Storm Drain Signage SD-13

Design Objectives

Maximize Infiltration

Provide Retention

Slow Runoff

Minimize Impervious Land Coverage

☑ Prohibit Dumping of Improper Materials

Contain Pollutants

Collect and Convey

Description

Waste materials dumped into storm drain inlets can have severe impacts on receiving and ground waters. Posting notices regarding discharge prohibitions at storm drain inlets can prevent waste dumping. Storm drain signs and stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets.

Approach

The stencil or affixed sign contains a brief statement that prohibits dumping of improper materials into the urban runoff conveyance system. Storm drain messages have become a popular method of alerting the public about the effects of and the prohibitions against waste disposal.

Suitable Applications

Stencils and signs alert the public to the destination of pollutants discharged to the storm drain. Signs are appropriate in residential, commercial, and industrial areas, as well as any other area where contributions or dumping to storm drains is likely.

Design Considerations

Storm drain message markers or placards are recommended at all storm drain inlets within the boundary of a development project. The marker should be placed in clear sight facing toward anyone approaching the inlet from either side. All storm drain inlet locations should be identified on the development site map.

Designing New Installations

The following methods should be considered for inclusion in the project design and show on project plans:

- Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language. Examples include “NO DUMPING

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– DRAINS TO OCEAN" and/or other graphical icons to discourage illegal dumping.

- Post signs with prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area.

Note - Some local agencies have approved specific signage and/or storm drain message placards for use. Consult local agency stormwater staff to determine specific requirements for placard types and methods of application.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. If the project meets the definition of "redevelopment", then the requirements stated under " designing new installations" above should be included in all project design plans.

Additional Information

Maintenance Considerations

- Legibility of markers and signs should be maintained. If required by the agency with jurisdiction over the project, the owner/operator or homeowner's association should enter into a maintenance agreement with the agency or record a deed restriction upon the property title to maintain the legibility of placards or signs.

Placement

- Signage on top of curbs tends to weather and fade.

- Signage on face of curbs tends to be worn by contact with vehicle tires and sweeper brooms.

Supplemental Information

Examples

- Most MS4 programs have storm drain signage programs. Some MS4 programs will provide stencils, or arrange for volunteers to stencil storm drains as part of their outreach program.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

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ASSESSMENT OF ENVIRONMENTAL NOISE

SINGLE FAMILY RESIDENCE AT LA SIERRA AND VICTORIA NOISE REPORT

May 3, 2024

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Contents

ASSESSMENT OF ENVIRONMENTAL NOISE

1.0 INTRODUCTION

This report evaluates potential impacts associated with the construction and operation noise of the proposed single family residential project at La Sierra and Victoria in Riverside, California.

1.1 Project Description

The proposed development consists of a two-story, 49-unit single-family residential project with an attached garage located at La Sierra and Victoria. The project is bounded by La Sierra Ave to the southwest, Victoria Avenue to the northwest, Millsweet Place to the northeast, and existing residential uses to the southeast.

Figure 1 – Areal Image of the Proposed Project Site

1.2 Characteristics of Noise

Noise is usually defined as unwanted sound and can be an undesirable by-product of society's normal day-to-day activities. Sound becomes unwanted when it interferes with normal activities, causes actual physical harm, or has an adverse effect on health.

People judge the relative magnitude of sound sensation in subjective terms such as "noisiness" or "loudness." However, the sound pressure magnitude can be objectively measured and quantified using a logarithmic ratio of pressures which yields the level of sound, utilizing the measurement scale of decibels (dB). The decibel is generally adjusted to the A-weighted level (dBA) which de-emphasizes very low frequencies to better approximate the human ear's range of sensitivity. In practice, the noise level of a sound source is measured using a sound level meter that includes an electronic filter corresponding to the A-weighting curve. Table A.1 in Appendix A of this report defines the decibel along with other technical terms used in this analysis.

Even though the A-weighted scale accounts for the relative loudness perceived by the human ear and, therefore, is commonly used to quantify individual events or general community sound levels, the degree of annoyance or other response effects also depends on several other perceptibility factors, including:

- Ambient (background) sound level
- Magnitude of the event sound level relative to the background noise
- Spectral (frequency) composition (e.g. presence of tones)
- Duration of the sound event
- Number of event occurrences, repetitiveness, and intermittency
- Time of day the event occurs.

In determining the daily level of environmental noise, it is important to account for the difference in human responses to daytime and nighttime noises. At night, exterior background noise levels are generally lower than daytime levels. However, most household noise also decreases at night, and exterior noise may become increasingly noticeable. Further, most people sleep at night and have greater sensitivity to noise intrusion. To account for human sensitivity to nighttime noise levels, a 24-hour descriptor, the Community Noise Equivalent Level (CNEL), has been developed. The CNEL divides the 24-hour day into a daytime period of 7:00 a.m. to 7:00 p.m., an evening period from 7:00 p.m. to 10:00 p.m., and a nighttime period of 10:00 p.m. to 7:00 a.m. In determining the CNEL, noise levels occurring during the evening period are increase by 5 dB, while noise levels occurring during the nighttime period are increased by 10 dB to account for the greater sensitivity during the evening and nighttime periods.

The effects of noise on people fall into three general categories:

- Subjective effects of annoyance and nuisance.
- Interference with activities such as speech, sleep, and learning.
- Physiological effects such as hearing loss.

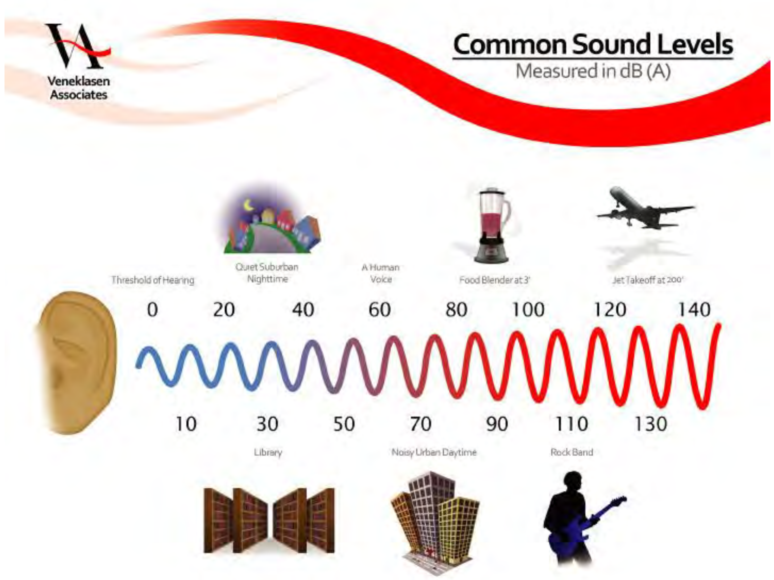
In most cases, the levels associated with environmental noise produce effects only in the first two categories. However, workers in industrial plants may experience noise effects in the last category. There is no completely effective way to measure the subjective effects of noise or the corresponding reactions of annoyance, because of the wide variation in individual thresholds of annoyance and degrees to which people become acclimated to noise. Thus, an important way of determining a person's subjective reaction to a new noise source is by comparison to the existing environment to which they are accustomed (the "ambient environment"). In general, the more the level of a noise event exceeds the prevailing ambient noise level, the less acceptable the noise source will be to those exposed to it.

With regard to increases in A-weighted noise levels, the following relationships are applicable to this analysis:

- Except in carefully controlled laboratory experiments, a 1 dB change cannot be perceived.
- Outside of a laboratory, a 3 dBA change will be generally perceivable by most people.
- A change in level of at least 5 dBA is considered a noticeable change by most people.
- A 10 dBA change will result in the perception of doubling or halving the loudness of the noise.

Common noise levels associated with various activities are shown on Figure 2, Common Noise Levels.

Figure 2 – Common Noise Levels



Noise sources are either "point sources", such as stationary equipment or individual motor vehicles, or "line sources", such as a roadway with a large number of mobile point sources (motor vehicles). Sound generated by a stationary point source typically diminishes (attenuates) at a rate of 6 dBA for each doubling of distance from the source to the receptor at acoustically "hard" sites, and at a rate of 7.5 dBA at acoustically "soft" sites.[1] For example, a 60 dBA noise level measured at 50 feet from a point source at an acoustically hard site would be 54 dBA at 100 feet from the source and it would be 48 dBA at 200 feet from the source. Sound generated by a line source typically attenuates at a rate of 3 dBA and 4.5 dBA per doubling of distance from the source to the receptor for hard and soft sites, respectively.[2] Man-made or natural barriers can also attenuate sound levels.

The minimum attenuation of exterior to interior noise provided by typical structures is provided in Table 1, Outside to Inside Noise Attenuation.

