NOISE AND VIBRATION IMPACT ANALYSIS

4738 PROCTOR ROAD SUBDIVISION PROJECT

CASTRO VALLEY, ALAMEDA COUNTY, CALIFORNIA

LSA

October 2022

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Project No. AYP2201

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LIST OF ABBREVIATIONS AND ACRONYMS

ADT	average daily trips
ALUC	Airport Land Use Compatibility
CEQA	California Environmental Quality Act
County	County of Alameda
CNEL	Community Noise Equivalent Level
dBA	A-weighted decibel(s)
FHWA	Federal Highway Administration
ft	foot/feet
FTA	Federal Transit Administration
FTA Manual	FTA *Transit Noise and Vibration Impact Assessment Manual*
in/sec	inch/inches per second
L_{dn}	day-night average noise level
L_{eq}	equivalent continuous sound level
L_{max}	maximum instantaneous sound level
mi	mile/miles
Noise Element	County of Alameda General Plan Noise Element
PPV	peak particle velocity
project	4738 Proctor Road Subdivision Project
OAK	Oakland International Airport
RMS	root-mean-square
STC	Sound Transmission Class
Town	Town of Castro Valley
VdB	vibration velocity decibels

INTRODUCTION

This noise and vibration impact analysis has been prepared to evaluate the potential noise and vibration impacts and reduction measures associated with the proposed 4738 Proctor Road Subdivision Project (project) in the Town of Castro Valley (Town), Alameda County (County), California. As the County is the lead agency for review under CEQA, this report is intended to satisfy the County's requirements for a project-specific noise impact analysis by examining the impacts of the project site and evaluating noise reduction measures that the project may require.

PROJECT LOCATION AND DESCRIPTION

The proposed project is located in unincorporated Alameda County in Castro Valley, east of Lake Chabot in an area consisting primarily of residential uses and undeveloped open space. The project site is bounded by Proctor Road to the south, single-family residential development to the east and west, and undeveloped open space to the north.

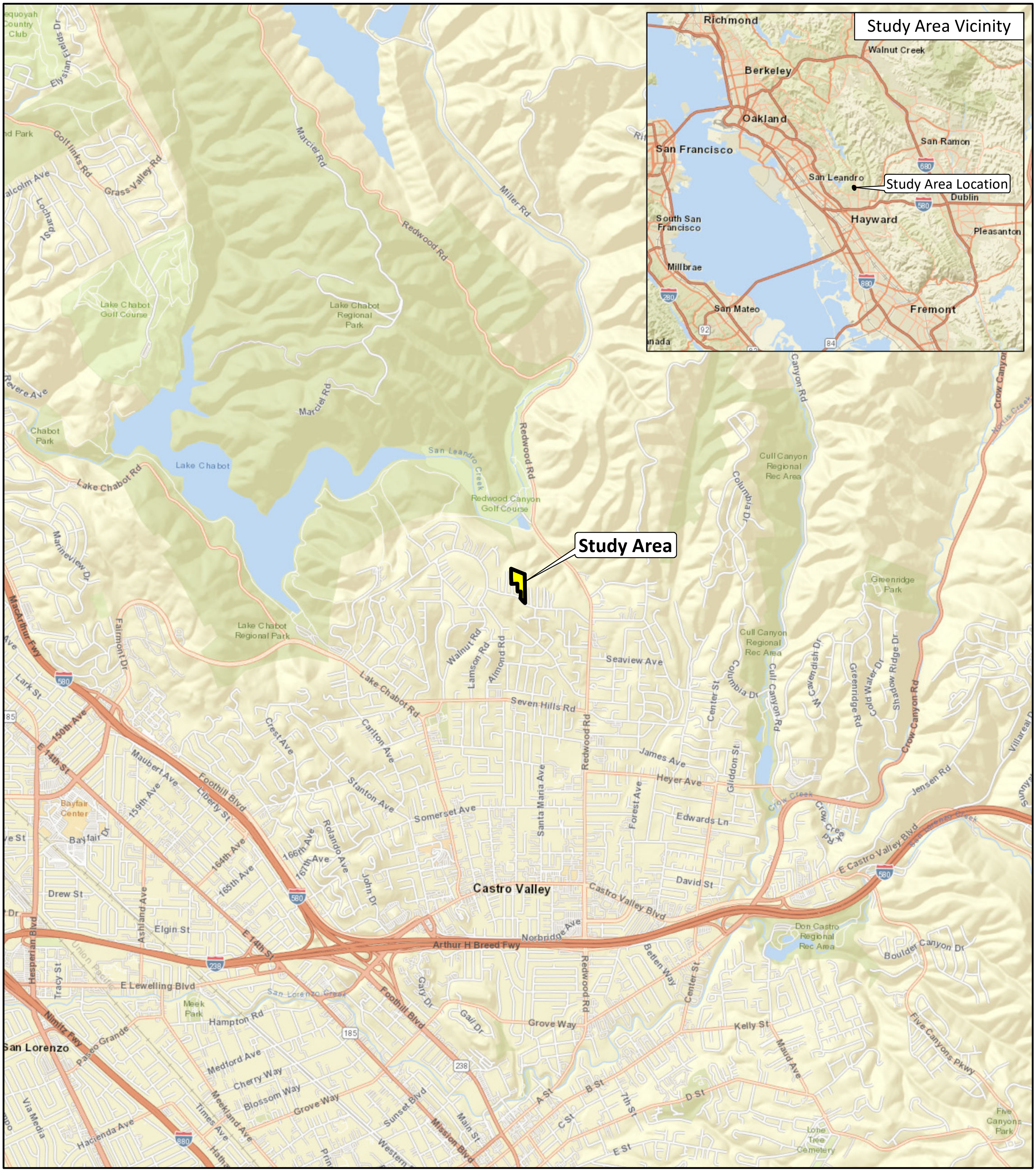
The proposed project would result in the subdivision of the existing parcel and the construction of 10 new single-family homes on the approximately 4-acre project site.

