manufacturer standards.

2. Place all stationary construction equipment so that emitted noise is directed away from the noise sensitive receptors nearest the project site.

3. As applicable, shut off all equipment when not in use.

4. Locate equipment staging in areas that create the greatest distance between construction-related noise/vibration sources and sensitive receptors.

5. Block and/or direct portable stationary noise sources away from sensitive receptors. Either one-inch plywood or sound blankets can be utilized for this purpose. They should reach up from the ground

and block the line of sight between the equipment and the sensitive receptor. The shielding should be without holes and cracks.

6. Prohibit amplified music and/or voice on the project site.

7. Limit haul truck deliveries to the same hours outlined previously in Mitigation Measure #2 per County Code Section 9.52.020.

8. Identify a liaison for surrounding residents and property owners to contact with concerns regarding construction noise and vibration. The liaison's telephone number(s) shall be prominently displayed at the project site where visible from the street.

9. Notify in writing all landowners and occupants of properties adjacent to the construction area of the anticipated construction schedule at least two weeks prior to groundbreaking.

B. Project Operation (On-Site)

Project operational noise is expected to range between 34 and 39 dBA L_{eq} at the nearby sensitive receivers and will not exceed the County's daytime stationary noise standard of 65 dBA L_{eq} (10-minute) or the nighttime standard of 45 dBA-10-minute L_{eq} as provided in Policy N 2.3 of the County of Riverside General Plan Noise Element. Project operation would not result in substantial increases in ambient noise levels. No mitigation is required.

C. Project Operation (Offsite)

Project generated vehicle traffic would result in a less than 1 dB increase in ambient noise levels and therefore, would not result in a substantial increase in ambient noise levels per the Federal Interagency Committee on Noise (FICON) standards. No mitigation is required.

D. Airport Noise

The closest airport to the project site is the Riverside Municipal Airport which is located approximately 4.8 miles north of the project site. The project site is not located within an airport land use compatibility plan area or within a 65 dBA CNEL airport noise contour. The proposed project is not located within a land use compatibility plan or a 65 dBA CNEL airport noise contour. Therefore, the project would not expose people residing or working in the area to excessive noise levels. No mitigation is required.

E. Groundborne Vibration Impacts

Based on the provided site plan and aerial photographs, the nearest off-site structures are within ten feet of the property line of the project site. PPV levels associated use of a large bulldozer could reach up to 0.035 inches per second (in./sec.) at these structures; and a vibratory roller could result in a PPV of 0.29 in./sec. at these structures. Both pieces of equipment could exceed the 0.2 PPV in./sec. damage threshold. Implementation of the following mitigation measures will reduce potential impacts to less than significant.

Mitigation Measure 3

In order to avoid exceeding the threshold for potential groundborne vibration damage during construction, the use of large bulldozers within 15 feet of existing off-site structures will be prohibited.

Mitigation Measure 4

In order to avoid exceeding the threshold for potential groundborne vibration damage during construction, the use of vibratory rollers within 25 feet of existing off-site structures will be prohibited.

II. Introduction and Setting

A. Purpose and Objectives

The purpose of this report is to provide an assessment of the noise and vibration impacts that may occur with the development of the proposed West Coast Storage Project and to identify mitigation measures that may be necessary to reduce those impacts. The objectives of the study include:

- documentation of existing noise conditions
- discussion of noise modeling methodology and procedures
- analysis of noise and vibration generated by the construction of the project
- analysis and discussion of potential traffic noise impacts from the proposed project
- analysis and discussion of noise impacts associated with on-site operation
- recommendations for mitigation measures

B. Project Location

The proposed project is located at 25914 Columbia Street in the Hemet area of Riverside County. Figure 1 and Figure 2 provide a regional and local context of the project location, respectively.

C. Proposed Project

The proposed project is to construct 36 new apartment units on 2.27 acres. The project would include 82 parking spaces, and roughly 0.8 acres of landscape area. The proposed site plan is shown in Figure 3.

Figure 1

Regional Location



Figure 2

Site Vicinity



Figure 3

Site Plan



III. Noise and Vibration Fundamentals

A. Basics of Sound and Noise

Sound can be described as the mechanical energy of a vibrating object transmitted by pressure waves through a liquid or gaseous medium (e.g., air) to a hearing organ, such as a human ear. Noise is defined as loud, unexpected, or annoying sound. Typical noise levels are shown in Table 1.

In the science of acoustics, the fundamental model consists of a sound (or noise) source, a receiver, and the propagation path between the two. The loudness of the noise source and the obstructions or atmospheric factors affecting the propagation path to the receiver determines the sound level and characteristics of the noise perceived by the receiver.

Table 1. Typical Noise Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	110	Rock Band
Jet fly-over at 1,000 feet		
	100	
Gas lawn mower at 3 feet		
	90	
Diesel truck at 50 feet at 50 mph*		Food blender at 3 feet
	80	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower at 100 feet	70	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	60	
		Large business office
Quiet urban daytime	50	Dishwasher in next room
Quiet urban nighttime	40	Theater, large conference room (background)
Quiet suburban nighttime		
	30	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	20	
		Broadcast/recording studio
	10	
	0	

Source: California Department of Transportation, 2013.

Since the range of intensities that the human ear can detect is so large, the scale frequently used to measure intensity is a scale based on multiples of 10, the logarithmic scale. The scale for measuring intensity is the decibel scale. Each interval of 10 decibels indicates a sound energy ten times greater than before, which is perceived by the human ear as being roughly twice as loud (EPA 1974). The most common sounds vary between 40 dBA (very quiet) to 100 dBA (very loud). Normal conversation at three feet is roughly at 60-65 dBA, while loud jet engine noises equate to 110 dBA at approximately 1,000 feet, which can cause serious discomfort (FTA 2011).

Loudness and Frequency

The amplitude of pressure waves generated by a sound source determines the loudness of that source. Sound pressure amplitude is measured in micro-Pascals (mPa), with one mPa representing approximately one hundred billionth of normal atmospheric pressure. Sound pressure amplitudes for different kinds of noise environments can range from less than 100 to 100,000,000 mPa. Because of this huge range of values, sound is rarely expressed in terms of mPa. Instead, a logarithmic scale is used to describe sound pressure level (SPL) in terms of decibels (dB). The threshold of audible sound is about 0 dB for a healthy human ear, which corresponds to 20 mPa.

The decibel scale alone does not adequately characterize how humans perceive noise, as the dominant frequencies of a sound have a substantial effect on the human response to that sound. Although the intensity (energy per unit area) of the sound is a purely physical quantity, the loudness or human response is determined by the characteristics of the human ear. Human hearing is limited in the range of audible frequencies, as well as in the way it perceives the SPL within that range. In general, people are most sensitive to the frequency range of 1,000 to 8,000 Hz and perceive sounds within that range better than sounds of the same amplitude in higher or lower frequencies. To approximate the response of the human ear, sound levels of individual frequency bands are weighted, depending on the human sensitivity to those frequencies. An “A-weighted” sound level (expressed in units of dBA) can then be calculated from this information. Noise levels are typically reported in terms of A-weighted decibels or dBA.

Sound Propagation

When sound propagates over a distance, it changes in level and frequency content. Sound from a localized source (i.e., a point source) propagates uniformly outward in a spherical pattern. The sound level attenuates (or decreases) at a rate of six dB for each doubling of distance from a point source. Sound levels from a line source (i.e., vehicle traffic) attenuate at a rate of three dB for each doubling of distance.

The propagation path of noise of common noise sources is usually very close to the ground. Noise attenuation from ground absorption adds to the attenuation associated with geometric spreading. Traditionally, the excess attenuation has also been expressed in terms of attenuation per doubling of distance. This approximation is usually sufficiently accurate for distances of less than 200 feet. For acoustically hard sites (i.e., sites with a reflective surface between the source and the receiver, such as a parking lot or body of water), no excess ground attenuation is assumed. For acoustically absorptive or soft sites (i.e., those sites with an absorptive ground surface between the source and the receiver such as soft dirt, grass, or scattered bushes and trees), an excess ground attenuation value of 1.5 dB per doubling of distance is normally assumed. When added to the cylindrical

spreading, the excess ground attenuation results in an overall drop-off rate of 4.5 dB per doubling of distance from a line source (FHWA 2001).

Receivers located downwind from a source can be exposed to increased noise levels relative to calm conditions, whereas locations upwind can have lowered noise levels. Sound levels can be increased at large distances (e.g., more than 500 feet) due to atmospheric temperature inversion (i.e., increasing temperature with elevation). Other factors such as air temperature, humidity, and turbulence can also have significant effects (EPA 1974).

Noise Barriers

A large object or barrier in the path between a noise source and a receiver can substantially attenuate noise levels at the receiver. However, the amount of attenuation provided by shielding depends on the size and density of the object and the frequency content of the noise source. Natural terrain features (e.g., hills and dense/deep woods) and human-made features (e.g., buildings and walls) can substantially reduce noise levels. Walls are often constructed between a source and a receiver specifically to reduce noise. A barrier that breaks the line of sight between a source and a receiver will typically result in at least five dB of noise reduction, with taller barriers providing increased noise reduction. Shielding by trees and other such vegetation typically only has an "out of sight, out of mind" effect. That is, only the perception of noise impact tends to decrease when vegetation blocks the line-of-sight to nearby residents and unless it is very thick and dense (vegetation more than 100 feet deep may provide a 5 dB reduction), it is unlikely to provide any measurable decrease in noise levels. The Federal Highway Administration (FHWA) does not consider the planting of vegetation to be a noise abatement measure (FHWA 2000).

B. Noise Descriptors

Another important aspect of noise is the duration of the sound and the way it is described and distributed in time. Noise in the daily human environment fluctuates over time; these changes can be minor or substantial, depending on individual factors. Specifically, noise fluctuations can be influenced by conditions such as: (1) whether noise levels occur in regular or random patterns; (2) if noise level fluctuations are rapid or slow; and (3) if noise levels vary widely or are relatively constant. Various noise descriptors have been developed to describe time-varying noise levels, with the following noise descriptors most commonly used in transportation noise analysis.