Table 1 – Outside to Inside Noise Attenuation (dBA)

Building Type	Open Windows	Closed Windows[1]
Residences	17	25
Schools	17	25
Churches	20	30
Hospitals/Convalescent Homes	17	25
Offices	17	25
Theaters	20	30
Hotels/Motels	17	25

Source: Transportation Research Board, National Research Council, Highway Noise: A Design Guide for Highway Engineers*, National Cooperative Highway Research Program Report 117.*
[1] *As shown, structures with closed windows can attenuate exterior noise by a minimum of 25 to 30 dBA.*

1.3 Characteristics of Vibration

Vibration is minute variation in pressure through structures and the earth, whereas, noise is minute variation in pressure through air. Some vibration effects can be caused by noise; e.g., the rattling of windows from truck pass-bys. This phenomenon is related to the coupling of the acoustic energy at frequencies that are close to the resonant frequency of the material being vibrated. Ground-borne vibration attenuates rapidly as distance from the source of the vibration increases. Vibration amplitude can be measured as peak particle velocity (PPV), the maximum

[1] U.S. Department of Transportation, Federal Highway Administration, *Highway Noise Fundamentals*, (Springfield, Virginia: U.S. Department of Transportation, Federal Highway Administration, September 1980), p. 97. A "hard" or reflective site does not provide any excess ground-effect attenuation and is characteristic of asphalt, concrete, and very hard packed soils. An acoustically "soft" or absorptive site is characteristic of normal earth and most ground with vegetation.

[2] U.S. Department of Transportation, Federal Highway Administration, *Highway Noise Fundamentals*, (Springfield, Virginia: U.S. Department of Transportation, Federal Highway Administration, September 1980), p. 97.

instantaneous peak amplitude in inches per second, or root-mean-square (RMS) velocity in inches per second or as vibration level in decibels (VdB) referenced to 1 micro-inch per second. The ratio between the PPV and the maximum RMS amplitude is termed the "crest factor." According to the Federal Transit Administration (FTA), the PPV level for construction equipment is typically 1.7 to 6 times greater than the RMS vibration level. The FTA uses a crest factor of 4 for the conversion of PPV levels to RMS vibration levels. For the purposes of ground-borne vibration analysis of impacts to existing structures, vibration velocity is described in terms of PPV. For the analysis of the human response to vibration, VdB is utilized.

The vibration velocity threshold of perception for humans is approximately 65 VdB, and a vibration velocity of 75 VdB is the approximate dividing line between barely perceptible and distinctly perceptible levels for many people[3]. Most perceptible indoor vibration is caused by sources within buildings such as operation of mechanical equipment, movement of people, or the slamming of doors. Typical outdoor sources of perceptible ground-borne vibration are construction equipment, steel-wheeled trains, and traffic on rough roads. Common ground-induced vibrations related to roadway traffic and construction activities pose no threat to buildings or structures. If a roadway is smooth, the ground-borne vibration from traffic is barely perceptible. The range of interest is from approximately 50 VdB, which is typically the background vibration velocity, to 94 VdB. This 94 VdB vibration level corresponds to 0.2 PPV, which is the general threshold where minor damage can occur in non-engineered timber and masonry buildings.

2.0 REGULATORY FRAMEWORK

Many government agencies have established noise regulations and policies to protect citizens from potential hearing damage and various other adverse physiological and social effects associated with noise and ground-borne vibration. The City of Riverside has adopted the Noise Element section, which is based in part on Federal and State regulations and is intended to control, minimize, or mitigate environmental noise effects. The regulations and policies that are relevant to project construction and operation noise are discussed below.

2.1 Applicable State Noise Standards

The State of California has adopted noise compatibility guidelines for general land use planning. The types of land uses addressed by the State standards and the acceptable noise categories for each land use are included in the State of California General Plan Guidelines, which is published and updated by the Governor's Office of Planning and Research. The level of acceptability of the noise environment is dependent upon the activity associated with the particular land use. According to the State, an exterior noise environment up to 65 CNEL is "normally acceptable" for single and multi-family residential uses, up to 75 CNEL is "conditionally acceptable" with special noise insulation

[3] – U.S. Department of Transportation, Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, (Washington, DC: U.S. Department of Transportation, Federal Transit Administration, May 2006), p. 7-8.

requirements, while 75 CNEL and above is identified as "clearly unacceptable" noise levels for residential and hotel uses, respectively.[4] The maximum allowable interior noise level for residential structures is 45 CNEL.

The California Environmental Quality Act (CEQA) Guidelines establishes guidelines for the evaluation of significant impacts of environmental noise attributable to a proposed project. The guidelines ask whether the project would result in:

1. Would the project generate a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?

2. Would the project generate excessive ground borne vibration or ground born noise levels?

3. For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?

2.2 City of Riverside General Plan Noise Element

The project site is located in the City of Riverside and therefore would potentially affect receptors within the city from onsite and offsite sources. The City Noise Element of the General Plan is a comprehensive program for including noise management in the planning process, providing a tool for planners to use in achieving and maintaining land uses that are compatible with existing and future environmental noise levels. The Noise Policy identifies noise-sensitive land uses and noise sources and defines areas of noise impact for the purpose of developing programs to ensure that residents in Riverside, and other noise sensitive land uses, will be protected from excessive noise intrusion.

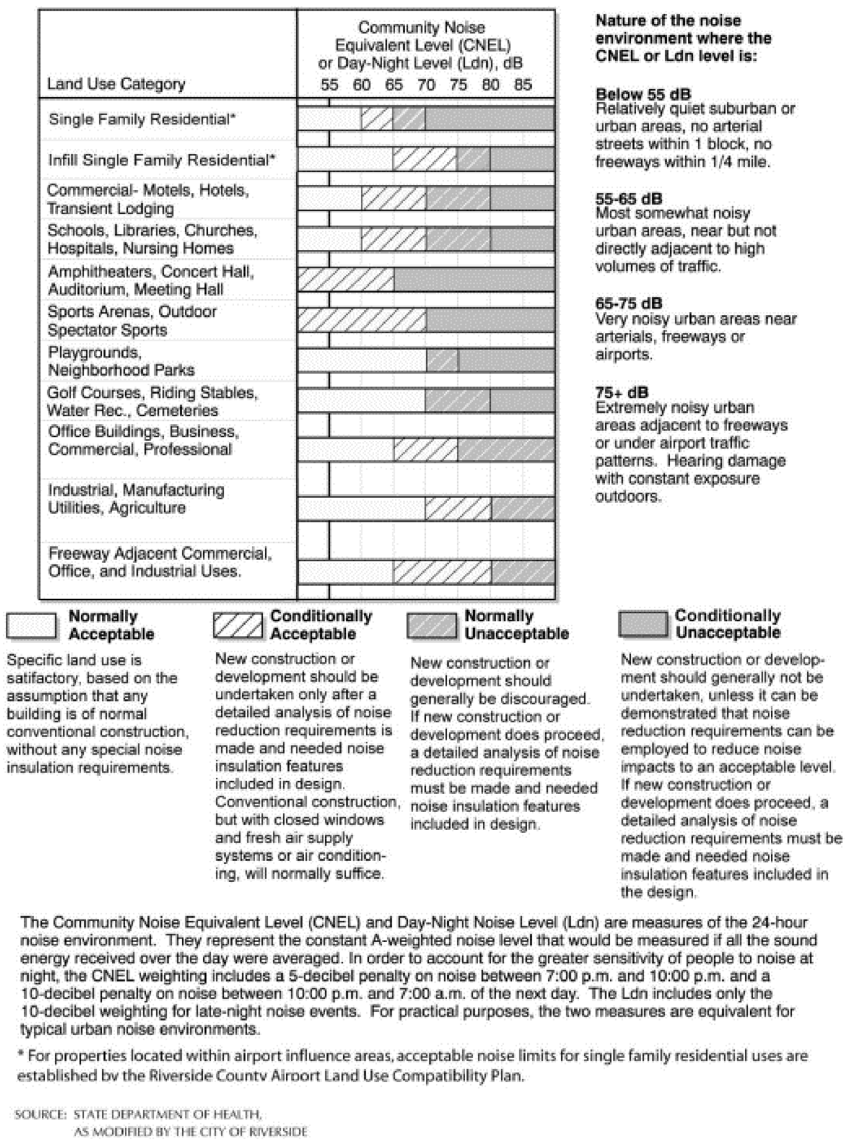
As development proposals are submitted to the City, each is evaluated with respect to the provisions in the Noise Element to ensure that noise impacts are reduced through planning and project design. Through implementation of the policies of the Noise Element, Riverside seeks to reduce or avoid adverse noise impacts for the purposes of protecting the general health, safety, and welfare of the community. The most basic planning strategy to minimize adverse impacts on new land uses due to noise is to avoid designating certain land uses at locations within the city that would negatively affect noise sensitive land users. Users such as schools, hospitals, childcare, senior care, congregate care, churches, and all types of residential use should be located outside of any area anticipated to exceed acceptable noise levels as defined by the Land Use Compatibility Matrix or should be protected from noise

[4] – State of California, Governor's Office of Planning and Research, *General Plan Guidelines*, (Sacramento, CA: State of California, Governor's Office of Planning and Research, October 2003), p. 250.

through sound attenuation measures such as site and architectural design and sound walls. The City of Riverside has adopted guidelines as a basis for planning decisions based on noise considerations. These guidelines are shown in Figure 3.