Regional vehicular access to the project site is provided by Interstate 580 (I-580), located approximately 1.85 miles south and 2.8 miles west of the project site. Bus stops along Seven Hills Road and Redwood Road provide transit service to the project site. The Castro Valley Bay Area Rapid Transit (BART) Station is located approximately 1.9 miles south of the project site Figures 1 and 2 show the project location and site plan, respectively.

EXISTING LAND USES IN THE PROJECT AREA

The project site is surrounded primarily by residential uses and vacant parcels. The areas adjacent to the project site include the following uses:

- **North:** Existing open space;
- **East:** Existing single-family residences;
- **South:** Existing single-family residences opposite Proctor Road; and
- **West:** Existing single-family residences.



LSA

LEGEND

Study Area

FIGURE 1

0 2000 4000
FEET

4738 Proctor Road Subdivision Project

Regional Location

SOURCE: Esri World Street Map (2022).

I:\AYP2201\GIS\MXDs\Cultural\Cultural Resources Study\Figure 1_Regional Location.mxd (6/6/2022)

NOTE

1. (N) STRUCTURES WILL BE LIMITED TO 30' MAXIMUM HEIGHT.
2. FIRE SPRINKLERS WILL BE REQUIRED FOR THE NEW HOUSES.
3. PAINT CURB RED WITH WORDING "NO PARKING – FIRE LANE" IN ALL NON PARKING AREAS TO MAINTAIN 20' MINIMUM FIRE LANE.
4. BUILDINGS ARE REQUIRED TO COMPLY WITH CHAPTER 7A OF THE 2019 CALIFORNIA BUILDING CODE AS ENFORCED BY THE BUILDING DEPARTMENT.
5. UNDERTAKE A PHOTOMETRIC STUDY TO DETERMINE HOW MANY STREET LIGHTS WILL BE NEEDED AT FOR THE NEW PUBLIC ROAD ALL LIGHTS SHALL HAVE LED LUMINAIRES.
6. AN ENCROACHMENT PERMIT FROM THE CITY IS REQUIRED FOR ANY WORK WITHIN PROCTOR RD RIGHT OF WAY.

KEYNOTES #

1. FIRE TRUCK TURN AROUND
2. BIORETENTION/DETENTION AREA
3. CURB AND GUTTER
4. CONCRETE SIDEWALK
5. VERTICAL CURB
6. 8'x22' PARKING STALL
7. EMERGENCY VEHICLE ACCESS TO PROCTOR TRAIL
8. CONCEPTUAL DRIVEWAY LOCATION
9. RETAINING WALL
10. CONFORM TO EXISTING
11. RECONSTRUCT (E) DRIVEWAY

CURVE TABLE			
CURVE #	LENGTH	RADIUS	DELTA
C1	21.16	16.00	Δ75°46'41"
C2	28.41	16.00	Δ101°44'46"
C3	97.41	156.00	Δ35°46'40"
C4	78.06	125.00	Δ35°46'40"
C5	55.41	90.00	Δ35°16'32"
C6	76.34	124.00	Δ35°16'32"
C7	76.34	124.00	Δ35°16'32"
C8	55.41	90.00	Δ35°16'32"
C9	35.69	30.50	Δ67°02'41"
C10	75.47	64.50	Δ67°02'41"
C11	42.07	105.00	Δ22°57'19"
C12	55.69	139.00	Δ22°57'19"
C13	43.98	28.00	Δ90°00'00"
C14	43.98	28.00	Δ90°00'00"