Equivalent Sound Level (L_{eq})

L_{eq} represents an average of the sound energy occurring over a specified period. In effect, L_{eq} is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The one-hour A-weighted equivalent sound level ($L_{eq}[h]$), for example, is the energy average of A-weighted sound levels occurring during a one-hour period. One hour is the normal (default) assumed time period for L_{eq} unless stated otherwise.

Percentile-Exceeded Sound Level (L_n)

Ln represents the sound level exceeded for a given percentage of a specified period. For example, L_{10} is the sound level exceeded 10 percent of the time, and L_{90} is the sound level exceeded 90 percent of the time.

Maximum Sound Level (L_{max})

L_{max} is the maximum sound level measured during a specified time period with "slow/1-second" time-averaging.

Day-Night Level (Ldn)

Ldn is the energy average of A-weighted sound levels occurring over a 24-hour period, with a 10-dB penalty applied to A-weighted sound levels occurring during nighttime hours between 10:00 PM and 7:00 AM

Community Noise Equivalent Level (CNEL)

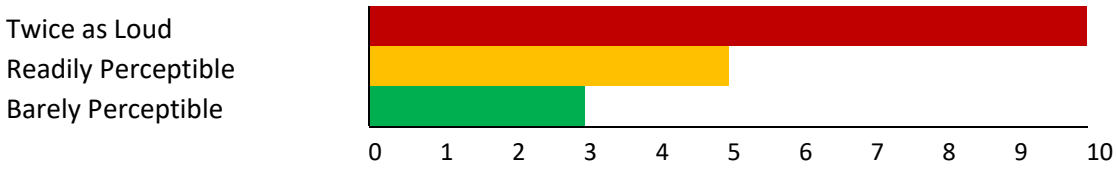
Similar to Ldn, CNEL is the energy average of the A-weighted sound levels occurring over a 24-hour period, with a 10-dB penalty applied to A-weighted sound levels occurring during the nighttime hours between 10:00 PM and 7:00 AM, and a 5-dB penalty applied to the A-weighted sound levels occurring during evening hours between 7:00 PM and 10:00 PM.

C. Human Perception of Noise

Since the range of intensities that the human ear can detect is so large, the scale frequently used to measure intensity is a scale based on multiples of 10, the logarithmic scale. The scale for measuring intensity is the decibel scale. Each interval of 10 decibels indicates a sound energy ten times greater than before, which is perceived by the human ear as being roughly twice as loud. (EPA 1974) The most common sounds vary between 40 dBA (very quiet) and 100 dBA (very loud). Normal conversation at a distance of three feet is roughly at 60 dBA, while loud jet engine noises equate to 110 dBA.

According to research originally published in the Noise Effects Handbook (FTA 2018), the percentage of persons who are highly annoyed by noise levels is approximately 0 percent at less than 45 dBA, 10 percent around 60 dBA, and increases rapidly to approximately 70 percent at greater than 85 dBA. Despite this variability in behavior on an individual level, the population can be expected to exhibit the following responses to changes in noise levels as shown in Table 2.

Table 2. Noise Level Increase Perception



Source: California Department of Transportation, 2013.

D. Noise Control

Noise control is the process of obtaining an acceptable noise environment for an observation point or receiver by controlling the noise source, transmission path, and/or receiver. This concept is known as the source-path-receiver concept. In general, noise control measures can be applied to these three elements. Source control could involve the use of quieter equipment, lower traffic volumes, or relocation of the source. Transmission path control involves the placement of a solid barrier, earthen berm, or other solid structure between the noise source and the noise receiver in a manner that blocks the direct line of sight between the two. Effective noise barriers can reduce noise levels by 10 to 15 dBA, cutting the loudness of the noise source in half. A noise barrier is most effective when placed close to the noise source or receiver. Noise barriers do have limitations, however. For a noise barrier to be effective, it must block the path of sound from the noise source, also called "line-of-sight". Installation of architectural upgrades to reduce the amount of exterior noise that is transmitted to interior spaces is also an effective measure to control interior noise levels.

E. Vibration Fundamentals

The way in which vibration is transmitted through the earth is called propagation. Propagation of earthborn vibration is complicated and difficult to predict because of the endless variations in the soil through which the waves travel. There are three main types of vibration propagation: surface, compression, and shear waves. Surface or "Raleigh" waves travel along the ground's surface. These waves carry most of their energy along an expanding circular wave front, similar to ripples produced by throwing a rock into a pool of water. Compression waves, or "P-waves", are body waves that carry their energy along an expanding spherical wave front. The particle motion in these waves is longitudinal (i.e., in a "push-pull" fashion). P-waves are analogous to airborne sound waves. Shear waves, or "S-waves", are also body waves that carry energy along an expanding spherical wave front. However, unlike P-waves, the particle motion is transverse, or side-to-side and perpendicular to the direction of propagation.

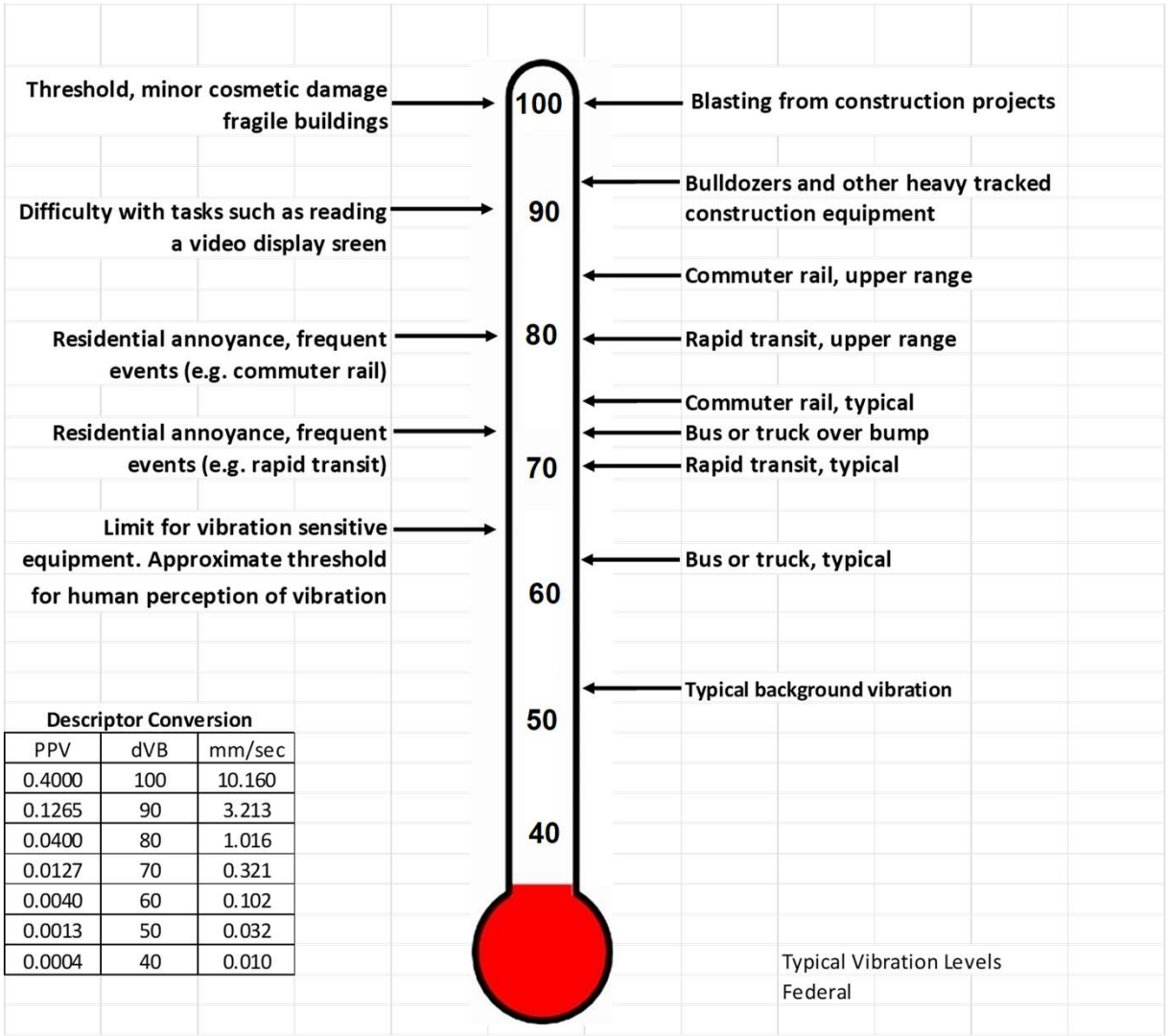
As vibration waves propagate from a source, the energy is spread over an ever-increasing area such that the energy level striking a given point is reduced with the distance from the energy source. This geometric spreading loss is inversely proportional to the square of the distance. Wave energy is also reduced with distance as a result of material damping in the form of internal friction, soil layering, and void spaces. The amount of attenuation provided by material damping varies with soil type and condition as well as the frequency of the wave. Vibration amplitudes are usually expressed with either their peak particle velocity (PPV) or root mean square (RMS) velocity. The PPV is defined as the maximum instantaneous peak of the vibration signal in inches per second. The RMS of a signal is the average of the squared amplitude of the signal in vibration decibels (VdB), with a reference of one micro-inch per second. The Federal Railroad Administration (FRA) uses the abbreviation "VdB" for vibration decibels to reduce the potential for confusion with sound decibel.

Sensitive receivers for vibration include structures (especially older masonry structures), people (especially residents, the elderly, and sick), and vibration-sensitive equipment and/or activities.

Typical Levels of Ground-Borne Vibration are provided in Figure 4.

Figure 4

Typical Levels of Groundborne Vibration



Descriptor Conversion

PPV	dVB	mm/sec
0.4000	100	10.160
0.1265	90	3.213
0.0400	80	1.016
0.0127	70	0.321
0.0040	60	0.102
0.0013	50	0.032
0.0004	40	0.010

Source: Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment Manual.

IV. Existing Noise Environment

A. Existing Land Uses and Sensitive Receptors

The State of California defines sensitive receptors as those land uses that require serenity or are otherwise adversely affected by noise events or conditions. Schools, libraries, churches, hospitals, and single and multiple family residential, including transient lodging, motels, and hotel uses, make up the majority of these areas.