In the case that the noise levels identified at a proposed project site fall within levels considered normally acceptable, the project is considered compatible with the existing noise environment.

Figure 3 – Noise/Land Use Compatibility Matrix



The goals, policies and implementation actions of the Noise Element address three major issues related to noise. These include:

1) Objective N-1: Minimize noise levels from point sources throughout the community and, wherever possible, mitigate the effects of noise to provide a safe and healthful environment.
2) Objective N–2: Minimize the adverse effects of airportrelated noise through proper land use planning.
3) Objective N–3: Ensure the viability of March Air Reserve Base/March Inland Port.
4) Objective N–4: Minimize ground transportation-related noise impacts.

<u>Objective N-1: Minimize noise levels from point sources.</u>

Policy N–1.1: Continue to enforce noise abatement and control measures particularly within residential neighborhoods.

Policy N–1.2: Require the inclusion of noise-reducing design features in development consistent with standards in Figure N–10 (Noise/Land Use Compatibility Criteria), Title 24 California Code of Regulations and Title 7 of the Municipal Code.

Policy N–1.3: Enforce the City of Riverside Noise Control Code to ensure that stationary noise and noise emanating from construction activities, private developments/residences and special events are minimized.

Policy N–1.4: Incorporate noise considerations into the site plan review process, particularly with regard to parking and loading areas, ingress/egress points and refuse collection areas.

Policy N–1-5: Avoid locating noise-sensitive land uses in existing and anticipated noise-impacted areas.

Policy N–1.6: Educate the public about City noise regulations.

Policy N–1.7: Evaluate noise impacts from roadway improvement projects by using the City's Acoustical Assessment Procedure.

Policy N–1.8: Continue to consider noise concerns in evaluating all proposed development decisions and roadway projects.

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<u>Objective N–2: Minimize the adverse effects of airport related noise:</u>

Policy N–2.1: Ensure that new development can be made compatible with the noise environment by using noise/land use compatibility standards (Figure N–10 – Noise/Land Use Noise Compatibility Criteria) and the airport noise contour maps (found in the Riverside County Airport Land Use Compatibility Plans) as guides to future planning and development decisions.

Policy N–2.2: Avoid placing noise-sensitive land uses (e.g., residential uses, hospitals, assisted living facilities, group homes, schools, day care centers, etc.) within the high noise impact areas (over 60 dB CNEL) for Riverside Municipal Airport and Flabob Airport in accordance with the Riverside County Airport Land Use Compatibility Plan.

Policy N–2.3: Support efforts of the Federal Aviation Administration and other responsible agencies to require the development of quieter aircraft.

Policy N–2.4: Work with the Federal Aviation Administration and neighboring airport authorities to minimize the noise impacts of air routes through residential neighborhoods within the City.
Policy N–2.5: Utilize the Airport Protection Overlay Zone, as appropriate, to advise landowners of special noise considerations associated with their development.

<u>Objective N–3: Ensure the viability of March Air Reserve Base</u>
Policy N–3.1: Avoid placing noise-sensitive land uses (e.g., residential uses, hospitals, assisted living facilities, group homes, schools, day care centers, etc.) within the high noise impact areas (over 65 dB CNEL) for March Air Reserve Base/March Inland Port in accordance with the Riverside County 2014 March Air Reserve Base/Inland Port Airport Land Use Compatibility Plan.
Policy N–3.2: Work with the Riverside County Airport Land Use Commission and the March Joint Powers Authority to develop noise/land use guidelines and City land use plans that are consistent with ALUC policies.
Policy N–3.3: Carefully consider planned future operations of the March Air Reserve Base and March Inland Port in land use decisions for properties located within the airport influenced area.

<u>Objective N–4: Minimize ground transportation-related noise impacts</u>.
Policy N–4.1: Ensure that noise impacts generated by vehicular sources are minimized through the use of noise reduction features (e.g., earthen berms, landscaped walls, lowered streets, improved technology).
Policy N–4.2: Investigate and pursue innovative approaches to reducing noise from railroad sources.
Policy N–4.3: Identify and aggressively pursue funding sources to provide grade separations and sound walls along train routes as noise reduction measures.
Policy N–4.4: Prioritize locations for implementing road/rail grade separations.
Policy N–4.5: Use speed limit controls on local streets as appropriate to minimize vehicle traffic noise.

2.3 City of Riverside Code of Ordinances

The City of Riverside Noise Element establishes noise/land use compatibility criteria. The city uses land use compatibility standards when planning and marking development decisions to ensure that noise producers do not adversely affect sensitive receptors. Per Chapter 7.25 Nuisance Exterior Sound Level Limit, Section 7.25.010 – Exterior Sound Level Limit, Table 7-25.0101 summarizes the City's noise standards for varies type of land uses (Table 2 Below). The standards represent the maximum acceptable noise levels and are used to determine potential noise impact.

Table 2 – The City of Riverside Noise Standard

Land Use Category	Time Period	Noise Level
Residential	Night (10:00 p.m. to 7:00 a.m.) Day (7:00 a.m. to 10:00 p.m.)	45 dBA 55 dBA

Office/commercial	Any time	65 dBA
Industrial	Any time	70 dBA
Community support	Any time	60 dBA
Public recreation facility	Any time	65 dBA
Nonurban	Any time	70 dBA

Chapter 7.30 – Nuisance Interior Sound Level Limits, section 7.30.015 Interior Sound Level Limit Table 7.30.015 summarize the interior noise standard (Table 3 below).

Table 3 – The City of Riverside Interior Noise Limits

Land Use Category	**Time Period**	**Noise Level**
Residential	Night (10 p.m. to 7 a.m.) Day (7 a.m. to 10 p.m.)	35 dBA 45 dBA
School	7 a.m. to 10 p.m. (while school is in session)	45 dBA
Hospital	Any time	45 dBA

Per Section 7.35.020 the following activities shall be exempt from the provisions of this title.

A. *Emergency work*. The provisions of this title shall not apply to the emission of sound for the purpose of alerting persons to the existence of an emergency or in the performance of emergency work.

B. *School events*. Sanctioned school activities conducted on public or private school grounds including but not limited to school athletic and entertainment events are exempt from the provisions of this chapter conducted between the hours of 7:00 a.m. and 11:00 p.m.

C. *Federal or State preempted activities*. The provisions of this Chapter shall not apply to any other activity the noise level of which is regulated by state or federal law.

D. *Minor maintenance to residential property*. The provisions of this title shall not apply to noise sources associated with minor maintenance to property used for residential purposes, provided the activities take place between the hours of 7:00 a.m. and 10:00 p.m.

E. *Right-of-way* construction. The provisions of this title shall not apply to any work performed in the City rights-of-way when, in the opinion of the Public Works Director or his designee, such work will create traffic congestion and/or hazardous or unsafe conditions.

F. *Public health, welfare and safety activities*. The provisions of this title shall not apply
to construction maintenance and repair operations conducted by public agencies and/or utility companies or their contractors which are deemed necessary to serve the best interests of the public and to protect the public health, welfare and safety, including but not limited to, trash collection, street sweeping, debris and limb removal, removal of downed wires, restoring electrical service, repairing traffic signals, unplugging sewers,

vacuuming catch basins, repairing of damaged poles, removal of abandoned vehicles, repairing of water hydrants and mains, gas lines, oil lines, sewers, storm drains, roads, sidewalks, etc.

G. Construction. Noise sources associated with construction, repair, remodeling, or grading of any real property; provided a permit has been obtained from the City as required; and provided said activities do not take place between the hours of 7:00 p.m. and 7:00 a.m. on weekdays, between the hours of 5:00 p.m. and 8:00 a.m. on Saturdays, or at any time on Sunday or a federal holiday.

H. *Warning devices.* Warning devices necessary for the protection of public safety, as for example fire, police, and ambulance sirens, including the testing of such devices, are exempted from the provisions of this title.