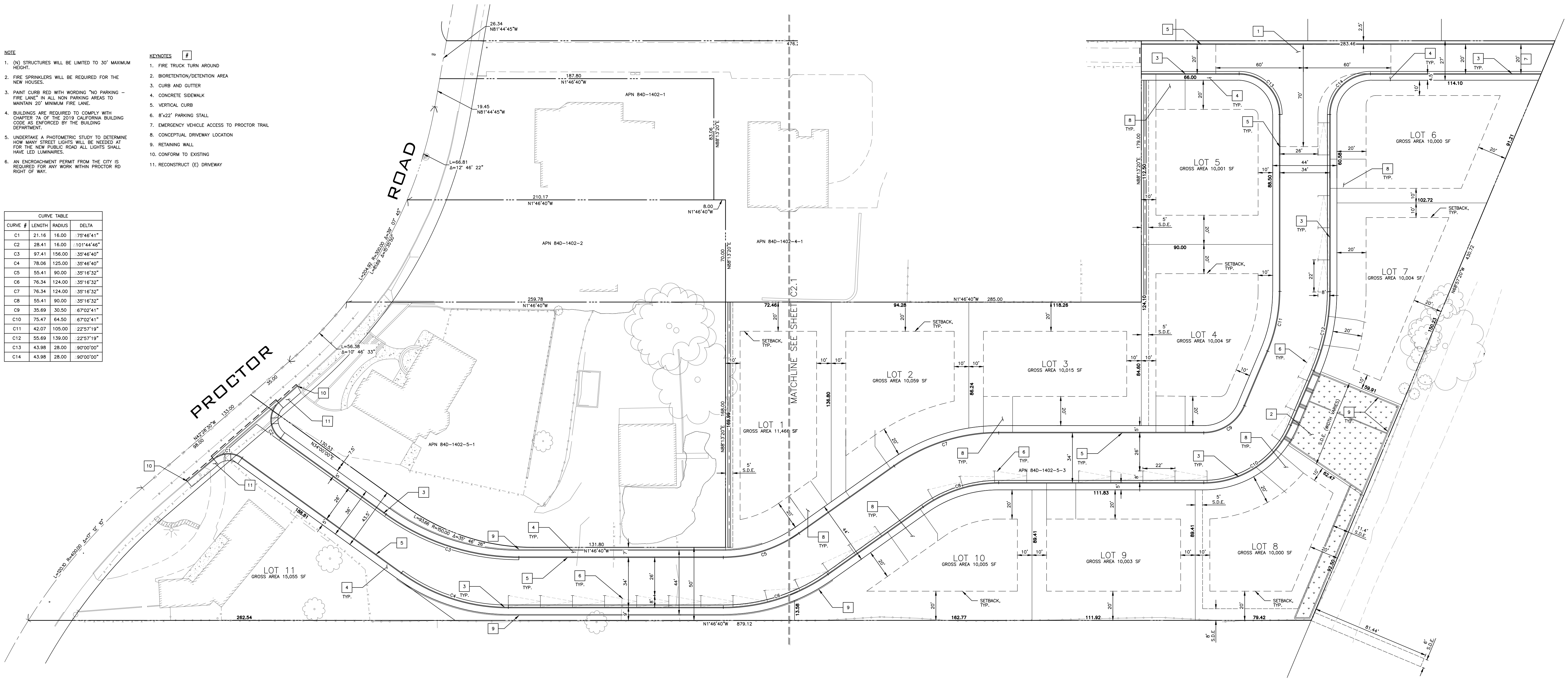


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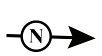
FIGURE 2



0 40 80
FEET

SOURCE: Greenwood & Moore, Inc.

4738 Proctor Subdivision

Site Plan

I:\SOC1801\G\Site_Plan.ai (9/19/2022)

NOISE AND VIBRATION FUNDAMENTALS

CHARACTERISTICS OF SOUND

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

To the human ear, sound has two significant characteristics: pitch and loudness. Pitch is generally an annoyance, while loudness can affect the ability to hear. Pitch is the number of complete vibrations, or cycles per second, of a sound wave, which results in the tone's range from high to low. Loudness is the strength of a sound, and it describes a noisy or quiet environment; it 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 is the average rate of sound energy transmitted through a unit area perpendicular to the direction in which the sound waves are traveling. 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 with the A-weighted decibel (dBA) scale to correct for the relative frequency response of the human ear. That is, an A-weighted noise level de-emphasizes low and very high frequencies of sound, similar to the human ear's de-emphasis of these frequencies. Decibels (dB), unlike the linear scale (e.g., inches or pounds), are measured on a logarithmic scale representing points on a sharply rising curve.

For example, 10 dB 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 sound's loudness. 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 levels dissipate exponentially with distance from their noise sources. 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. Line-source sound levels decrease 4.5 dB for each doubling of distance in a relatively flat environment with absorptive vegetation.

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. CNEL is the time-weighted average 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 relaxation hours. CNEL and L_{dn} are within 1 dBA of each other and are normally interchangeable. The County uses the CNEL noise scale for long-term traffic noise impact assessment.

Other noise rating scales of importance when assessing the annoyance factor include the maximum instantaneous noise level (L_{max}), which is the highest 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. It 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, which are 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 sound levels higher than 85 dBA. Exposure to high sound levels affects the entire system, with prolonged sound 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 sound exposure above 90 dBA would result in permanent cell damage. When the sound level reaches 120 dBA, a tickling sensation occurs in the human ear, even with short-term exposure. This level of sound is called the threshold of feeling. As the sound reaches 140 dBA, the tickling sensation is replaced by a feeling of pain in the ear (i.e., the threshold of pain). A sound level of 160–165 dBA will result in dizziness or a loss of equilibrium. The ambient or background noise problem is widespread and generally more concentrated in urban areas than in outlying, less developed areas.