Existing sensitive receptors that may be affected by project noise include residences located north, south and west of the project site, and the Desert Hills Memory Care Center is located north of the project. Land east of the project site is currently vacant.

B. Ambient Noise Measurements

Existing noise measurements were conducted by Greve & Associates, LLC on March 22, 2022 (see Appendix A). Prior to taking the noise measurements, a visual survey of the project site and the surrounding area was conducted to determine the location of a set of noise measurements that would provide a noise profile of the area in the vicinity of the project site. Several criteria were used in the site selection process including, but not limited to, the proximity of a measurement site to sensitive land uses as well as its proximity to significant noise generators. Three sites were selected for noise measurements. Noise Measurement Locations are shown in Figure 5.

All noise measurements were performed using a Rion NL-52 Type 1 Sound Level Meter. During the measurements a large windscreen (i.e., Rion WL-10) covered the sound meter's microphone to dampen-out any unwanted wind-generated noise. Both before and after the set of measurements were taken, a Rion NC-74 Class 1 Sound Calibrator was used to check the calibration of the sound meter to ensure that the measured sound levels readings were accurate. Both pieces of equipment have current certification that is traceable to the National Institute of Standards and Technology (NIST). The monitoring system is Type 1, which is the highest rating available for environmental noise measurements. In other words, this system provides the most accurate level of measurements. For each site, two 15-minute measurements were made to ensure that the noise levels measured were consistent. At the conclusion of each set of measurements, the Leq, Lmin, Lmax, L1.7, L8, L25, and L50 values for the full-time period were written down on a data sheet. Prevailing weather conditions were noted along with any other factors that might affect the noise measurements.

As shown in Table 3, measured short-term (15-minute) noise levels in the project vicinity ranged between 63.5 and 76.6 dBA $L_{eq.}$ Noise measurement field sheets and data are provided in Appendix A. Measured noise levels at all sites were typical of an urban area. The noise levels were dominated by traffic on the adjacent streets. Significant noise from other sources, for example aircraft, were not present. The loudest noise level of 102.4 dBA at Site 1 was due to an extremely loud motorcycle. In fact, the loudest noise levels at all sites were due to some type of motor vehicle.

Table 3. Short-Term Noise Measurement Summary

Site Location	Time Started	L_{eq}	L_{max}	L(1.7)	L(8)	L(25)	L(50)	Lmin
1	12:15 PM	76.6	102.4	78.7	71.4	61.9	52.8	40.6
1	12:32 PM	63.5	83.5	74.2	67.9	56.1	48.9	39.8
2	1:34 PM	70.7	87.8	79.0	75.0	70.0	64.4	43.7
2	1:50 PM	69.9	83.9	78.9	74.4	70.9	63.8	42.4
3	12:58 PM	64.2	78.7	74.4	70.1	61.9	53.9	37.7
3	1:14 P.M.	65.7	78.7	75.2	71.4	64.9	56.7	38.7

Figure 5

Noise Measurement Locations



Source: Greve & Associates, LLC on March 22, 2022
(See Appendix A)

V. Regulatory Setting

A. Federal Regulation

Federal Noise Control Act of 1972

The U.S. Environmental Protection Agency (EPA) Office of Noise Abatement and Control was originally established to coordinate federal noise control activities. After its inception, EPA's Office of Noise Abatement and Control issued the Federal Noise Control Act of 1972, establishing programs and guidelines to identify and address the effects of noise on public health, welfare, and the environment. In response, the EPA published Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety (Levels of Environmental Noise). The Levels of Environmental Noise recommended that the Ldn should not exceed 55 dBA outdoors or 45 dBA indoors to prevent significant activity interference and annoyance in noise-sensitive areas.

In 1981, EPA administrators determined that subjective issues such as noise would be better addressed at lower levels of government. Consequently, in 1982 responsibilities for regulating noise control policies were transferred to State and local governments. However, noise control guidelines and regulations contained in EPA rulings in prior years remain in place by designated Federal agencies, allowing more individualized control for specific issues by designated Federal, State, and local government agencies.

Federal Interagency Committee on Noise

The Federal Interagency Committee on Noise (FICON) developed guidance (1992) to be used for the assessment of project-generated increases in noise levels that consider the ambient noise level. The FICON recommendations are based on studies that relate aircraft noise levels to the percentage of persons highly annoyed by aircraft noise. Although the FICON recommendations were specifically developed to assess aircraft noise impacts, these recommendations are often used in environmental noise impact assessments involving the use of cumulative noise exposure metrics, such as the average-daily noise level (CNEL) and equivalent continuous noise level (L_{eq}).

As previously stated, the approach used in this noise study recognizes that there is no single noise increase that renders a noise impact significant, based on a 2008 California Court of Appeal ruling on Gray v. County of Madera (2008). If the existing ambient noise environment is below 60 dBA, a 5 dBA or greater project-related noise level increase is considered to be a substantial increase in ambient noise levels. If the existing ambient noise environment consists of noise levels that range between 60 and 65 dBA, a 3 dBA, or a noise level increase would result in a substantial increase in noise levels; and if existing ambient noise levels exceed 65 dBA, an increase of 1.5 dBA or greater would result in a substantial increase in noise levels.

Federal Transit Administration

Construction Noise

According to the Federal Transit Administration (FTA), local noise ordinances are typically not very useful in evaluating construction noise. They often define nuisances and hours of allowed activity and sometimes specify limits in terms of maximum levels but are generally not practical for assessing the impact of a construction project. Project construction noise criteria should account for the existing noise

environment, the absolute noise levels produced during construction activities, the duration of the construction, and the adjacent land uses. Due to the lack of standardized construction noise thresholds, the FTA provides guidelines that can be considered reasonable criteria for construction noise assessment (Table 4).

Table 4. FTA Construction Noise Criteria

Land Use	$L_{eq,(8\ hr)}$, dBA	
	Day	Night
Residential	80	70
Commercial	85	85
Industrial	90	90

Source: Federal Transit Administration (FTA), 2018.

Groundborne Vibration

The Federal Transit Administration (FTA) provides reasonable criteria for addressing potential impacts related to groundborne vibration. As shown in Table 5, the peak particle velocity (PPV) threshold for risk of "architectural" damage is 0.5 in/sec for reinforced-concrete, steel or timber (no plaster) buildings, 0.3 in/sec for engineered concrete and masonry (no plaster) buildings, 0.2 in/sec for non-engineered timber and masonry buildings, and 0.1 in/sec for buildings extremely susceptible to vibration damage.

Table 5. FTA Construction Vibration Damage Criteria

Building/Structural Category	PPV, in/sec
I. Reinforced-concrete, steel or timber (no plaster)	0.5
II. Engineered concrete and masonry (no plaster)	0.3
III. Non-engineered timber and masonry buildings	0.2
IV. Buildings extremely susceptible to vibration damage	0.1

Source: Federal Transit Administration (FTA), 2018.

B. State Regulations

State of California General Plan Guidelines 2017

Though not adopted by law, the State of California General Plan Guidelines 2017, published by the California Governor's Office of Planning and Research (OPR) (OPR Guidelines), provides guidance for the compatibility of projects within areas of specific noise exposure. The OPR Guidelines identify the suitability of various types of construction relative to a range of outdoor noise levels and provide each local community some flexibility in setting local noise standards that allow for the variability in community preferences. Findings presented in the Levels of Environmental Noise Document (EPA 1974) influenced the recommendations of the OPR Guidelines, most importantly in the choice of noise exposure metrics (i.e., Ldn or CNEL) and in the upper limits for the normally acceptable outdoor exposure of noise-sensitive uses.

The OPR Guidelines include a Noise and Land Use Compatibility Matrix which identifies acceptable and unacceptable community noise exposure limits for various land use categories. Where the "normally acceptable" range is used, it is defined as the highest noise level that should be considered for the construction of buildings which do not incorporate any special acoustical treatment or noise mitigation. The "conditionally acceptable" or "normally unacceptable" ranges include conditions calling for detailed acoustical study prior to the construction or operation of the proposed project. The County of Riverside has adopted these guidelines in their General Plan.

C. County of Riverside General Plan

Land Use Compatibility

The Land Use Compatibility for Community Noise Exposure Matrix is shown in Table 6. The proposed commercial use of the project is considered normally acceptable with unmitigated exterior noise levels of less than 70 dBA CNEL. Residential designated land uses in the project study area are considered normally acceptable with exterior noise levels below 60 dBA CNEL and conditionally acceptable with exterior noise levels of up to 70 dBA CNEL. When future noise levels are expected to fall into the conditionally acceptable category, new construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is completed and the needed noise insulation features are included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning, will normally suffice.

Applicable portions of County of Riverside General Plan Policies N 1.1 through 1.8 aim to protect noise-sensitive land uses from excessive noise levels by either restricting noise-producing activities or implementing noise buffers like setbacks or landscaping. These policies also encourage directing noise-tolerant land uses to areas already impacted by noise, such as transportation corridors or near airport noise contours. Specific guidelines are provided to classify noise-sensitive land uses, discourage certain uses in high noise areas, assess noise compatibility of existing land uses with new projects through site surveys, and mitigate noise impacts on residents, employees, and noise-sensitive facilities. Moreover, the policies stress the importance of minimizing noise spillover from commercial and industrial areas into residential neighborhoods, as well as limiting noise levels impacting adjacent land uses within property lines, barring exceptions for noise emissions from wind turbines.

N 1.1: Protect noise-sensitive land uses from high levels of noise by restricting noise-producing land uses from these areas. If the noise-producing land use cannot be relocated, then noise buffers such as setbacks, landscaping, or block walls shall be used.

N 1.2 Guide noise-tolerant land uses into areas irrevocably committed to land uses that are noise-producing, such as transportation corridors or within the projected noise contours of any adjacent airports.

N 1.3 Consider the following uses noise-sensitive and discourage these uses in areas in excess of 65 CNEL: Schools, Hospitals, Rest Homes, Long Term Care Facilities, Mental Care Facilities, Residential Uses, Libraries, Passive Recreation Uses, and Places of Worship.

N 1.4 Determine if existing land uses will present noise compatibility issues with proposed projects by undertaking site surveys.