I. *Agriculture.* Any agricultural activity, operation, or facility, or appurtenances thereof (e.g., wind machines), conducted or maintained for commercial purposes, and in a manner consistent with proper and accepted customs and standards as allowed under California Civil Code Section 3482 as amended from time to time.

2.4 City of Riverside – Ground-Borne Vibration

The City of Riverside does not establish criteria for maximum vibration thresholds.

The Federal Transit Administration (FTA) provides standards and guidelines for perceptibility and annoyance for ground-borne vibration as well as construction vibration impact criteria for building damage. As discussed in the *Characteristics of Vibration* section above, in most circumstances common ground-induced vibrations related to roadway traffic and construction activities pose no threat to buildings or structures, and for smooth roadways, the ground-borne vibration from traffic is barely perceptible.

The FTA has published a technical manual titled, “Transit Noise and Vibration Impacts Assessment,” that provides ground-borne vibration impact criteria with respect to building damage and human response during construction activities. As discussed above, building vibration damage is measured in peak particle velocity described in the unit of inches per second. Table 4, below, provides the Federal Transit Administration vibration criteria applicable to construction activities. According to Federal Transit Administration guidelines, a vibration criterion of 0.20 inch per second should be considered as the significant impact level for non-engineered timber and masonry buildings. Furthermore, structures or buildings constructed of reinforced-concrete, steel, or timber, have vibration damage criteria of 0.50 inch per second pursuant to the FTA guidelines.

Table 4 - Federal Transit Administration Construction Vibration Impact Criteria for Building Damage

Building Category	Peak Particle Velocity (inch per second)
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	0.12
Source: Federal Transit Administration, 2006.	

Impacts for the human response to vibration levels are given in VdB by the FTA in Table 8-1 of the *Transit Noise and Vibration Impact Assessment* manual[5], as shown in Table 5 below. The FTA Land Use Category 1 impact criteria is intended for vibration-sensitive research and manufacturing facilities, hospitals with vibration-sensitive equipment, and university research operations. These Category 1 impact criteria vibration levels are well below those associated with human annoyance but are equal to the threshold of perceptibility. The FTA vibration criteria for Category 2, residential impact, indicate impacts occur at a 72 VdB vibration level for frequent events occurring more than 70 times per day, at 75 VdB for occasional events occurring between 30 and 70 times per day, and at 80 VdB for infrequent events occurring less than 30 times per day.

Table 5 - Federal Transit Administration Ground-Borne Vibration Impact Criteria for General Assessment

Land Use Category	GBV Impact Levels (VdB re 1 micro-inch /sec)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]
Category 1: Buildings where vibration would interfere with interior operations	65 VdB[4]	65 VdB[4]	65 VdB[4]
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB
Category 3: Institutional land uses with primarily daytime use	75 VdB	78 VdB	83 VdB

Notes:
1. "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
2. "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have these many operations.
3. "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.
4. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.
Source: Federal Transit Administration, 2006.

5 U.S. Department of Transportation, Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, (Washington, DC: U.S. Department of Transportation, Federal Transit Administration, May 2006), p. 8-3

2.5 Project Requirements

The above requirements are summarized in the following Table 6.

Table 6 - Project Requirements

Activity	Standard
Residential (General Plan)	Zone A – 50-60 CNEL (Normally Acceptable) Zone B – 60-65 CNEL (Conditionally Acceptable)
Exterior Noise at Residential Zones	45 dBA (Night 10:00 p.m. to 7:00 a.m.) 55 dBA (Daytime 7:00 a.m. to 10:00 p.m.)
Interior Noise at Residences	35 dBA (Night 10:00 p.m. to 7:00 a.m.) 45 dBA (Daytime 7:00 a.m. to 10:00 p.m.)
Construction Noise	Prohibited between 7:00 P.M. and 7:00 A.M. Monday thru Saturday, and anytime Sunday and public holidays
Operational Noise	At residential property, one-hour average sound level: 55 dBA from 7:00 a.m. to1 0:00 p.m. 45 dBA from 10:00 p.m. to 7:00 a.m.
Vibration	At residences where people normally sleep: 72 VdB – greater than 70 events per day. 75 VdB – between 30-70 events per day. 80 VdB – less than 30 events per day.

3.0 ENVIRONMENTAL IMPACTS AND SIGNIFICANCE

3.1 Significance Thresholds

The following significance thresholds are used in this report to evaluate the significance of the project noise impacts:

- Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.
- Generation of excessive ground borne vibration or ground born noise levels.
- For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels.

3.2 Impact 1. Noise levels in excess of standards

Would the project result in generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?

3.2.1 Methodology

Analysis of the existing and future noise environments presented in this section is based on technical reports, noise monitoring, and noise prediction modeling. CNEL predictions are based on short-term measured ambient sound levels and statistical analysis "*LoVerde, John; Dong, Wayland; Rawlings, Samantha. Noise Prediction of Traffic on Freeways and Arterials from Measured Data, (Fort Lauderdale, Florida: Noise-Con 2014)*" method (see published paper on Appendix B for further information). This was accomplished using the Federal Highway Administration Highway Noise Prediction Model (TNM Version 2.5) within SoftNoise Predictor V2023 modeling program. TNM Version 2.5 is required to be used on all Federal-aid highway projects. The California Department of Transportation (Caltrans) published the "Technical Noise Supplement (TeNS)" in October of 1998 which defines how to predict traffic noise for projects in California. The TeNS, Section N-5520 requires that any traffic noise study conducted after March 30, 2000 utilize the calculation methods used by Federal Highway Administration (FHWA) TNM. This model calculates the average noise level at specific locations based on traffic volumes, average speeds, roadway geometry, and site conditions. The off-site traffic noise is analyzed on an increase in CNEL basis to determine the project's impact.

3.2.2 Existing Ambient Monitored Noise Levels

Traffic on La Sierra Avenue and Victoria Avenue was the primary source of noise affecting the site. Veneklasen visited the site on Friday, February 16, 2024 and placed sound level meters at locations shown in Figure 4 to capture the hourly sound levels on the site. During the measurement, Veneklasen observed frequent propeller planes, helicopters, and commercial planes flying over the project site. Figure 4 and Table 7 show the location and summary of the noise measurements. Noise readings were measured over 1-second intervals with "A" frequency fast time weighting. The weather conditions were normal, and no anomalies were present during the survey periods.

Table 7, Existing Ambient Monitored Noise Levels, provides the noise level data associated with each monitoring period for each location. As shown, noise levels range from 54 dBA to 68 dBA, dependent on the road traffic activity and the relative distance between the noise source and the measurement positions. Appendix C shows the collected data from the noise monitoring equipment at each location.

Figure 4 – La Sierra and Victoria Site and Noise Monitoring Locations

Table 7 – Existing Ambient Monitored Noise Levels

Position	Measurement Time Length	Average Sound Level, L_{eq} dBA	Predicted CNEL
Pos S1	4 hours	67	69
Pos S2	4 hours	68	70
Pos S3	4 hours	66	67
Pos S4	4 hours	54	54

Notes:
Noise measurements taken on February 16, 2024.
Source: Veneklasen Associates, 2024.

As mentioned before Veneklasen also utilized the 2023 version of the SoftNoise Predictor TNM 2.5 modeling software to verify and predict vehicular noise levels at locations shown in Figure 4 due to traffic conditions. The primary purpose of the computer model was to determine how the noise environment will change due to traffic and site changes. Traffic counts were obtained by the Riverside Transportation Department. The roadway parameters for the calculations are presented in Table 8 below.

Table 8 – Roadway Parameters

Rodway Segment	ADT Volume	Speed (mph)
La Sierra Avenue	25,457	45
Victoria Avenue	5,857	45

The analysis assumes that medium trucks represent two percent of the total vehicle distribution, heavy trucks represent one percent of the total vehicle distribution, and the remaining ninety-seven percent was assumed to be standard automobiles.