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

Table A: Definitions of Acoustical Terms

Term	Definitions
Decibel, dB	A unit of sound measurement that denotes the ratio between two quantities that are proportional to power; the number of decibels is 10 times the logarithm (to the base 10) of this ratio.
Frequency, Hz	Of a function periodic in time, the number of times that the quantity repeats itself in 1 second (i.e., the 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 and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. (All sound levels in this report are A-weighted unless reported otherwise.)
L_{01}, L_{10}, L_{50}, L_{90}	The fast A-weighted noise levels that are equaled or exceeded by a fluctuating sound level 1%, 10%, 50%, and 90% of a stated time period, respectively.
Equivalent Continuous Noise Level, L_{eq}	The level of a steady sound that, in a stated time period and at a stated location, has the same A-weighted sound energy as the time-varying sound.
Community Noise Equivalent Level, CNEL	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 5 dBA to sound levels occurring in the evening from 7:00 p.m. to 10:00 p.m. and after the addition of 10 dBA to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
Day/Night Noise Level, L_{dn}	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 10 dBA to sound levels occurring in the night between 10:00 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 upon its amplitude, duration, frequency, time of occurrence, and tonal or informational content, as well as the prevailing ambient noise level.

Source: *Handbook of Acoustical Measurements and Noise Control* (Harris 1991).

Table B: Common Sound Levels and Their Noise Sources

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

Source: Compiled by LSA (2022).

FUNDAMENTALS OF VIBRATION

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

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

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

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

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

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

REGULATORY SETTING

APPLICABLE NOISE STANDARDS

The applicable noise standards governing the project site include the criteria in the California Code of Regulations, the Noise Element of the Alameda County's General Plan (Noise Element), and the Code of Ordinances.

California Code of Regulations

Interior noise levels for residential habitable rooms are regulated by Title 24 of the California Code of Regulations California Noise Insulation Standards. Title 24, Chapter 12, Section 1206.4, of the 2019 California Building Code requires that interior noise levels attributable to exterior sources not exceed 45 CNEL in any habitable room. A habitable room is a room used for living, sleeping, eating, or cooking. Bathrooms, closets, hallways, utility spaces, and similar areas are not considered habitable rooms for this regulation (Title 24 California Code of Regulations, Chapter 12, Section 1206.4).

Alameda County

Noise Element of the General Plan

The Alameda County Noise Element contains goals, objectives, and implementation programs for the entire County to provide its residents with an environment that is free from excessive noise and promotes compatibility of land uses with respect to noise. The Countywide Noise Element does not explicitly state what the acceptable outdoor noise level is for the backyards of single-family homes or common outdoor spaces of multi-family housing projects, but it recognizes the Federal Environmental Protection Agency (EPA) noise level standards for residential land uses. These standards are an exterior L_{dn} of 55 dBA and an interior L_{dn} of 45dBA. (The L_{dn} measurement, which also includes a 10 dBA weighting for night-time sound, is approximately equal to the CNEL for most environmental settings.) The Noise Element also references noise and land use compatibility standards developed by an Association of Bay Area Governments (ABAG), which identified a CNEL of 65 dBA or less as a basis for finding little noise impact on residential land uses, 65 to 70 dBA as a moderate impact, and any level above 70 dBA as a significant impact.

Code of Ordinances

Alameda County's Noise Ordinance (County General Code, Chapter 6.60) allows higher noise levels for commercial properties than for residential uses, schools, hospitals, churches, or libraries. These standards augment the State-mandated requirements of the Alameda County Building Code, which establishes standards for interior noise levels consistent with the noise insulation standards in the California State Building Code. Table C shows the number of cumulative minutes that a particular external noise level is permitted for receiving sensitive land uses such as single- or multi- family residential, school, hospital, church or public library properties.

The County Noise Ordinance also restricts the operation and use of electric and gas-powered tools in residential areas and authorizes the imposition of more stringent noise limits on activities subject to a conditional use permit. The Noise Ordinance does not apply to noise associated with construction if such activities take place between 7 a.m. and 7 p.m. on weekdays or between 9 a.m. and 8 p.m. on weekends.

Table C: Exterior Noise Level Standards - Sensitive Land Uses

Category	Cumulative Number of Minutes in any one-hour time period	Daytime 7 a.m. to 10 p.m.	Nighttime 10 p.m. to 7 a.m.
1	30	50	45
2	15	55	50
3	5	60	55
4	1	65	60
5	0	70	65

Source: Section 6.60.040 of the County of Alameda Code of Ordinance.
[1] Daytime means 7:00 a.m. to 10:00 p.m.
[2] Nighttime means 10:01 p.m. to 6:59 a.m.
dBA = A-weighted decibels
L_{eq} = equivalent continuous sound level

Federal Transit Administration

Although the City does not have daytime construction noise level limits for activities that occur within the specified hours in Section 11.80.030(D)(7) to determine potential California Environmental Quality Act (CEQA) noise impacts, construction noise was assessed using criteria from the *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018) (FTA Manual). Table D shows the Federal Transit Administration's (FTA) Detailed Assessment Construction Noise Criteria based on the composite noise levels per construction phase.