N 1.5: Prevent and mitigate the adverse impacts of excessive noise exposure on the residents, employees, visitors, and noise-sensitive uses of Riverside County.

N 1.6 Minimize noise spillover or encroachment from commercial and industrial land uses into adjoining residential neighborhoods or noise-sensitive uses.

N 1.8 Limit the maximum permitted noise levels that cross property lines and impact adjacent land uses, except when dealing with noise emissions from wind turbines. Please see the Wind Energy Conversion Systems section for more information.

Noise Mitigation Strategies

N 2.2 Require a qualified acoustical specialist to prepare acoustical studies for proposed noise-sensitive projects within noise impacted areas to mitigate existing noise.

N 2.3 Mitigate exterior and interior noises to the levels listed in Table 7 below to the extent feasible, for stationary noise sources.

Table 7. Stationary Source Land Use Noise Standards

Land Use	**Interior Standards**	**Exterior Standards**
Residential	dBA Leq (10-minute)	
10:00 PM to 7:00 AM	40	45
7:00 AM to 10:00 PM	55	65
Note: These are only preferred standards; final decision will be made by the Riverside County Planning Department and Office of Public Health.		

Noise Producers

N 3.2 Require acoustical studies and subsequent approval by the Planning Department and the Office of Industrial Hygiene, to help determine effective noise mitigation strategies in noise-producing areas.

Community Noise Inventory

N 4.1 Prohibit facility-related noise received by any sensitive use from exceeding the following worst case noise levels:

- 45 dBA-10-minute Leq between 10:00 PM and 7:00 AM
- 65 dBA-10-minute Leq between 7:00 AM and 10:00 PM

Airports

N 7.1 New land use development within Airport Influence Areas shall comply with airport land use noise compatibility criteria contained in the corresponding airport land use compatibility plan for the area. Each Area Plan affected by a public-use airport includes one or more Airport Influence Areas, one for each airport. The applicable noise compatibility criteria are fully set forth in Appendix I-1and summarized in the Policy Area section of the affected Area Plan.

N 7.2 Adhere to applicable noise compatibility criteria when making decisions regarding land uses adjacent to airports. Refer to the Airports section of the Land Use Element (Page LU-32) and the Airport Influence Area sections of the corresponding Area Plans.

N 7.3 Prohibit new residential land uses, except construction of a single-family dwelling on a legal residential lot of record, within the current 60 dB CNEL contours of any currently operating public-use, or military airports. The applicable noise contours are as defined by the Riverside County Airport Land Use Commission and depicted in Appendix I-1, as well as in the applicable Area Plan's Airport Influence Area section.

N 7.4 Check each development proposal to determine if it is located within an airport noise impact area as depicted in the applicable Area Plan's Policy Area section regarding Airport Influence Areas. Development proposals within a noise impact area shall comply with applicable airport land use noise compatibility criteria.

Building and Design Techniques

N 12.1 Utilize natural barriers such as hills, berms, boulders, and dense vegetation to assist in noise reduction.

N 12.2 Utilize dense landscaping to effectively reduce noise. However, when there is a long initial period where the immaturity of new landscaping makes this approach only marginally effective, utilize a large number of highly dense species planted in a fairly mature state, at close intervals, in conjunction with earthen berms, setbacks, or block walls.

Temporary Construction

N 13.1 Minimize the impacts of construction noise on adjacent uses within acceptable practices.

N 13.2 Ensure that construction activities are regulated to establish hours of operation in order to prevent and/or mitigate the generation of excessive or adverse noise impacts on surrounding areas.

N 13.3 Condition subdivision approval adjacent to developed/occupied noise-sensitive land uses by requiring the developer to submit a construction-related noise mitigation plan to the County for review and approval prior to issuance of a grading permit. The plan must depict

the location of construction equipment and how the noise from this equipment will be mitigated during construction of this project, through the use of such methods as:

a. Temporary noise attenuation fences;
b. Preferential location of equipment; and
c. Use of current noise suppression technology and equipment.

N 13.4 Require that all construction equipment utilizes noise reduction features (e.g. mufflers and engine shrouds) that are no less effective than those originally installed by the manufacturer.

Building and Design Techniques

N 14.1 Enforce the California Building Standards that sets standards for building construction to mitigate interior noise levels to the tolerable 45 CNEL limit. These standards are utilized in conjunction with the Uniform Building Code by the County's Building Department to ensure that noise protection is provided to the public. Some design features may include extra-dense insulation, double-paned windows, and dense construction materials.

N 14.2 Continue to develop effective strategies and mitigation measures for the abatement of noise hazards reflecting effective site design approaches and state-of-the-art building technologies.

N 14.3 Incorporate acoustic site planning into the design of new development, particularly large scale, mixed-use, or master planned development, through measures which may include:

• Separation of noise-sensitive buildings from noise generating sources.
• Use of natural topography and intervening structure to shield noise-sensitive land uses.
• Adequate sound proofing within the receiving structure.

Non-habitable areas within a home include: kitchens, bathrooms, hallways, garages, closets, utility rooms, and laundry rooms

N 14.4 Consider and, when necessary, to lower noise to acceptable limits, require noise barriers and landscaped berms.

N 14.6 Prevent the transmission of excessive and unacceptable noise levels between individual tenants and businesses in commercial structures and between individual dwelling units in multi-family residential structures.

N 14.9 Mitigate 600 square feet of exterior space to 65 dB CNEL when new development is proposed on residential parcels of 1 acre or greater.

D. County of Riverside Development Code

General Sound Level Standards are provided in Section 9.52.040 of the Riverside County Code. However, Section 9.52.010, of County Code clarifies that they are not to be used for analysis associated with the California Environmental Quality Act. Section 9.52.020 of code also exempts the following from compliance with the noise standards presented in section 9.52.040.

- Private construction activity that is located within one-quarter of a mile from an inhabited dwelling is exempt from the noise standards provided in Section 9.52.040 of the County code, between the hours of 6:00 AM and 6:00 PM during the months of June through September, and 7:00 AM and 6:00 PM during the months of October through May. An application for a construction-related exception can be made to and considered by the director of building and safety.

- Property maintenance, including, but not limited to, the operation of lawnmowers, leaf blowers, etc., provided such maintenance occurs between the hours of seven a.m. and eight p.m.; Heating and air conditioning equipment; and

- Safety, warning and alarm devices, including, but not limited to, house and car alarms, and other warning devices that are designed to protect the public health, safety, and welfare;

VI. Methodology

This section discusses the analysis methodologies used to assess noise impacts.

A. Construction Noise Modeling

Construction noise associated with the proposed project was calculated at sensitive receptor locations utilizing methodology found in the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment Manual (2018) together with several key construction parameters, including: distance to the property line of each receptor, equipment, percent usage factor, and baseline parameters for the project site. The equipment used to calculate the construction noise levels for each phase were based on the assumptions provided in the CalEEMod construction emission modeling provided in the Air Quality and Greenhouse Gas Analysis prepared for the proposed project (Greve & Associates, LLC 2022). It is important to understand that for construction, per FTA methodology, noise levels are being calculated from the center of the site in order to represent an average as the equipment moves around the site over an eight-hour period. Furthermore, noise levels are calculated at the property line of each sensitive receptor and not to the actual structure. Therefore, distances to sensitive receptors may differ from those described in other technical documents prepared for this project.

Construction noise will vary depending on the construction process, type of equipment involved, location of the construction site with respect to sensitive receptors, the schedule proposed to carry out each task (e.g., hours and days of the week) and the duration of the construction work. Sound emission levels associated with typical construction equipment as well as typical usage factors are provided in Table 8. Construction noise worksheets are provided in Appendix B.

Table 8. Equipment Noise Emissions and Acoustical Usage Factors

Equipment Description	Impact Device?	Acoustical Use Factor (%)	Spec. Lmax @ 50ft (dBA, slow)	Actual Measured Lmax @ 50ft (dBA, slow)	No. of Actual Data Samples (Count)
Backhoe	No	40	80	78	372
Cement Mortar Mixers	No	15	83	-N/A-	0
Compactor (ground)	No	20	80	83	57
Compressor (air)	No	40	80	78	18
Crane	No	16	85	81	405
Dozer	No	40	85	82	55
Dump Truck	No	40	84	76	31
Excavator	No	40	85	81	170
Flat Bed Truck	No	40	84	74	4
Forklift	No	50	n/a	61	n/a
Front End Loader	No	40	80	79	96
Generator	No	50	82	81	19

Equipment Description	Impact Device?	Acoustical Use Factor (%)	Spec. Lmax @ 50ft (dBA, slow)	Actual Measured Lmax @ 50ft (dBA, slow)	No. of Actual Data Samples (Count)
Grader	No	40	85	-N/A-	0
Man Lift	No	20	85	75	23
Roller	No	20	85	80	16
Tractor	No	40	84	-N/A-	0
Welder	No	40	73	74	5

Source: FHWA, 2006.

B. Stationary Source/Operational Noise Modeling

The SoundPLAN acoustical modeling software was utilized to model stationary project operational noise from the proposed project to adjacent and nearby land uses. SoundPLAN is capable of evaluating stationary noise sources (e.g., parking lots, drive-through menus, car wash equipment, vacuums, etc.). The SoundPLAN software utilizes algorithms (based on the inverse square law) to calculate noise level projections. The software allows the user to input specific noise sources, spectral content, sound barriers, building placement, topography, and sensitive receptor locations. In addition to the information provided below, noise modeling input and outputs assumptions are provided in Appendix C.

The project operational L_{eq} was modeled utilizing representative sound levels in the SoundPLAN model and project trip generation. Modeled noise sources include vehicle movement/parking lot noise and HVAC equipment. Peak hour traffic movements were assumed and full operation of the HVAC units was assumed.

On-site Vehicle Trips

Based on the Traffic Circulation Assessment for the proposed project (Translutions 2024), the project will generate approximately 14 trips during the AM peak hour, 18 trips during PM peak hour and 243 total daily trips.

Mechanical Equipment (HVAC Units)

Sound Spectrum data for 15 and 20 Ton HVAC units were utilized to model proposed HVAC noise. HVAC units are proposed to be located in utility closets. Given this fact, 15 dB was deducted from the sound power level of each unit to represent the attenuation provided by the structure. Representative HVAC sound data is provided in Appendix C.