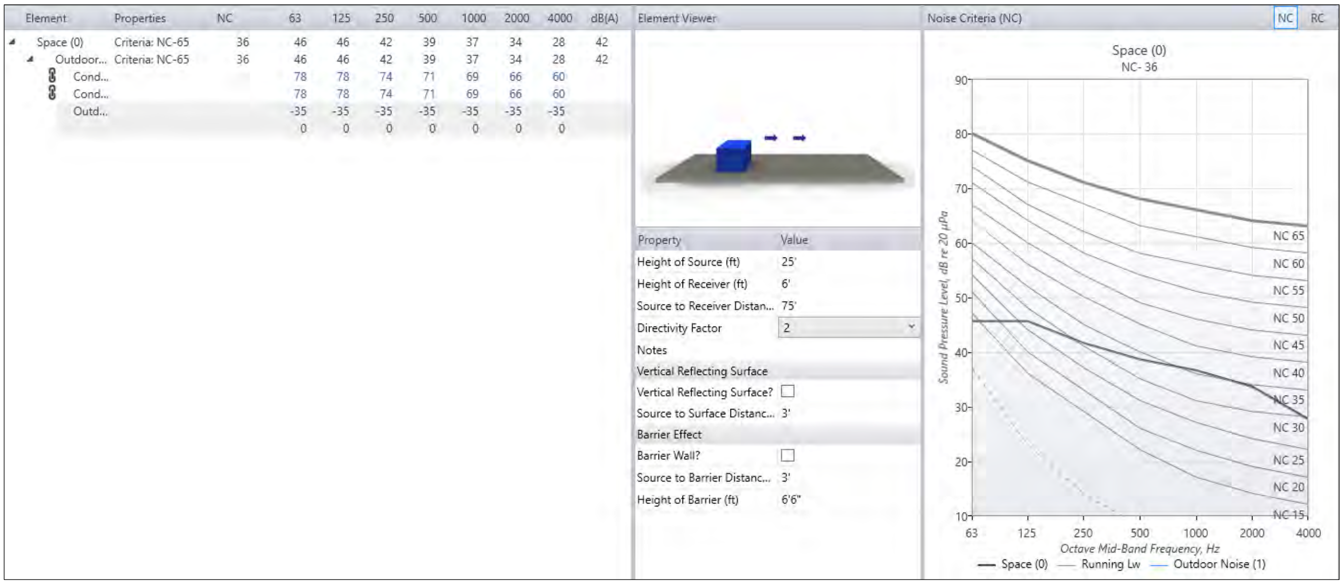
3.2.3 Future Exterior Project Noise Levels

The anticipated traffic flow resulting from the proposed project is unlikely to significantly impact the ambient noise levels in neighboring areas. A barely perceptible change will need an increment of at least 3 CNEL decibels and such a change in sound level will require doubling the volume of traffic in the area, which is unlikely to be caused by the existence of the proposed project. Therefore, the resultant off-site noise levels are deemed less than significant, and no additional analysis is required.

3.2.4 Operational Noise

Veneklasen understands that the project will include outdoor mechanical equipment, such as split-system outdoor condensing units. Veneklasen has utilized sound power data for typical air conditioning condensing units which range between 2 to 5 tons. In order to represent the worst-case scenario, Veneklasen modeled the operation of multiple condensing units operating 24-hours a day at a minimum distance of 75 feet which represent the closest distance from the mechanical equipment and the nearest residences. The software AIM by Pottorff was utilized to model this noise condition which considers the distance sound attenuation as well as the height of the mechanical equipment relative to the receiver height.

Figure 5 – Calculated Outdoor Equipment



As is shown in the figure above, the predicted mechanical equipment noise level at the nearest receiver will be 42 dBA. These levels comply with the Riverside's Noise Standards for day and nighttime hours. Therefore, the impact is less than significant.

3.2.5 Temporary Increase in Ambient Noise Levels

To minimize potential impact from construction activities, the City of Riverside Municipal Code under Section 7.35.020(G) exempts construction noise from its stationary-source noise level limits provided said activities do not take place between the hours of 7:00 p.m. and 7:00 a.m. on weekdays, between the hours of 5:00 p.m. and 8:00 a.m. on Saturdays, or at any time on Sunday or a federal holiday.

The construction noise impact was analyzed considering the type and amount of equipment used at each phase of construction. An itemized list of the equipment used at each construction phase was provided by the developer and is shown in Table 9.

Based on the equipment list provided, noise predictions were performed according to the Roadway Construction Noise Model (RCNM) calculation method. Samples of the calculations are included in Appendix D.

Table 9 – Proposed Equipment used in Construction Phases

Phase Name	Equipment Type	Sound Level at Reference Distance (dBA at 50-feet)	Total number of Equipment Allowed to be use at each Phase	Load Factor	Noise Data Source
Phase 1-Site Clearance	Chain saw	85	3	20%	FHWA
	Tractor	88	2	100%	FTA
	Shovel	82	4	100%	FTA
Phase 2-Grading	Dozer	85	3	40%	FHWA
	Grader	85	3	40%	FHWA
Phase 3-Site Utility	Delivery Truck	88	2	100%	FHWA
	Excavators	85	3	40%	FHWA
	Forklifts	80	4	40%	FHWA
Phase 4-Foundation & Slab Pouring	Excavators	85	3	40%	FHWA
	Concrete Truck Mixture	85	3	40%	FHWA
Phase 5-Paving	Dozer	85	3	40%	FHWA
	Paver	88	2	50%	FHWA
	Roller	85	3	20%	FHWA
Phase 6-Building Construction	Pneumatic tools	85	3	50%	FHWA
	Air Compressor	80	4	100%	FHWA

Veneklasen understands that the equipment will be moving through the site and multiple construction equipment will operate simultaneously. To represent the average noise levels at each construction phase, Veneklasen assumed that the equipment will be moving between the center of the site and near all property lines.

The nearest off-site residential sensitive receivers are located to the northeast, east, and southeast of the project site. The distance to the property lines of the nearest sensitive receivers from the perimeter of the project site is shown in Table 10 below.

Table 10 – Distance to the Sensitive Receivers from the Center of Project Site and Property Line

Receiver	Address of the Location	Direction from the Project Site	Distance from the Project Property line (feet)
Receiver 1	2551 Wildcat Ln	Southwest	119
Receiver 2	2550 Wildcat Ln	Southwest	121
Receiver 3	11115 Old Fashion Way	South	159
Receiver 4	11081 Kayjay St	South	95
Receiver 5	11037 Kayjay St	Southeast	133
Receiver 6	11015 Kayjay St	Southeast	175
Receiver 7	2615 Millsweet Pl	East	60
Receiver 8	2675 Millsweet Pl	East	64
Receiver 9	10980 Stonehenge Pl	North	167
Receiver 10	10998 Stonehenge Pl	Northwest	176

The maximum predicted hourly average noise levels at these sensitive receptors due to construction operations are shown in Table 11 below. Figure 6 shows the location of sensitive receivers adjacent to the site.

Figure 6 - Sensitive Receiver Locations

Table 11 - Construction Noise Levels at the Boundary of Receiver Locations

Project Phase	Receptor	Construction Noise Level (dBA)
Site Clearance	REC-1	80
	REC-2	80
	REC-3	78
	REC-4	80
	REC-5	78
	REC-6	76
	REC-7	80
	REC-8	82
	REC-9	77
	REC-10	77
Phase 2-Grading	REC-1	75
	REC-2	74
	REC-3	72
	REC-4	75
	REC-5	73
	REC-6	71
	REC-7	78
	REC-8	77
	REC-9	72
	REC-10	72
Phase 3-Site Utility	REC-1	78
	REC-2	78
	REC-3	77
	REC-4	80
	REC-5	78
	REC-6	76
	REC-7	83
	REC-8	83
	REC-9	76
	REC-10	76
Phase 4-Foundation & Slab Pouring	REC-1	76
	REC-2	75
	REC-3	74
	REC-4	77
	REC-5	75
	REC-6	73
	REC-7	80
	REC-8	79
	REC-9	73
	REC-10	73
Phase 5-Paving	REC-1	77
	REC-2	77
	REC-3	75
	REC-4	77

	REC-5	75
	REC-6	73
	REC-7	81
	REC-8	79
	REC-9	74
	REC-10	74
Phase 6-Building Construction	REC-1	73
	REC-2	72
	REC-3	70
	REC-4	73
	REC-5	71
	REC-6	69
	REC-7	76
	REC-8	75
	REC-9	70
	REC-10	70

According to the equipment list provided by the developer, the construction noise level will range between 69 to 83 dBA at the nearest receptors.

To assess potential short-term noise impacts of the Project at nearby receiver locations, Veneklasen uses an 80 dBA Leq threshold for the daytime construction hours. The analysis confirms that this threshold is met at all closest receiver locations except for locations REC-7 and REC-8 during Phase 3 which exceeds the threshold by 3 decibels. Such exceedance in sound level is barely perceived. Therefore, the project construction noise is deemed less than significant.

Mitigation 1. The impact is less than significant and the following mitigation measures have been identified to further minimize potential effects of construction noise on adjacent properties.

- Limit construction activity to the hours listed in Table 6 (7:00 am to 7:00 pm).
- Schedule highest noise-generating activity and construction activity away from noise-sensitive land uses.
- Equip internal combustion engine-driven equipment with original factory (or equivalent) intake and exhaust mufflers which are maintained in good condition.
- Prohibit and post signs prohibiting unnecessary idling of internal combustion engines.
- Locate all stationary noise-generating equipment such as air compressors and portable generators as far as practicable from noise-sensitive land uses.
- Utilize “quiet” air compressors and other stationary equipment where feasible and available.
- Designate a noise disturbance coordinator who would respond to neighborhood complaints about construction noise by determining the cause of the noise complaints and require implementation of reasonable measures to correct the problem. Conspicuously post a telephone number for the disturbance coordinator at the construction site.