Table D: Detailed Assessment Daytime Construction Noise Criteria

Land Use	Daytime 8-hour L_{eq} (dBA)
Residential	80
Commercial	85
Industrial	90

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018).
dBA = A-weighted decibels
L_{eq} = equivalent continuous sound level

APPLICABLE VIBRATION STANDARDS

Federal Transit Administration

Because the County does not have vibration standards, vibration standards included in the FTA Manual are used in this analysis for ground-borne vibration impacts on human annoyance. The criteria for environmental impact from ground-borne vibration and noise are based on the maximum levels for a single event. Table E provides the criteria for assessing the potential for interference or annoyance from vibration levels in a building while Table F lists the potential vibration building damage criteria associated with construction activities.

Table E: Interpretation of Vibration Criteria for Detailed Analysis

Land Use	Max 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 20×).
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 (100×) and other equipment of low sensitivity.

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

[1] As measured in 1/3-octave bands of frequency over a frequency range of 8 to 80 Hertz.

FTA = Federal Transit Administration
Max = maximum
L_V = velocity in decibels
VdB = vibration velocity decibels

Table F: Construction Vibration Damage Criteria

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

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

FTA = Federal Transit Administration
PPV = peak particle velocity
in/sec = inch/inches per second

OVERVIEW OF THE EXISTING NOISE ENVIRONMENT

The primary existing noise sources in the project area are transportation facilities. Traffic on Proctor Road is a steady source of background ambient noise.

AMBIENT NOISE MEASUREMENTS

Long-Term Noise Measurements

Long-term (24-hour) noise level measurements were conducted on September 6 and 7, 2022, using two Larson Davis Spark 706RC Dosimeters. Table G provides a summary of the measured hourly noise levels from the long-term noise level measurements. Hourly noise levels at surrounding sensitive uses are as low as 39.9 dBA L_{eq} during nighttime hours and 37.8 dBA L_{eq} during daytime hours. Long-term noise monitoring data results are provided in Appendix A. Figure 3 shows the long-term monitoring locations.

Table G: Long-Term Ambient Noise Level Measurements

Location		Daytime Noise Levels[1] (dBA L_{eq})	Nighttime Noise Levels[2] (dBA L_{eq})	Day-Night Average Noise Level (dBA L_{dn})
LT-1	Along the eastern property line of the project site, approximately 390 feet north of Proctor Road.	39.7 – 48.3	39.9 – 45.9	49.8
LT-2	On the northwest portion of the project site, approximately 65 feet west if 17320 and 17360 Cardinal Court shared property line.	37.8 – 49.4	44.0 – 48.5	52.2

Source: Compiled by LSA (2022).
Note: Noise measurements were conducted from September 6 to September 7, 2022, starting at 3:00 p.m.
[1] Daytime Noise Levels = Noise levels during the hours from 7:00 a.m. to 10:00 p.m.
[2] Nighttime Noise Levels = Noise levels during the hours from 10:00 p.m. to 7:00 a.m.
dBA = A-weighted decibels
L_{eq} = equivalent continuous sound level

EXISTING AIRCRAFT NOISE

Airport-related noise levels are primarily associated with aircraft engine noise made while aircraft are taking off, landing, or running their engines while still on the ground. The closest airport to the proposed project site is Oakland International Airport (OAK) located approximately 7 miles (mi) west of the project site. Based on the Oakland International Airport Master Plan, the project is located well outside of the 60 dBA CNEL noise contour of the airport.

LSA

LEGEND

Project Site Boundary

LT-1 Long-term Noise Monitoring Location

FIGURE 3

0 150 300

FEET

4738 Proctor Subdivision

Noise Monitoring Locations

SOURCE: Google Earth, 8/5/2020; LSA, 2022

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Figure 3: Noise Monitoring Locations

PROJECT IMPACT ANALYSIS

SHORT-TERM CONSTRUCTION NOISE IMPACTS

Two types of short-term noise impacts could occur during the construction of the proposed project. First, construction crew commutes and the transport of construction equipment and materials to the site for the proposed project would incrementally increase noise levels on access roads leading to the site. 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 84 dBA L_{max}), the effect on longer-term ambient noise levels would be small when compared to existing daily traffic volumes of 2,339 (TJKM 2010) on Proctor Road. Because construction-related vehicle trips would not approach existing daily traffic volumes, traffic noise would not increase by 3 dBA CNEL. A noise level increase of less than 3 dBA would not be perceptible to the human ear in an outdoor environment. Therefore, short-term, construction-related impacts associated with worker commute and equipment transport to the project site would be less than significant.