C. Mobile Source Noise Modeling

In order to determine if project generated vehicle trips would result in any substantial increases in ambient noise levels, they were evaluated in light of the existing noise environment, which is dominated by vehicle traffic. The proposed project would generate 243 vehicle trips accessing the site via Columbia Street locally and State Highway 74 for more regional trips. Traffic count data provided by the County of

Riverside[1] shows that there are approximately 6,344 vehicle trips a day traveling on Columbia Street in vicinity of the proposed project and per Caltrans operational data[2] 21,300 trips per day travelling on State Highway 74. The posted speed on both Columbia St3reet and State Highway 74 is 35 miles per hour in the vicinity of the proposed project. Vehicle mixes provided in the Riverside County Requirements for determining and mitigating traffic noise impacts to residential structures memorandum (2009) were used for modeling purposes. Existing and existing plus project roadway noise modeling worksheets are provided in Appendix D.

D. Groundborne Vibration Modeling

Groundborne vibration modeling was performed using vibration propagation equations and construction equipment source levels obtained from the FTA Transit Noise and Vibration Impact Assessment Manual (2018). Table 9 shows typical vibration levels associated with commonly used construction equipment based on data from the FTA. The fundamental equation used to calculate vibration propagation through average soil conditions and distance is as follows:

$$PPV_{equipment} = PPV_{ref} (25/D_{rec})^n$$

Where:

PPV_{ref} = *reference PPV at 25ft.*

D_{rec} = *distance from equipment to receiver in ft.*

n = 1.5 (*the value related to the attenuation rate through ground*)

Table 9. Construction Equipment Vibration Source Levels

Equipment		PPV at 25 ft, in/sec
Pile Driver (impact)	upper range	1.518
	typical	0.644
Pile Driver (sonic)	upper range	0.734
	typical	0.170
clam shovel drop (slurry wall)		0.202
Hydromill (slurry wall)	in soil	0.008
	in rock	0.017
Vibratory Roller		0.210
Hoe Ram		0.089
Large Bulldozer		0.089
Caisson Drilling		0.089
Loaded Trucks		0.076
Jackhammer		0.035
Small Bulldozer		0.003

Source: Federal Transit Administration: Transit Noise and Vibration Impact Assessment Manual, 2018.

*RMS velocity in decibels, VdB re 1 micro-in/sec

[1] County of Riverside Transportation Department Traffic Counts 2020. https://trans.rctlma.org/sites/g/files/aldnop401/files/migrated/Portals-7-documents-Traffic-2020-TRANS-WEB-COUNTS.PDF.pdf

[2] https://dot.ca.gov/programs/traffic-operations/census

VIII. Analysis and Findings

A. Project Construction

Construction noise associated with the proposed project will vary depending on the construction process, type of equipment involved, location of the construction site with respect to sensitive receptors, the schedule proposed to carry out each task (e.g., hours and days of the week) and the duration of the construction work. Construction phases are anticipated to include site preparation, grading, and paving. A summary of typical noise level data for a variety of construction equipment compiled by the Federal Highway Administration that will likely be used during project construction is presented in Table 8. Typical operating cycles for these types of construction equipment may involve one or two minutes of full power operation followed by three to four minutes at lower power settings.

Existing sensitive receptors that may be affected by construction noise include single-family residential land uses located north, south and west of the project site and a memory care center located north of the project site.

Construction noise associated with each construction phase was modeled using FTA methodology. As shown in Table 10, the FTA construction noise threshold would be exceeded during the grading phase, the building phase, and the paving phase. This impact is potentially significant. Implementation of the following mitigation measures presented below would reduce construction noise impacts to less than significant. The best management practices listed after Table 10 are not required to achieve noise levels below the standard. They are simply provided to further minimize construction noise impacts if desired.

Mitigation Measure 1

Equip all large bulldozers, tractors, loaders and backhoes, pavers and paving equipment with mufflers that provide at least 10 dB in noise emission reduction or otherwise show that they do not exceed their noise emission reference levels shown in Table 8 minus 10 dB. For example, the contractor would need to show that bulldozers onsite do not exceed a sound level of 72 dB Lmax at a distance of 50 feet. This can be done by submitting sound specifications from the manufacturer or by field measurement.

Mitigation Measure 2

Limit construction hours of operation to between the hours of 6:00 AM and 6:00 PM during the months of June through September, and 7:00 AM and 6:00 PM during the months of October through May."

Table 10. Construction Noise Levels

Phase	Receptor Location	Construction Noise Levels (dBA Leq)	Construction Noise Levels Exceed 80 dBA Threshold?	Mitigated Construction Noise Levels (dBA Leq)
Demolition	Residential Land Uses to the North & South	80.0	N	71.2
	Residential Land Uses to the West	70.4	N	66.4
	Memory Care Center to the North	71.0	N	66.5
Site Preparation	Residential Land Uses to the North & South	79.9	N	69.8
	Residential Land Uses to the West	68.7	N	67.9
	Memory Care Center to the North	69.5	N	67.9
Grading	Residential Land Uses to the North & South	83.6	Y	79.6
	Residential Land Uses to the West	72.5	N	68.4
	Memory Care Center to the North	73.3	N	69.2
Building Construction	Residential Land Uses to the North & South	81.9	Y	80.1
	Residential Land Uses to the West	70.7	N	68.9
	Memory Care Center to the North	71.5	N	69.7
Paving	Residential Land Uses to the North & South	84.9	Y	79.3
	Residential Land Uses to the West	73.7	N	68.2
	Memory Care Center to the North	74.5	N	68.9
Architectural Coating	Residential Land Uses to the North & South	71.7	N	71.7
	Residential Land Uses to the West	60.6	N	60.6
	Memory Care Center to the North	61.4	N	61.4

Sources: Referenced noise levels from the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment Manual (September 2018) and the FHWA Roadway Construction Noise Model User's Guide (January 2006) and SoundPLAN GmbH, SoundPLAN Noise Model reference noise level.

Recommended Best Management Practices

Although not required, the following Best Management Practices (BMPs) can be implemented to further reduce noise at sensitive receptors.

1. Equip all construction equipment, fixed or mobile, with properly operating and maintained mufflers, consistent with manufacturer standards.

2. Place all stationary construction equipment so that emitted noise is directed away from the noise sensitive receptors nearest the project site.

3. As applicable, shut off all equipment when not in use.

4. Locate equipment staging in areas that create the greatest distance between construction-related noise/vibration sources and sensitive receptors.

5. Block and/or direct portable stationary noise sources away from sensitive receptors. Either one-inch plywood or sound blankets can be utilized for this purpose. They should reach up from the ground and block the line of sight between the equipment and the sensitive receptor. The shielding should be without holes and cracks.

6. Prohibit amplified music and/or voice on the project site.

7. Limit haul truck deliveries to the same hours outlined previously in Mitigation Measure #2 per County Code Section 9.52.020.

8. Identify a liaison for surrounding residents and property owners to contact with concerns regarding construction noise and vibration. The liaison's telephone number(s) shall be prominently displayed at the project site where visible from the street.

9. Notify in writing all landowners and occupants of properties adjacent to the construction area of the anticipated construction schedule at least two weeks prior to groundbreaking.

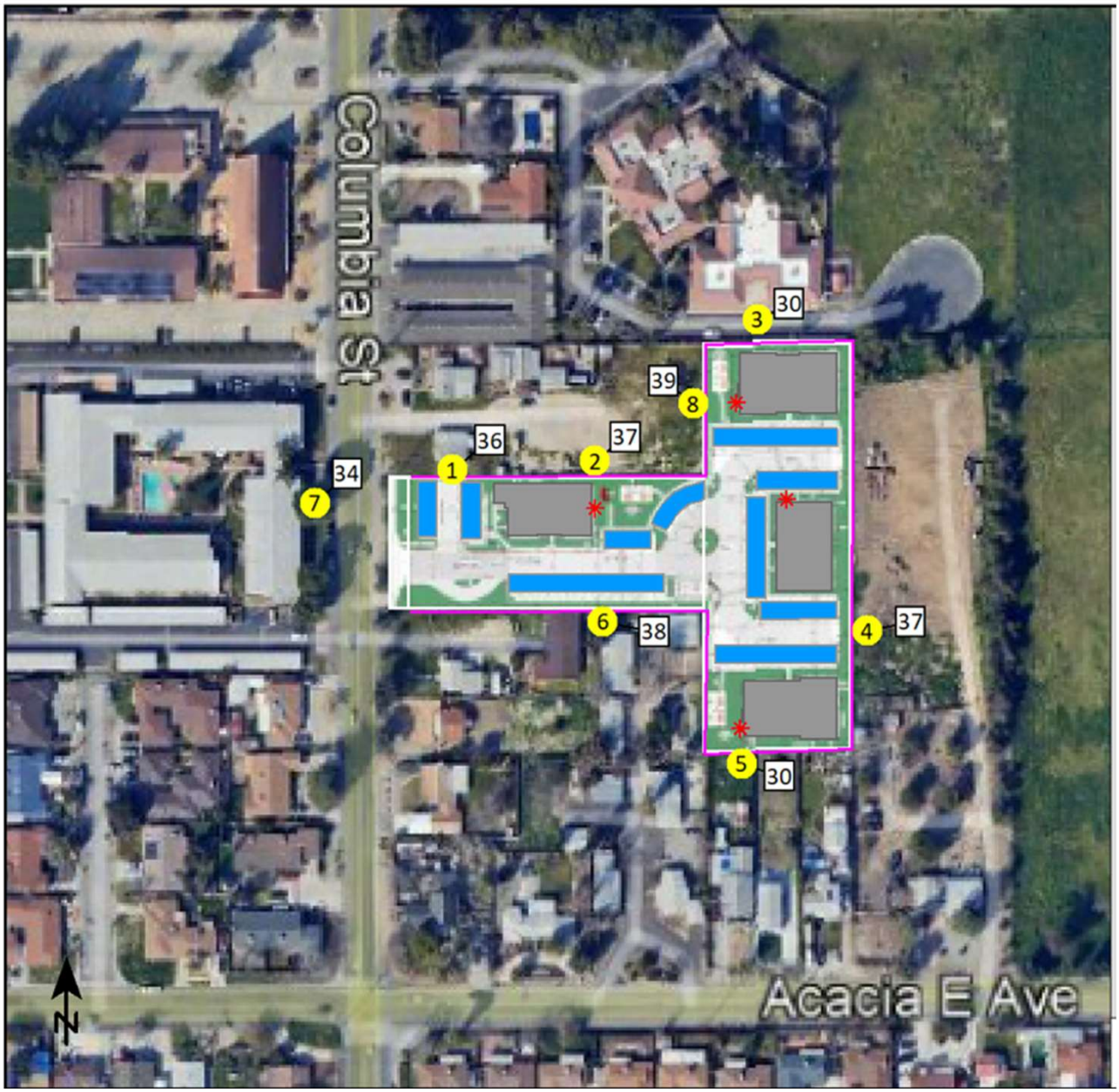
B. Project Operation (On-Site)