3.3 Impact 2. Excessive ground-borne vibration

Would the project result in exposure of persons to or generation of excessive ground-borne vibration or ground-borne noise levels?

Construction equipment associated with building the project would be the only vibration-generating source introduced by the project, as there are no vibration sources from operations that will introduce vibration into the environment. Vibration generated by construction equipment, unless specified otherwise through permitting, would only occur during approved work hours per the City of Riverside, 7:00 am – 7:00 pm, six days a week, excluding holidays. Table 9 shows the equipment used in each construction phase.

Table 12 below, shows the construction equipment proposed by the project planning group and the typical vibration levels generated during operation. It is understood that for this project, pile drivers will not be used. The vibration levels for the equipment used in the construction phase are unavailable, therefore, Veneklasen utilized the vibration levels provided by the FTA Manual. Calculations were performed according to the FTA manual method. Samples of the calculations are included in Appendix E.

Table 12 –Vibration Levels (Lv, VdB) of Typical Construction Equipment at 25 ft

Equipment	Reference RMS Velocity (Lv) at 25 ft. (VdB)
Vibratory roller	94
Large bulldozer	87
Caisson drilling	87
Loaded trucks	86
Jackhammer	79
Small bulldozer	58

Source: Federal Transit Administration (except Hanson 2001 for Vibratory rollers), 1995.

Based on the reference vibration levels generated by typical construction equipment and analysis carried out by Veneklasen, construction equipment vibration levels at the project site boundary will not exceed the criteria per FTA guidelines shown in Table 4. Therefore, the impact is less than significant, and no mitigation is required. The predicted vibration levels of the proposed construction equipment at the boundary of the project site are shown in Table 13.

Table 13 – Construction Vibration Levels at the Boundary of Project Site

Project Phase	Receptor	Construction Vibration Level, PPV	Construction Vibration Level, Lv, dB
Site Clearance	REC-1	0.005	63
	REC-2	0.005	63
	REC-3	0.004	60
	REC-4	0.007	65
	REC-5	0.005	62
	REC-6	0.003	59
	REC-7	0.015	71
	REC-8	0.011	69
	REC-9	0.004	59
	REC-10	0.003	59
Phase 2-Grading	REC-1	0.0004	39
	REC-2	0.0004	38
	REC-3	0.0003	35
	REC-4	0.001	40
	REC-5	0.0004	37
	REC-6	0.0003	34
	REC-7	0001	46
	REC-8	0.001	44
	REC-9	0.0003	34
	REC-10	0.0003	34
Phase 3-Site Utility	REC-1	0.006	63
	REC-2	0.006	63
	REC-3	0.004	60
	REC-4	0.007	65
	REC-5	0.005	61
	REC-6	0.003	59
	REC-7	0.015	71
	REC-8	0.011	69
	REC-9	0.004	59
	REC-10	0.003	59
Phase 4-Foundation & Slab Pouring	REC-1	0.006	63
	REC-2	0.006	63
	REC-3	0.004	60
	REC-4	0.007	65
	REC-5	0.005	62
	REC-6	0.003	59
	REC-7	0.015	71
	REC-8	0.011	69
	REC-9	0.004	59
	REC-10	0.003	59
Phase 5-Paving	REC-1	0.0004	39
	REC-2	0.0004	38
	REC-3	0.0003	35
	REC-4	0.001	40
	REC-5	0.0004	37
	REC-6	0.0003	34

	REC-7	0.001	46
	REC-8	0.001	44
	REC-9	0.0003	34
	REC-10	0.0003	34
Phase 6-Building Construction	REC-1	The equipment used at this stage of construction is mainly handheld tools and low vibration equipment which produces very low levels of vibration compared to the equipment used at previous phases.	
	REC-2		
	REC-3		
	REC-4		
	REC-5		
	REC-6		
	REC-7		
	REC-8		
	REC-9		
	REC-10		

3.4 Impact 3. Airport noise exposure

For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?

The project is not within two miles of a public airport or public use airport. Therefore, there is no impact.

4.0 SUMMARY

4.1 Summary of Mitigation Measures

Mitigation 1. The impact is less than significant without mitigation measures. The following measures are identified to further minimize the potential effects of construction noise on adjacent properties.

- Limit construction activity to the hours listed in Table 4 (6:00 am to 7:00 pm).
- Schedule highest noise-generating activity and construction activity away from noise-sensitive land uses.
- Equip internal combustion engine-driven equipment with original factory (or equivalent) intake and exhaust mufflers which are maintained in good condition.
- Prohibit and post signs prohibiting unnecessary idling of internal combustion engines.
- Locate all stationary noise-generating equipment such as air compressors and portable generators as far as practicable from noise-sensitive land uses.
- Utilize "quiet" air compressors and other stationary equipment where feasible and available.
- Designate a noise disturbance coordinator who would respond to neighborhood complaints about construction noise by determining the cause of the noise complaints and require implementation of reasonable measures to correct the problem. Conspicuously post a telephone number for the disturbance coordinator at the construction site.

4.2 Summary of significance of impacts

CEQA Noise Impact Question		No Impact	Less Than Significant	Less Than Significant with Mitigation	Potentially Significant
1	Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	X			
2	Generation of excessive ground borne vibration or ground born noise levels.	X			
3	For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels	X			

APPENDIX A

Table A.1 – Definitions of Noise-Related Terms

Term	Definition
Decibel, dB	A unit describing the amplitude of sound equivalent to 20 times the logarithm, to the base 10, of the ratio of the pressure of the sound to the reference pressure of 20 μPa.
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured in an A-weighting filter network. The A-weighting de-emphasizes the very low 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 in the A-weighted scale.
L_0 (L_{max}), L_2, L_8, L_{25}, L_{50}	The A-weighted noise levels that are exceeded 0 percent (maximum noise level), 2 percent, 8 percent, 25 percent, and 50 percent of the time during the measurement period.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the stated measurement period.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 P.M. to 10:00 P.M., and after addition of 10 decibels to noise levels in the night between 10:00 P.M. and 7:00 A.M.
Day-Night Noise Level, DNL, Ldn	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 P.M. and 7:00 A.M.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Impulsive Noise	Sound of short duration. Typically associated with an abrupt onset and rapid decay (i.e., gun-shots, etc.).
Pure Tones	A sound wave, residing over a small range of frequencies, which has a sinusoidal behavior over time.
VdB	Unit of measurement used by FHWA to describe ground-borne vibration. Equivalent to 20 times the logarithm, to the base 10, of the ratio of the root mean square ground-borne velocity to the reference of reference of $1x10^{-6}$ in/sec.

APPENDIX B

Fort Lauderdale, Florida
NOISE-CON 2014
2014 September 8-10

Noise prediction of traffic on freeways and arterials from measured sound data

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ABSTRACT

Evaluation and mitigation of noise from exterior noise sources is common as a building design criterion, and has long been part of federal and California building design requirements for residential housing. Criterion is included in LEED building design standards for school and healthcare facilities, and will be included for all buildings types in LEED version 4. These criteria require that the noise level be quantified precisely, but do not provide a method for defining the noise level given the normal variations in exterior sound level that occur. This paper analyzes long term traffic noise measurement data to develop statistically meaningful definitions of exterior noise from vehicular sources. Methods for predicting the noise level using data from relatively short measurement periods are evaluated, and minimum survey requirements to determine specific exterior noise parameters are suggested.

1. INTRODUCTION

Traffic noise is a common noise source impacting all building types and has been the subject of considerable study. Previous measurement surveys[1,2] have primarily examined the spatial variations, variations in vehicle type or speed, or variations during a single day. Long-term measurement programs to document the day-to-day variations in level have been performed[3], have been focused on average or 24-hour hour metrics, which are normally used for residential noise criteria. However recent criteria have required evaluation of the loudest instead of the average level. Evaluating the maximum level requires a different level of type of analysis than have previously been documented.

2. BUILDING CODES AND REGULATIONS

A. Daily metrics

Noise from transportation sources has long been a part of codes and guidelines for residential projects, and the noise level has been evaluated in terms of daily metrics such as L_{dn} and CNEL (or L_{den}). The U.S. Department of Housing and Urban Development defines an acceptable acoustical environment in terms of L_{dn}[4]. In California, the state building code[5], as well as the General Plans of many municipalities, similarly defines noise level requirements in terms of CNEL or L_{dn}.