The second type of short-term noise impact is related to noise generated during construction, which includes demolition, site preparation, grading, building construction, paving, and architectural coating on the project site. Construction is completed in discrete steps, each of which has its own mix of equipment and, consequently, its own noise characteristics. These various sequential phases would change the character of the noise generated on the site and, therefore, the noise levels surrounding the site as construction progresses. Despite the variety in the type and size of construction equipment, similarities in the dominant noise sources and patterns of operation allow construction-related noise ranges to be categorized by work phase. Table H lists typical construction equipment noise levels recommended for noise impact assessments, based on a distance of 50 ft between the equipment and a noise receptor, taken from the Federal Highway Administration (FHWA) *Roadway Construction Noise Model* (FHWA 2006).

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

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

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

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

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

D = distance from the receiver to the piece of equipment.

Table H: Typical Construction Equipment Noise Levels

Equipment Description	Acoustical Usage Factor (%)[1]	Maximum Noise Level (L_{max}) at 50 Feet[2]
Auger Drill Rig	20	84
Backhoes	40	80
Compactor (ground)	20	80
Compressor	40	80
Cranes	16	85
Dozers	40	85
Dump Trucks	40	84
Excavators	40	85
Flat Bed Trucks	40	84
Forklift	20	85
Front-end Loaders	40	80
Graders	40	85
Impact Pile Drivers	20	95
Jackhammers	20	85
Paver	50	77
Pickup Truck	40	55
Pneumatic Tools	50	85
Pumps	50	77
Rock Drills	20	85
Rollers	20	85
Scrapers	40	85
Tractors	40	84
Trencher	50	80
Welder	40	73

Source: *FHWA Roadway Construction Noise Model User's Guide,* Table 1 (FHWA 2006).
Note: 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 Central Artery/Tunnel program to be consistent with the City of Boston's Noise Code for the "Big Dig" project.
FHWA = Federal Highway Administration
L_{max} = maximum instantaneous sound level

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

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

Using the equations from the methodology above, the reference information in Table H, and the construction equipment list provided, the composite noise level of each construction phase was calculated. The project construction composite noise levels at a distance of 50 feet would range from 74 dBA L_{eq} to 88 dBA L_{eq}, with the highest noise levels occurring during the site preparation phase.

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

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

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

Table I shows the nearest sensitive uses to the project site, their distance from the center of construction activities, and composite noise levels expected during construction. These noise level projections do not consider intervening topography or barriers. Construction equipment calculations are provided in Appendix B.

Table I: Potential Construction Noise Impacts at Nearest Receptor During Site Preparation

Receptor (Location)	Composite Noise Level (dBA L_{eq}) at 50 feet[1]	Distance (feet)	Composite Noise Level (dBA L_{eq})
Residences (West)	88	170	77
Residences (East)		285	73
Residences (South)		440	69

Source: Compiled by LSA (2022).

[1] The composite construction noise level represents the site preparation phases, which are expected to result in the greatest noise level as compared to other phases.

dBA = A-weighted decibels L_{eq} = equivalent continuous sound level

While construction noise will vary, it is expected that composite noise levels during construction at the nearest off-site sensitive residential use to the west would reach an average noise level of 77 dBA L_{eq} during daytime hours. These predicted noise levels would only occur when all construction equipment is operating simultaneously and, therefore, are assumed to be rather conservative in nature. While construction-related short-term noise levels have the potential to be higher than existing ambient noise levels in the project area under existing conditions, the noise impacts would no longer occur once project construction is completed.

As stated above, construction activities are regulated by the County's Noise Ordinance. The proposed project would comply with the construction hours specified in the County's Noise Ordinance, which states that construction activities are allowed between the hours of 7 a.m. and 7 p.m. on weekdays or between 9 a.m. and 8 p.m. on weekends.

As it relates to off-site uses, construction-related noise levels would remain below the daytime 80 dBA L_{eq} 8-hour construction noise level criteria established by the FTA for residential and similar sensitive uses and, therefore, would be considered less than significant. Best construction practices presented at the end of this analysis shall be implemented to minimize noise impacts to surrounding receptors.

SHORT-TERM CONSTRUCTION VIBRATION IMPACTS

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

Table J shows the PPV and VdB values at 25 ft from the construction vibration source. As shown in Table J, bulldozers and other heavy-tracked construction equipment (expected to be used for this project) generate approximately 0.089 PPV in/sec or 87 VdB of ground-borne vibration when measured at 25 ft, based on the FTA Manual. The distance to the nearest buildings for vibration impact analysis is measured between the nearest off-site buildings and the project construction boundary (assuming the construction equipment would be used at or near the project setback line).

Table J: 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[2]	**0.089**	**87**
Caisson Drilling	0.089	87
Loaded Trucks[2]	**0.076**	**86**
Jackhammer	0.035	79
Small Bulldozer	0.003	58

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018).
[1] RMS vibration velocity in decibels (VdB) is 1 μin/sec.
[2] Equipment shown in **bold** is expected to be used on site.
μin/sec = microinches per second
ft = foot/feet
FTA = Federal Transit Administration
in/sec = inch/inches per second
L_V = velocity in decibels
PPV = peak particle velocity
RMS = root-mean-square
VdB = vibration velocity decibels

The formulae for vibration transmission are provided below, and Tables K and L provide a summary of off-site construction vibration levels.