As described previously, operational noise was modeled utilizing representative sound levels in the SoundPLAN noise model. Modeled noise sources include vehicle movement/parking lot noise and heating and ventilation (HVAC) equipment. Proposed HVAC units will be located within equipment rooms in each building. Other noise that can be expected to be associated with the proposed project will include occasional fire alarms and landscaping equipment. Landscaping and maintenance activities would occur occasionally and are exempt from the City's noise standards per County Code 9.52.020 as long as they occur between the hours of seven AM and eight PM. Safety, warning and alarm devices, including, but not limited to, house and car alarms, and other warning devices that are designed to protect the public health, safety, and welfare. Finally, California Assembly Bill 1307 specifies that the in the context of residential projects, noise generated by residents and their guests is not to be considered as a significant effect on the environment for purposes of CEQA.

As shown in Figure 6, peak operational noise is expected to range between 34 and 39 dBA L_{eq} at the nearby sensitive receivers and will not exceed the County's daytime stationary noise standard of 65 dBA L_{eq} (10-minute) or the nighttime standard of 45 dBA-10-minute L_{eq} as provided in Policy N 2.3 of the County of Riverside General Plan Noise Element. Project operation would not result in substantial increases in ambient noise levels. No mitigation is required. Operational noise modeling worksheets are provided in Appendix C.

Figure 6

Operational Noise Levels



Signs and symbols

- Proposed 6-ft Solid Vinyl Fence
- Proposed Building
- Receiver
- Point source - HVAC
- Parking lot
- Noise Level Tables (dBA, Leq)

N

C. Project Operation (Offsite)

In order to determine if project generated vehicle trips would result in a substantial increase in ambient noise levels, they were evaluated in light of the existing noise environment, which is dominated by vehicle traffic. As discussed previously, project generated vehicle traffic would result in a substantial increase in ambient noise levels if:

1. It results in a 5 dBA increase or more at noise sensitive land uses where existing ambient noise levels are than 60 dBA;
2. It results in a 3 dBA increase at a noise sensitive land use where existing ambient noise levels range between 60 and 65 dBA; or
3. If it results in a 1.5 dBA increase at a noise sensitive land use where existing noise levels exceed 65 dBA.

The proposed project would generate 243 vehicle trips that will access the project site via Columbia Street locally, and State Highway 74 for more regional trips. Traffic count data provided by the County of Riverside[3] shows that there are approximately 6,344 vehicle trips a day traveling on Columbia Street in vicinity of the proposed project and per Caltrans operational data[4] 21,300 trips per day travelling on State Highway 74.

As shown in Table 11, the modeled existing traffic noise level at the right-of-way of Columbia Street in the vicinity of the project site is 71.42 dBA CNEL and modeled existing plus project traffic noise level is 71.45 dBA CNEL. Further, the existing modeled traffic noise levels at the right-of-way of State Highway 74 is 72.3 dBA CNEL and modeled existing plus project traffic noise level is 72.75 dBA CNEL. Therefore, the project generated vehicle traffic would result in a less than 1 dB increase in ambient noise levels and therefore, would not result in a substantial increase in ambient noise levels per the Federal Interagency Committee on Noise (FICON) standards. No mitigation is required. Traffic noise modeling sheets are provided in Appendix D.

Table 11. Change in Existing Noise Levels Along Roadways as a Result of Project (dBA CNEL)

	CNEL at 100 Feet		Change in Noise Level	Applicable FICON Standard (dBA)	Potential Significant Impact (Yes/No)
Roadway	Existing Without Project	Existing Plus Project			
Columbia Street	71.42	71.45	0.03	1.5	N
Highway 74	72.73	72.75	0.02	1.5	N

D. Airport Noise

The closest airport to the project site is the Riverside Municipal Airport which is located approximately 4.8 miles north of the project site. The project site is not located within an airport land use compatibility plan area or within a 65 dBA CNEL airport noise contour.

[3] County of Riverside Transportation Department Traffic Counts 2020. https://trans.rctlma.org/sites/g/files/aldnop401/files/migrated/Portals-7-documents-Traffic-2020-TRANS-WEB-COUNTS.PDF.pdf
[4] https://dot.ca.gov/programs/traffic-operations/census

As discussed previously, the project would result in an impact if it exposed people residing or working to noise level thresholds established in each airport land use compatibility plan, which is usually 65 dBA CNEL. The proposed project is not located within a land use compatibility plan or within a 65 dBA CNEL airport noise contour. Therefore, the project would not expose people residing or working in the area to excessive noise levels. No mitigation is required.

E. Groundborne Vibration Impacts

Project construction would result in excessive groundborne vibration that could lead to "architectural" damage if exceeds 0.2 PPV (in/sec). The greatest potential sources of groundborne vibration expected to be utilized during construction of the project include a vibratory roller and a large bulldozer. As shown in Table 9, a vibratory roller can generate a vibration level of approximately 0.21 in/sec PPV at a distance of 25 feet, while a large bulldozer can generate a vibration level of 0.089 in/sec PPV at 25 feet. Groundborne vibration associated with these two pieces of equipment at the nearest off-site structures was estimated. Worksheets are provided in Appendix E.

Based on the provided site plan and aerial photographs, the nearest off-site structures are within ten feet of the property line of the project site. Assuming a worst-case scenario that assumes that if a large bulldozer is utilized along the property line, PPV levels may reach up to 0.035 in./sec. at these structures, exceeding the 0.2 PPV in./sec. damage threshold. The following mitigation measure will reduce potential impacts to less than significant.

Mitigation Measure 3

In order to avoid exceeding the threshold for potential groundborne vibration damage during construction, the use of large bulldozers within 15 feet of existing off-site structures will be prohibited.

As stated above, use of a vibratory roller also has the potential to result in damage to off-site structures. As shown in Figure **3**, driveways and parking areas are proposed as close as 10 feet from the property line where there are also existing off-site structures within 10 feet from the property line. PPV levels associated with the use of a vibratory roller in preparation of proposed driveways and parking areas could reach up to 0.29 in./sec. at these structures, and could exceed the 0.20 PPV in./sec. damage threshold. The following mitigation measure will reduce potential impacts to less than significant.

Mitigation Measure 4

In order to avoid exceeding the threshold for potential groundborne vibration damage during construction, the use of vibratory rollers within 25 feet of existing off-site structures will be prohibited.

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APPENDIX A

Larson Davis 820 Noise Measurement Data

G&A

Project: COLUMBIA HEIGHTS Site #: 1 Date: 3/22/2022

Description of Site: @ SIDE OF ROAD IN FRONT OF LOT

Start Cal 94.1 End Cal: _____ Meter/Calib.: NL-52

Weather: SUNNY, HOT, WISPY CLOUDS, 81°, N 5 MPH @WINDS F.T.: CVG

Time Start: 12.15 p, 12.32p Duration: 15 x 2

General Sources of Noise: CARS ON COLUMBIA STREET, CARS/TRUCKS (DELIVERY VEHICLES ALSO) LEAVING MOTORS RUNNING IN FRONT OF APT BUILDING, TV IN APT BUILDING, LOW LEVEL NOISE FROM FLORIDA, DISTANT PLANES, MOTOR BIKES, SLIGHT BIRDS

Leq:	76.6	63.5
Lmax:	102.4	83.5
L1.7:	79.7	74.2
L8.3:	71.4	67.9
L25:	61.9	56.1
L50:	52.8	48.9
L90:	42.9	42.2
Lmin	40.6	39.8

68.9 @ 1.20 = CAR

72.7 @ 3.50 = CAR

CONSTRUCTION OR ROOF @ APT BUILDING

63.5 @ 7.48 = VEHICLE PULLING AWAY

75.0 @ 8.08 = PICKUP TRUCK

102.3 @ 10.30 = MOTOR BIKE

73.1 @ 2.18 = PICKUP TRUCK

74.1 @ 3.52 = CAR

74.8 @ 5.10 = PICKUP TRUCK

44.0 @ 5.44 = AC UNIT, FLORIDA AVE

42.1 @ 12.00 = CAR IDLING IN DISTANCE,

70.9 @ 13.22 = PICKUP AC UNIT

G&A

Project: COLUMBIA HEIGHTS Site #: 2 Date: 3/22/2022

Description of Site: ALONG FLORIDA AVE, ACROSS FROM EMPTY LOT NEXT TO EL PATRON

Start Cal 94.1 End Cal: _____ Meter/Calib.: NL-52

Weather: HOT, SUNNY, SLIGHT CLOUDS, 81°, N 5 MPH WINDS F.T.: CVG

Time Start: ~~1~~ 1:34p / 1:50p Duration: 15 x 2

General Sources of Noise: BUSES, CARS, PICKUP TRUCKS, DISTANT (← SCHOOL + MUNICIPAL) ROOFING, GARBAGE TRUCKS, MOTORCYCLES, SMALL PLANES

Leq:	~~70.4~~ 70.7	69.9
Lmax:	87.8	83.9
L1.7:	79.0	78.9
L8.3:	75.0	74.4
L25:	70.0	70.9
L50:	64.4	63.8
L90:	51.4	49.2
Lmin	43.7	42.4

77.0 @ 1.25 = BUS

80.8 @ 3.04 = SUV

87.0 @ 6.25 = LOUD CAR

46.8 @ 7.17 = DISTANT CAR SOUNDS

87.6 @ 2.11 = MOTORCYCLE

65.5 @ 1.11 = PLANE (SMALL)