B. Hourly metrics

Recently there have been an increased number of design requirements and guidelines for non-residential projects, many associated with green building guidelines. The California Green Building Standards require that the interior noise level "does not exceed an hourly equivalent noise level (Leq-1Hr) of 50 dBA in occupied areas during any hour of operation."[6] This applies to most non-residential projects.

Green building guidelines for schools, such as the California Collaborative for High Performance Schools, reference ANSI S12.60. The requirements for noise from exterior sources are defined in terms of "the noisiest continuous one-hour period during times when learning activities take place."[7] LEED v4 BD+C: Schools "requires mitigation for high-noise sites (peak-hour Leq above 60 dBA during school hours)".

C. Daily Average vs. Maximum Hour

While criteria for residential projects has historically been in terms of 24-hour averaged metrics, recent requirements for commercial and school projects is framed in terms of the loudest hourly Leq during the period of operation. However, none of the criteria documents provide or describe any procedures or guidance regarding how the "loudest hour" should be defined, given the day-to-day variations in noise level. Even if given a large data set encompassing the full range of variation, which level does the acoustician define to be "typical"?

Further, while it is straightforward to determine the loudest hour of any measurement period, how would one know that the loudest hour of the day, or the loudest day of the week, had been captured? What about longer term variations with the school year or the seasons? How much information regarding variations can the designer be expected to obtain?

Currently, acousticians faced with these questions have simply measured over a single day and used the loudest hour to perform calculations. In our view, there has been insufficient consideration of the variation of the sound level, and whether the measurement constitutes adequate sampling to have confidence that the reported sound level is accurate.

3. MEASUREMENT PROGRAM

In order to begin to address these questions and clarify procedure, we performed long-term noise surveys of roadways, with an aim to determine not just the level but the temporal distribution of levels. Based on the measured variation in noise level, hour-to-hour and day-to-day, a reasonable definition of the "loudest hour" can be extracted. Finally, we wish to determine the minimum length of measurement required determine the loudest hour to the desired accuracy.

A. Long term traffic noise survey

Measurements were performed on several arterial roadways and freeways. The results from one arterial are presented here. The arterial in questions is a 4-lane road with a wide median and a 40 mile per hour speed limit. A microphone was mounted to the rooftop of a building at the façade facing the street. This location had unobstructed exposure to all four lanes in both directions at an approximate elevation of 20 feet. A Bruel & Kjaer type 2260 sound level meter logged the noise level at high time resolution from February 11 through March 14, 2014.

The data was reduced to hourly intervals synced to the clock for this analysis. The weekends were significantly quieter than the weekdays, and the weekends were excluded from the analysis. The hourly Leq's for all weekdays are shown in Figure 1. The dashed lines show February 18, which was the Presidents Day holiday, and had slightly reduced noise levels. The dotted line shows a day when work crews were conducting tree trimming on the street. Although this was not a traffic source and this day was excluded from the data for this analysis, it bears considering what effect such an event might have on an unmanned measurement.

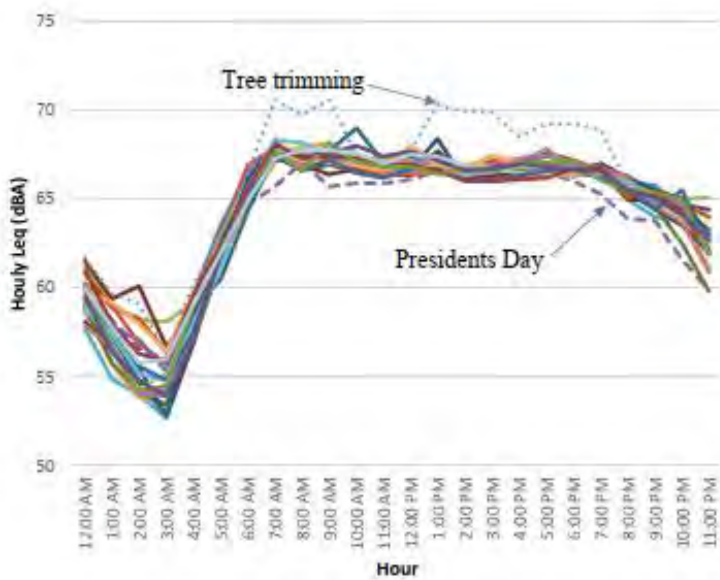

Figure 1. Hourly Leq's for all days measured.

B. Analysis

During the daytime hours (from 7:00 AM to 7:00 PM), there is very little variation in level, both day-to-day and from hour-to-hour within a day for a free flowing arterial. In fact, over the 22 weekdays in the measurement period, the daytime hourly Leq ranged from 66–69 dBA. Because the spread in the data was so small, we analyzed the data at a resolution of a tenth of a dB in order to reduce rounding errors. The average hourly Leq was 67.0 dBA, and the standard deviation was 0.5 dB.

It is the authors' opinion that the "maximum" level of a distribution, assuming that it is approximately normal, should be defined as 2 standard deviations above the mean. This is an arbitrary but common convention in many branches of science and engineering, corresponding to approximate 95 percent confidence interval about the mean. It is the 97.5 percentile of the distribution. For the measured data, 2 standard deviations are 1.0 dB and the "loudest hour" is therefore defined to be 68.0 dBA. (Note that the mean and maximum values have tenth-dB resolution and are not rounded. It is coincidence that they happened to end up on zero tenths.)

4. REQUIRED LENGTH OF MEASUREMENT

We have determined that the "true" average hourly level is 67 dBA and the loudest hourly level is 68 dBA. Given the month-long measurement period, we are confident that these values accurately encompass the normal daily variation in level. (Seasonal variations may remain.) For a typical project, the measurement period will be much shorter. How long does the measurement period need to be to ensure an accurate result?

A. Monte Carlo Method

Monte Carlo method is ideal for this analysis. We use a random number generator to randomly select a start hour from the data set. From the start hour, we calculate the average noise level (Leq) that would be achieved after measuring for n hours, so that n is the length of the measurement. For each n, we repeat for at least 1000 trials and plot the results. The distribution of the results gives the probability of measuring that level after a measurement that is n hours long. The process is repeated with different values of n. Representative results are shown in Figure 2.

Figure 2 shows that the mean of the distribution is the same as the mean of the measurement data, as expected. Also as expected, the distribution narrows (variation become smaller) as the measurement time increases. However, the narrowing "levels off" and there is no further improvement after 4 or 5 hours. Measuring for 8 hours or 12 hours (the entire daytime) would not yield a more accurate measurement (compared to the monthly average) than the level measured after 5 hours.

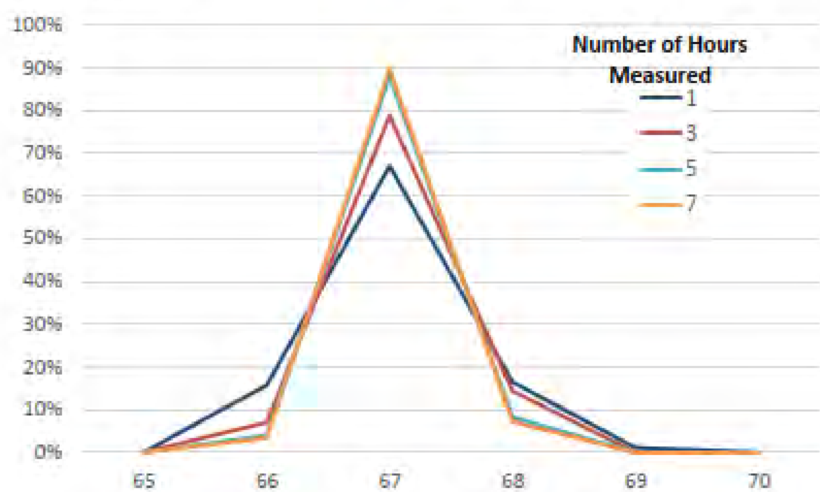

Figure 2. Results of Monte Carlo analysis with n=1, 3, 5, 7 hours.

B. Length of Measurement Predictions

Given the above information, we can evaluate methods for determining the level of the loudest hour for an actual project on this or a similar roadway. While acoustical overdesign should be avoided, a slightly conservative estimate is appropriate. It is important to avoid underestimating the measured level, which could lead to interior levels that exceed the criteria. For this roadway, the loudest hour is 68 dBA, and a level of 69 dBA would be acceptable. However, the measurement method should not result in a level below 68 dBA.

For this roadway, a one-hour measurement will usually result in a level of 67 dBA, so adding 1 dB would result in the correct loudest hour. However, 16 percent of the time this estimate will be too low. Measuring for 2 hours would reduce this to 10 percent of the time, and a 4 hour measurement would reduce this to 4 percent. A better method may be to add 2 dB to the measured level. This would be too high 17 percent of the time, but will prevent erring on the low side.