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

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

As shown in Table E, above, the threshold at which vibration levels would result in annoyance would be 78 VdB for daytime residential uses. As shown in Table F, the FTA guidelines indicate that for a non-engineered timber and masonry building, the construction vibration damage criterion is 0.2 in/sec in PPV.

Table K: Potential Construction Vibration Annoyance Impacts at Nearest Receptor

Receptor (Location)	Reference Vibration Level (VdB) at 25 ft[1]	Distance (ft)[2]	Vibration Level (VdB)
Residences (West)	87	170	62
Residences (East)		285	55
Residences (South)		440	50

Source: Compiled by LSA (2022).

[1] The reference vibration level is associated with a large bulldozer, which is expected to be representative of the heavy equipment used during construction.

[2] The reference distance is associated with the average condition, identified by the distance from the center of construction activities to surrounding uses.

ft = foot/feet

VdB = vibration velocity decibels

Table L: Potential Construction Vibration Damage Impacts at Nearest Receptor

Receptor (Location)	Reference Vibration Level (PPV) at 25 ft[1]	Distance (ft)[2]	Vibration Level (PPV)
Residences (West)	0.089	45	0.037
Residences (East)		20	0.124
Residences (South)		80	0.016

Source: Compiled by LSA (2022).

[1] The reference vibration level is associated with a large bulldozer, which is expected to be representative of the heavy equipment used during construction.

[2] The reference distance is associated with the peak condition, identified by the distance from the perimeter of construction activities to surrounding structures.

ft = foot/feet

PPV = peak particle velocity

Based on the information provided in Table K, vibration levels are expected to approach 62 VdB at the closest residential uses located immediately west of the project site, which is below the 78 VdB threshold for annoyance. Based on the information provided in Table L, vibration levels are expected to approach 0.124 PPV in/sec at the nearest surrounding structures and would be below the 0.2 PPV in/sec damage threshold.

Because construction activities are regulated by the County’s Code of Ordinance, which states that temporary construction, maintenance, or demolition activities are allowed between the hours of 7 a.m. and 7 p.m. on weekdays or between 9 a.m. and 8 p.m. on weekends, vibration impacts would not occur during the more sensitive nighttime hours.

LONG-TERM OFF-SITE TRAFFIC NOISE IMPACTS

In order to assess the potential traffic impacts related to the proposed project, LSA prepared the *Traffic Analysis for 4738 Proctor Road Subdivision Project in Castro Valley, California*. Based on the analysis results, it was determined that a net additional 85 average daily trips (ADT) would be generated by the proposed project. The existing (2010) traffic volume on the adjacent segment of Proctor Road is 2,339 (TJKM 2010). Using 2,339 as the existing ADT is considered a conservative approach as the current ADT is likely higher. The following equation was used to determine the potential impacts of the project:

$$\text{Change in CNEL} = 10\ log_{10}\left[V_{e+p}/V_{existing}\right]$$

where: $V_{existing}$ = existing daily volumes
V_{e+p} = existing daily volumes plus project
Change in CNEL = increase in noise level due to the project

The results of the calculations show that an increase of approximately 0.2 dBA CNEL is expected along the streets adjacent to the project site. A noise level increase of less than 1 dBA would not be perceptible to the human ear; therefore, the traffic noise increases in the vicinity of the project site resulting from the proposed project would be less than significant. No mitigation is required.

LONG-TERM TRAFFIC-RELATED VIBRATION IMPACTS

The proposed project would not generate vibration levels related to on-site operations. In addition, vibration levels generated from project-related traffic on the adjacent roadways are unusual for on-road vehicles because the rubber tires and suspension systems of on-road vehicles provide vibration isolation. Vibration levels generated from project-related traffic on the adjacent roadways would be less than significant, and no mitigation measures are required.

BEST CONSTRUCTION PRACTICES

In addition to compliance with the County's code of ordinance allowed hours of construction allowed between the hours of 7 a.m. and 7 p.m. on weekdays or between 9 a.m. and 8 p.m. on weekends, the following recommendations would reduce construction noise to the extent feasible:

- The project construction contractor should equip all construction equipment, fixed or mobile, with properly operating and maintained noise mufflers, consistent with manufacturer's standards.
- The project construction contractor should locate staging areas away from off-site sensitive uses during the later phases of project development.
- The project construction contractor should place all stationary construction equipment so that emitted noise is directed away from sensitive receptors nearest the project site whenever feasible.

LAND USE COMPATIBILITY

The dominant source of noise in the project vicinity is traffic noise from roadways in the vicinity of the project.

EXTERIOR NOISE ASSESSMENT

As shown in Table G, the existing measured noise levels at the project site range from approximately 49.8 dBA L_{dn} to 52.2 dBA L_{dn}. As compared to the information in the County's Noise Element section of this report, an exterior noise level of up to 55 dBA L_{dn} would be considered the standard for community noise exposure.

Based on the project site plan, the rear yards are considered as an exterior sensitive use, with estimated noise levels approaching 53 dBA L_{dn} without accounting for shielding provided by existing or proposed buildings. This level is below the County's 55 dBA L_{dn} exterior noise level standard. Therefore, noise reduction measures would not be required.