80.1 @ 2.37 = SUV

77.8 @ 2.54 = SCHOOL BUS

92.2 @ 6.03 = PLANE

82.9 @ 6.44 = EMERGENCY VEHICLE, SIRENS OFF

*91.3 @ 8.13 = BOX TRUCK

45.4 @ 10.04 = DISTANT CARS

G&A

Project: COLUMBIA HEIGHTS Site #: 3 Date: 3/22/2022

Description of Site: SIDE OF ROAD IN NEIGHBORHOOD

Start Cal 94.1 End Cal: _____ Meter/Calib.: NL-52

Weather: HOT, WISPY CLOUDS, 81°, N 5 MPH WIND F.T.: CVG

Time Start: 12.58p / 1.14p Duration: 15 x 2

General Sources of Noise: TRAFFIC ON ACACIA, BIRDS, NEIGHBORHOOD

DOGS BARKING, YELLING, BICYCLES, SCHOOL BUS, MAIL TRUCK

Leq:	64.2	65.7
Lmax:	78.7	78.7
L1.7:	74.4	75.2
L8.3:	70.1	71.4
L25:	61.9	64.9
L50:	53.9	56.7
L90:	41.9	44.2
Lmin	37.7	38.7

72.4 @ 1.16 PICKUP TRUCK

77.8 @ 3.03 = PICKUP TRUCK

40.7 @ 5.05 = BIRDS, DISTANT PLANE, DISTANT TRAFFIC ON ACACIA

74.7 @ 5.54 = 2 PICKUP TRUCKS

71.6 @ 10.16 = SUV

75.7 @ 13.20 = SCHOOL BUS

77.7 @ .33 = CAR

73.1 @ 1.45 = ARMY HELICOPTER

74.2 @ 4.21 = CAR

40.0 @ 6.19 = DOGS BARKING

9.45 - 9.12 = MAIL TRUCK STOPPING

75.6 @ 9.30 = BOX TRUCK

76.7 @ 10.30 = LOUD CAR

Site #1







Site #2







Site #3







APPENDIX B

Construction Noise Calculations

Receptor - Residential Land Uses to the North and South

Construction Phase Equipment Item	# of Items	Item Lmax at 50 feet, dBA[1]	Distance to Receptor[2]	Usage Factor	Dist. Correction dB	Usage Adj. dB	Receptor Item Lmax, dBA	Receptor Item Leq, dBA	Required Mitigation	Mitigated Noise Level
Concrete/Industrial Saws	1	90	65	0.20	-17.5	-7.0	72.5	65.6	n/a	65.6
Rubber Tired Dozers	1	82	65	0.40	-2.3	-4.0	79.7	75.7	n/a	65.7
Tractors/Loaders/Backhoes	1	84	65	0.40	-2.3	-4.0	81.7	77.7	n/a	67.7
							Log Sum	**80.0**		71.2
Site Preparation										
Rubber Tired Dozers	1	82	65	0.40	-2.3	-4.0	79.7	75.7	n/a	65.7
Tractors/Loaders/Backhoes	1	84	65	0.40	-2.3	-4.0	81.7	77.7	n/a	67.7
							Log Sum	**79.9**		69.8
Grading										
Graders	1	85	65	0.40	-2.3	-4.0	82.7	78.7		78.7
Rubber Tired Dozers	1	82	65	0.40	-2.3	-4.0	79.7	75.7	Muffler (10 dB Reduction)	65.7
Tractors/Loaders/Backhoes	2	84	65	0.80	-2.3	-1.0	81.7	80.8	Muffler (10 dB Reduction)	70.8
							Log Sum	**83.6**		79.6
Building Construction										
Cranes	1	85	65	0.16	-2.3	-8.0	82.7	74.8	n/a	74.8
Forklifts[3]	1	64	65	0.40	-2.3	-4.0	61.7	57.7	n/a	57.7
Generator Sets	1	82	65	0.50	-2.3	-3.0	79.7	76.7	n/a	76.7
Welders	3	74	65	1.20	-2.3	0.8	71.7	72.5	n/a	72.5
Tractors/Loaders/Backhoes	1	84	65	0.40	-2.3	-4.0	81.7	77.7	Muffler (10 dB Reduction)	67.7
							Log Sum	**81.9**		80.1
Paving										
Pavers	1	85	65	0.50	-2.3	-3.0	82.7	79.7	Muffler (10 dB Reduction)	69.7
Paving Equipment	1	85	65	0.50	-2.3	-3.0	82.7	79.7	Muffler (10 dB Reduction)	69.7
Rollers	1	85	65	0.20	-2.3	-7.0	82.7	75.7		75.7
Tractors/Loaders/Backhoes	1	84	65	0.40	-2.3	-4.0	81.7	77.7	Muffler (10 dB Reduction)	67.7
Cement and Mortar Mixers	1	80	65	0.40	-2.3	-4.0	77.7	73.7		73.7
							Log Sum	**84.9**		79.3
Architectural Coating										
Air Compressors	1	78	65	0.40	-2.3	-4.0	75.7	**71.7**		71.7

Notes:

(1) Source: Referenced noise levels from the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment Manual (September 2018) and the FHWA Roadway Construciton Noise Model User's Guide (January 2006)

(2) Distance to receptor calculated from center of site. Construction noise projected from the center of the project site to nearest sensitive use (property line).

Receptor - Residential Land Uses to the West

Construction Phase Equipment Item	# of Items	Item Lmax at 50 feet, dBA[1]	Distance to Receptor[2]	Usage Factor	Dist. Correction dB	Usage Adj. dB	Receptor Item Lmax, dBA	Receptor Item Leq, dBA	Required Mitigation	Mitigated Noise Level
Concrete/Industrial Saws	1	90	235	0.20	-17.5	-7.0	72.5	65.6	n/a	65.6
Rubber Tired Dozers	1	82	235	0.40	-13.4	-4.0	68.6	64.6	n/a	54.6
Tractors/Loaders/Backhoes	1	84	235	0.40	-13.4	-4.0	70.6	66.6	n/a	56.6
							Log Sum	**70.4**		66.4
Site Preparation										
Rubber Tired Dozers	1	82	235	0.40	-13.4	-4.0	68.6	64.6	n/a	54.6
Tractors/Loaders/Backhoes	1	84	235	0.40	-13.4	-4.0	70.6	66.6	n/a	67.7
							Log Sum	**68.7**		67.9
Grading										
Graders	1	85	235	0.40	-13.4	-4.0	71.6	67.6		67.6
Rubber Tired Dozers	1	82	235	0.40	-13.4	-4.0	68.6	64.6	Muffler (10 dB Reduction)	54.6
Tractors/Loaders/Backhoes	2	84	235	0.80	-13.4	-1.0	70.6	69.6	Muffler (10 dB Reduction)	59.6
							Log Sum	**72.5**		68.4
Building Construction										
Cranes	1	85	235	0.16	-13.4	-8.0	71.6	63.6	n/a	63.6
Forklifts[3]	1	64	235	0.40	-13.4	-4.0	50.6	46.6	n/a	46.6
Generator Sets	1	82	235	0.50	-13.4	-3.0	68.6	65.5	n/a	65.5
Welders	3	74	235	1.20	-13.4	0.8	60.6	61.3	n/a	61.3
Tractors/Loaders/Backhoes	1	84	235	0.40	-13.4	-4.0	70.6	66.6	Muffler (10 dB Reduction)	56.6
							Log Sum	**70.7**		68.9
Paving										
Pavers	1	85	235	0.50	-13.4	-3.0	71.6	68.5	Muffler (10 dB Reduction)	58.5
Paving Equipment	1	85	235	0.50	-13.4	-3.0	71.6	68.5	Muffler (10 dB Reduction)	58.5
Rollers	1	85	235	0.20	-13.4	-7.0	71.6	64.6		64.6
Tractors/Loaders/Backhoes	1	84	235	0.40	-13.4	-4.0	70.6	66.6	Muffler (10 dB Reduction)	56.6
Cement and Mortar Mixers	1	80	235	0.40	-13.4	-4.0	66.6	62.6		62.6
							Log Sum	**73.7**		68.2
Architectural Coating										
Air Compressors	1	78	235	0.40	-13.4	-4.0	64.6	**60.6**		60.6

Notes:

(1) Source: Referenced noise levels from the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment Manual (September 2018) and the FHWA Roadway Construciton Noise Model User's Guide (January 2006)

(2) Distance to receptor calculated from center of site. Construction noise projected from the center of the project site to nearest sensitive use (property line).

Receptor - Memory Care to the North

Construction Phase Equipment Item	# of Items	Item Lmax at 50 feet, dBA[1]	Distance to Receptor[2]	Usage Factor	Dist. Correction dB	Usage Adj. dB	Receptor Item Lmax, dBA	Receptor Item Leq, dBA	Required Mitigation	Mitigated Noise Level
Concrete/Industrial Saws	1	90	215	0.20	-17.5	-7.0	72.5	65.6	n/a	65.6
Rubber Tired Dozers	1	82	215	0.40	-12.7	-4.0	69.3	65.4	n/a	55.4
Tractors/Loaders/Backhoes	1	84	215	0.40	-12.7	-4.0	71.3	67.4	n/a	57.4
							Log Sum	**71.0**		66.5
Site Preparation										
Rubber Tired Dozers	1	82	215	0.40	-12.7	-4.0	69.3	65.4	n/a	55.4
Tractors/Loaders/Backhoes	1	84	215	0.40	-12.7	-4.0	71.3	67.4	n/a	67.7
							Log Sum	**69.5**		67.9
Grading										
Graders	1	85	215	0.40	-12.7	-4.0	72.3	68.4		68.4
Rubber Tired Dozers	1	82	215	0.40	-12.7	-4.0	69.3	65.4	Muffler (10 dB Reduction)	55.4
Tractors/Loaders/Backhoes	2	84	215	0.80	-12.7	-1.0	71.3	70.4	Muffler (10 dB Reduction)	60.4
							Log Sum	**73.3**		69.2
Building Construction										
Cranes	1	85	215	0.16	-12.7	-8.0	72.3	64.4	n/a	64.4
Forklifts[3]	1	64	215	0.40	-12.7	-4.0	51.3	47.4	n/a	47.4
Generator Sets	1	82	215	0.50	-12.7	-3.0	69.3	66.3	n/a	66.3
Welders	3	74	215	1.20	-12.7	0.8	61.3	62.1	n/a	62.1
Tractors/Loaders/Backhoes	1	84	215	0.40	-12.7	-4.0	71.3	67.4	Muffler (10 dB Reduction)	57.4
							Log Sum	**71.5**		69.7
Paving										
Pavers	1	85	215	0.50	-12.7	-3.0	72.3	69.3	Muffler (10 dB Reduction)	59.3
Paving Equipment	1	85	215	0.50	-12.7	-3.0	72.3	69.3	Muffler (10 dB Reduction)	59.3
Rollers	1	85	215	0.20	-12.7	-7.0	72.3	65.3		65.3
Tractors/Loaders/Backhoes	1	84	215	0.40	-12.7	-4.0	71.3	67.4	Muffler (10 dB Reduction)	57.4
Cement and Mortar Mixers	1	80	215	0.40	-12.7	-4.0	67.3	63.4		63.4
							Log Sum	**74.5**		68.9
Architectural Coating										
Air Compressors	1	78	215	0.40	-12.7	-4.0	65.3	**61.4**		61.4

Notes:

(1) Source: Referenced noise levels from the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment Manual (September 2018) and the FHWA Roadway Construciton Noise Model User's Guide (January 2006)

(2) Distance to receptor calculated from center of site. Construction noise projected from the center of the project site to nearest sensitive use (property line).

APPENDIX C

SoundPLAN Input/Output

Noise emissions of industry sources

Source name	Reference	Level		Frequency spectrum [dB(A)]								Corrections		
			dB(A)	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	Cwall dB	CI dB	CT dB
1	Lw/unit	Day	69.1	51.0	52.8	56.8	63.6	63.7	62.7	58.2	49.3	3.0	-	-
2	Lw/unit	Day	71.5	54.4	56.4	60.6	66.0	66.7	64.1	59.2	50.2	3.0	-	-
3	Lw/unit	Day	71.5	54.4	56.4	60.6	66.0	66.7	64.1	59.2	50.2	3.0	-	-
4	Lw/unit	Day	71.5	54.4	56.4	60.6	66.0	66.7	64.1	59.2	50.2	3.0	-	-
5	Lw/unit	Day	86.5	69.4	71.4	75.6	81.0	81.7	79.1	74.2	65.2	-	-	-

Noise emissions of parking lot traffic

Name	Parking lot type	Size	Movements per hour			Road surface	Separated method	Lw,ref
			Day	Evening	Night			dB(A)
1	Housing estate	16 Parking bays	0.400	0.400	0.150	Asphaltic driving lanes	no	77.2
2	Housing estate	13 Parking bays	0.400	0.400	0.150	Asphaltic driving lanes	no	75.6
3	Housing estate	8 Parking bays	0.400	0.400	0.150	Asphaltic driving lanes	no	72.0
4	Housing estate	8 Parking bays	0.400	0.400	0.150	Asphaltic driving lanes	no	72.0
5	Housing estate	13 Parking bays	0.400	0.400	0.150	Asphaltic driving lanes	no	75.6
6	Housing estate	6 Parking bays	0.400	0.400	0.150	Asphaltic driving lanes	no	70.8
7	Housing estate	4 Parking bays	0.400	0.400	0.150	Asphaltic driving lanes	no	69.0
8	Housing estate	5 Parking bays	0.400	0.400	0.150	Asphaltic driving lanes	no	70.0
9	Housing estate	6 Parking bays	0.400	0.400	0.150	Asphaltic driving lanes	no	70.8
10	Housing estate	11 Parking bays	0.400	0.400	0.150	Asphaltic driving lanes	no	74.2

Receiver list

No.	Receiver name	Building side	Floor	Limit Day dB(A)	Level w/o NP Day dB(A)	Level w NP Day dB(A)	Difference Day dB	Conflict Day dB
1	1	-	EG	-	42.4	35.6	-6.8	-
2	2	-	EG	-	42.3	37.0	-5.3	-
3	3	-	EG	-	31.9	29.6	-2.2	-
4	4	-	EG	-	41.9	36.6	-5.3	-
5	5	-	EG	-	40.1	29.7	-10.4	-
6	6	-	EG	-	44.5	38.4	-6.2	-
7	7	-	EG	-	34.2	33.6	-0.6	-
8	8	-	EG	-	45.0	39.4	-5.6	-

APPENDIX D

Traffic Modeling Sheets

FHWA Sound32 Spreadsheet

Existing Traffic Noise

Project: **Columbia Heights**

Road: **Columbia Street**

Segment: **Vicinity of the Project**

	DAYTIME			EVENING			NIGHTTIME			ADT	21300.00
	AUTOS	M.TRUCKS	H.TRUCKS	AUTOS	M.TRUCKS	H.TRUCKS	AUTOS	M.TRUCKS	H.TRUCKS	SPEED	35.00
										DISTANCE	25.00
INPUT PARAMETERS											
Vehicles per hour	1339.86	27.70	11.36	892.09	6.40	1.42	221.29	4.49	1.89	% A	97.4
Speed in MPH	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00		
Left angle	-90.00	-90.00	-90.00	-90.00	-90.00	-90.00	-90.00	-90.00	-90.00		
Right angle	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	% MT	1.84
NOISE CALCULATIONS											
Reference levels	65.11	74.83	80.05	65.11	74.83	80.05	65.11	74.83	80.05	% HT	0.74
ADJUSTMENTS											
Flow	25.52	8.68	4.81	23.76	2.32	-4.23	17.70	0.77	-2.98		
Distance	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	LEFT	-90.00
Finite Roadway	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	RIGHT	90.00
Barrier	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CNEL	71.42
Constant	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	DAY LEQ	70.21
LEQ	68.57	61.45	62.79	66.81	55.08	53.76	60.75	53.54	55.01	Day hour	89.00
										Absorbtive?	no
	DAY LEQ	70.21		EVENING LEQ	67.29		NIGHT LEQ	62.39		Use hour?	no
										GRADE dB	0.00
		CNEL	**71.42**								

FHWA Sound32 Spreadsheet

Existing Plus Project Traffic Noise

Project: **Columbia Heights**

Road: **Columbia Street**

Segment: **Vicinity of the Project**

	DAYTIME			EVENING			NIGHTTIME			ADT	21543.00
	AUTOS	M.TRUCKS	H.TRUCKS	AUTOS	M.TRUCKS	H.TRUCKS	AUTOS	M.TRUCKS	H.TRUCKS	SPEED	35.00
										DISTANCE	25.00
INPUT PARAMETERS											
Vehicles per hour	1355.55	27.70	11.36	902.54	6.40	1.42	223.88	4.49	1.89	% A	97.43
Speed in MPH	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00		
Left angle	-90.00	-90.00	-90.00	-90.00	-90.00	-90.00	-90.00	-90.00	-90.00		
Right angle	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	% MT	1.82
NOISE CALCULATIONS											
Reference levels	65.11	74.83	80.05	65.11	74.83	80.05	65.11	74.83	80.05	% HT	0.73
ADJUSTMENTS											
Flow	25.57	8.68	4.81	23.81	2.32	-4.23	17.75	0.77	-2.98		
Distance	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	LEFT	-90.00
Finite Roadway	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	RIGHT	90.00
Barrier	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CNEL	71.45
Constant	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	DAY LEQ	70.25
LEQ	68.62	61.45	62.79	66.86	55.08	53.76	60.80	53.54	55.01	Day hour	89.00
										Absorbtive?	no
	DAY LEQ	70.25		EVENING LEQ	67.33		NIGHT LEQ	62.42		Use hour?	no
										GRADE dB	0.00
		CNEL	**71.45**								

APPENDIX E

Groundborne Vibration Calculations

GROUNDBORNE VIBRATION ANALYSIS			
Project:	Collumbia Street		Date: 11/2/25
Source:	Large Bulldozer		
Scenario:	Unmitigated		
Location:	Nearest Structure		
Address:			
PPV = PPVref(25/D)^n (in/sec)			
INPUT			
Equipment Type =	2	Large Bulldozer	INPUT SECTION IN GREEN
PPVref =	0.089	Reference PPV (in/sec) at 25 ft.	
D =	10.00	Distance from Equipment to Receiver (ft)	
n =	1.50	Vibration attenuation rate through the ground	
Note: Based on reference equations from Vibration Guidance Manual, California Department of Transportation, 2006, pgs 38-43.			
RESULTS			
PPV =	0.352	IN/SEC	OUTPUT IN BLUE

GROUNDBORNE VIBRATION ANALYSIS			
Project:	Collumbia Street		Date: 11/2/25
Source:	Vibratory Roller		
Scenario:	Unmitigated		
Location:	Nearest Structure		
Address:			
PPV = PPVref(25/D)^n (in/sec)			
Columbia Street			
Equipment = Type	1	Vibratory Roller	INPUT SECTION IN GREEN
PPVref =	0.21	Reference PPV (in/sec) at 25 ft.	
D =	25.00	Distance from Equipment to Receiver (ft)	
n =	1.50	Vibration attenuation rate through the ground	
Note: Based on reference equations from Vibration Guidance Manual, California Department of Transportation, 2006, pgs 38-43.			
RESULTS			
PPV =	0.210	IN/SEC	OUTPUT IN BLUE

GROUNDBORNE VIBRATION ANALYSIS			
Project:	Collumbia Street		Date: 11/2/25
Source:	Large Bulldozer		
Scenario:	Mitigated		
Location:	Nearest Structure		
Address:			
PPV = PPVref(25/D)^n (in/sec)			
INPUT			
Equipment Type =	2	Large Bulldozer	INPUT SECTION IN GREEN
PPVref =	0.089	Reference PPV (in/sec) at 25 ft.	
D =	15.00	Distance from Equipment to Receiver (ft)	
n =	1.50	Vibration attenuation rate through the ground	
Note: Based on reference equations from Vibration Guidance Manual, California Department of Transportation, 2006, pgs 38-43.			
RESULTS			
PPV =	0.191	IN/SEC	OUTPUT IN BLUE