INTERIOR NOISE ASSESSMENT

As discussed above, per the California Code of Regulations and the County's interior noise level standard, an interior noise level standard of 45 dBA CNEL or less is required for all noise-sensitive rooms. Based on the expected future exterior noise levels at the residences closest to Proctor Road approaching 53 dBA CNEL, a minimum noise reduction of 8 dBA would be required.

The interior noise levels were calculated from the exterior noise levels and based on the United States Environmental Protection Agency's (EPA) Protective Noise Levels, with a combination of exterior walls, doors, and windows. Standard construction in California residential buildings would provide an exterior-to-interior noise reduction of 12 dBA or more with windows open (the national average is 15 dBA with windows open). Therefore, with standard building construction, interior noise levels would meet the County's noise standard.

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APPENDIX A

NOISE MONITORING DATA

Noise Measurement Survey – 24 HR

Project Number: AYP2201
Project Name: 4738 Proctor Subdivision

Test Personnel: J.T. Stephens
Equipment: Spark 706RC (SN:18903)

Site Number: LT-1 Date: 9/6-9/7/22

Time: From 3:00 p.m. To 3:00 p.m.

Site Location: Along the eastern property line of the project site, approximately 390 feet north of Proctor Road

Primary Noise Sources: General ambient, distant construction

Comments: Very quiet

Photo:

Noise Measurement Survey – 24 HR

Project Number: AYP2201
Project Name: 4738 Proctor Subdivision

Test Personnel: J.T. Stephens
Equipment: Spark 706RC (SN:18904)

Site Number: LT-2 Date: 9/6-9/7/22

Time: From 3:00 p.m. To 3:00 p.m.

Site Location: On the northwest portion of the project site, approximately 65 feet west of the 17320 and 17360 Cardinal Court shared property line.

Primary Noise Sources: General ambient, distant construction

Comments: Very quiet

Photo:

APPENDIX B

CONSTRUCTION NOISE CALCULATIONS

Construction Calculations

Phase: Demolition

Equipment	Quantity	Reference (dBA) 50 ft Lmax	Usage Factor[1]	Distance to Receptor (ft)	Ground Effects	Noise Level (dBA)	
						Lmax	Leq
Concrete Saw	1	90	20	50	0.5	90	83
Excavator	3	81	40	50	0.5	81	82
Dozer	2	82	40	50	0.5	82	81
					Combined at 50 feet	**91**	**87**

Phase: Site Preparation

Equipment	Quantity	Reference (dBA) 50 ft Lmax	Usage Factor[1]	Distance to Receptor (ft)	Ground Effects	Noise Level (dBA)	
						Lmax	Leq
Dozer	3	82	40	50	0.5	82	83
Tractor	4	84	40	50	0.5	84	86
					Combined at 50 feet	**86**	**88**
					Combined at Receptor 170 feet	**75**	**77**
					Combined at Receptor 285 feet	**71**	**73**
					Combined at Receptor 440 feet	**67**	**69**

Phase: Grading

Equipment	Quantity	Reference (dBA) 50 ft Lmax	Usage Factor[1]	Distance to Receptor (ft)	Ground Effects	Noise Level (dBA)	
						Lmax	Leq
Excavator	1	81	40	50	0.5	81	77
Grader	1	85	40	50	0.5	85	81
Dozer	1	82	40	50	0.5	82	78
Tractor	3	84	40	50	0.5	84	85
					Combined at 50 feet	**89**	**87**

Phase:Building Construstion

Equipment	Quantity	Reference (dBA) 50 ft Lmax	Usage Factor[1]	Distance to Receptor (ft)	Ground Effects	Noise Level (dBA)	
						Lmax	Leq
Crane	1	81	16	50	0.5	81	73
Man Lift	3	75	20	50	0.5	75	73
Generator	1	81	50	50	0.5	81	78
Tractor	3	84	40	50	0.5	84	85
Welder / Torch	1	74	40	50	0.5	74	70
					Combined at 50 feet	**87**	**86**

Phase:Paving

Equipment	Quantity	Reference (dBA) 50 ft Lmax	Usage Factor[1]	Distance to Receptor (ft)	Ground Effects	Noise Level (dBA)	
						Lmax	Leq
Paver	1	77	50	50	0.5	77	74
All Other Equipment > 5 HP	2	85	50	50	0.5	85	85
Roller	2	80	20	50	0.5	80	76
Drum Mixer	2	80	50	50	0.5	80	80
Tractor	1	84	40	50	0.5	84	80
					Combined at 50 feet	**89**	**88**

Phase:Architectural Coating

Equipment	Quantity	Reference (dBA) 50 ft Lmax	Usage Factor[1]	Distance to Receptor (ft)	Ground Effects	Noise Level (dBA)	
						Lmax	Leq
Compressor (air)	1	78	40	50	0.5	78	74
					Combined at 50 feet	**78**	**74**

Sources: RCNM

[1]- Percentage of time that a piece of equipment is operating at full power.
dBA – A-weighted Decibels
Lmax- Maximum Level
Leq- Equivalent Level