5. CONCLUSIONS

The method described is intended to optimize measurement times while minimizing risk. This is accomplished by understanding the temporal behavior of the source. For arterial roadways similar to the free flowing one in this study, the loudest levels are in the daytime hours from 7:00 AM to 7:00 PM. There is remarkably little variation in noise level, both hour-to-hour and day-to-day. Following common science and engineering practice, we define the "loudest hour" as 2 standard deviations above the mean (97.5 percentile).

It is possible to accurately estimate the "true" long-term maximum hourly level to within +1/-0 dB with short term measurements. For this roadway, the method would be to add 1 or 2 dB to the measured value, depending on the length of the measurement and how conservative a result is desired.

ACKNOWLEDGEMENTS

The authors wish to thank Veneklasen Associates for their assistance.

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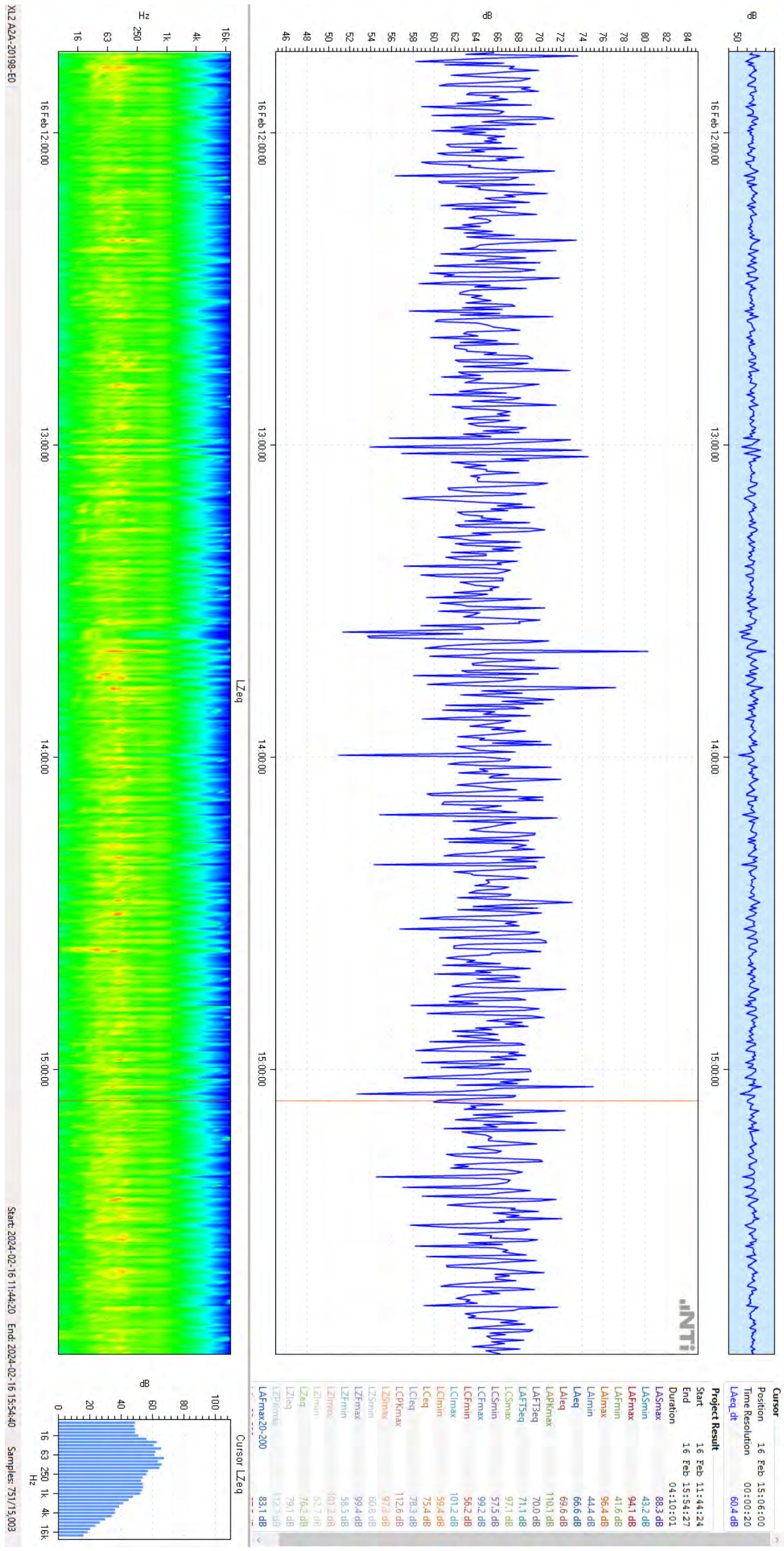
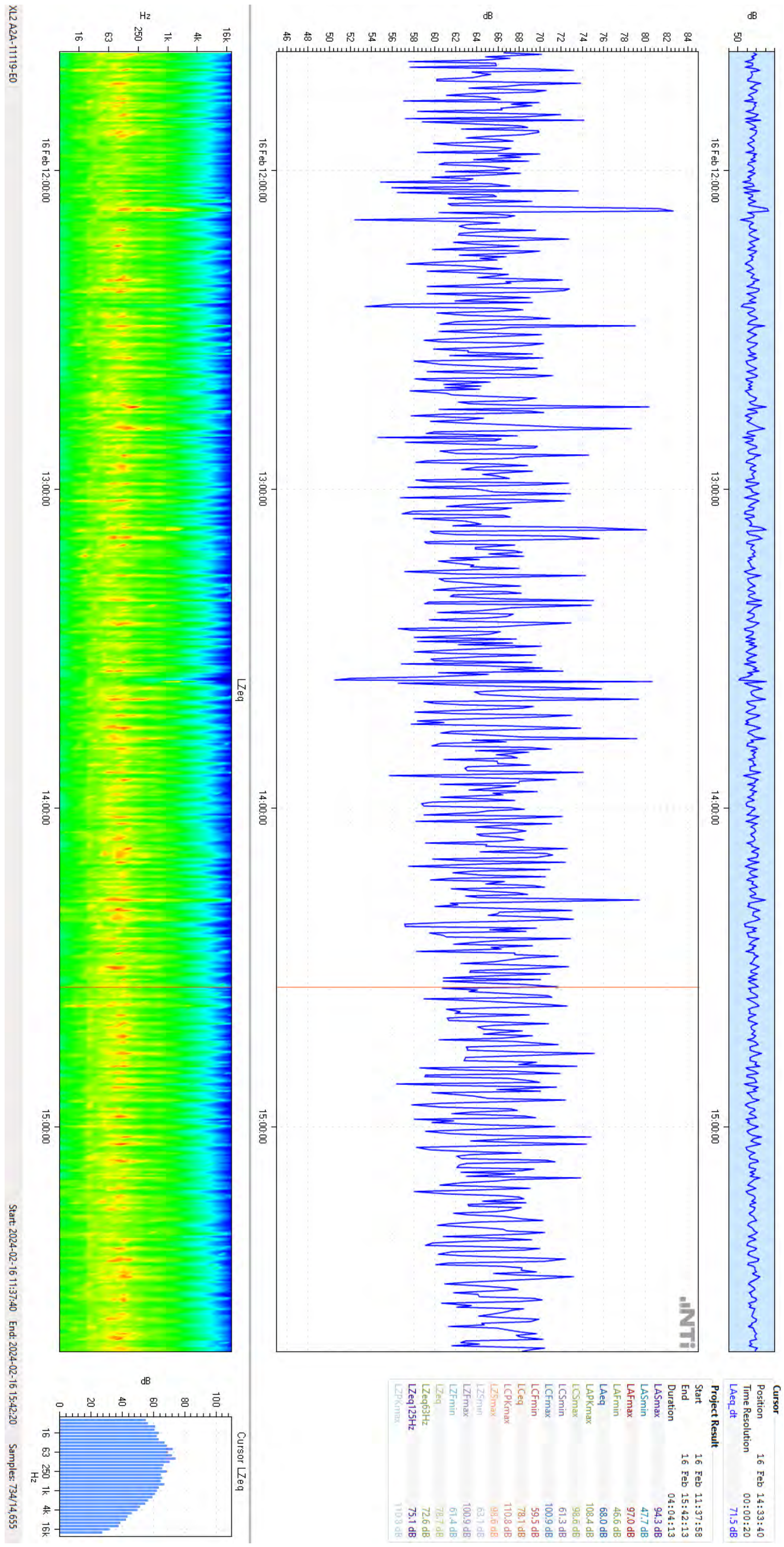
APPENDIX C

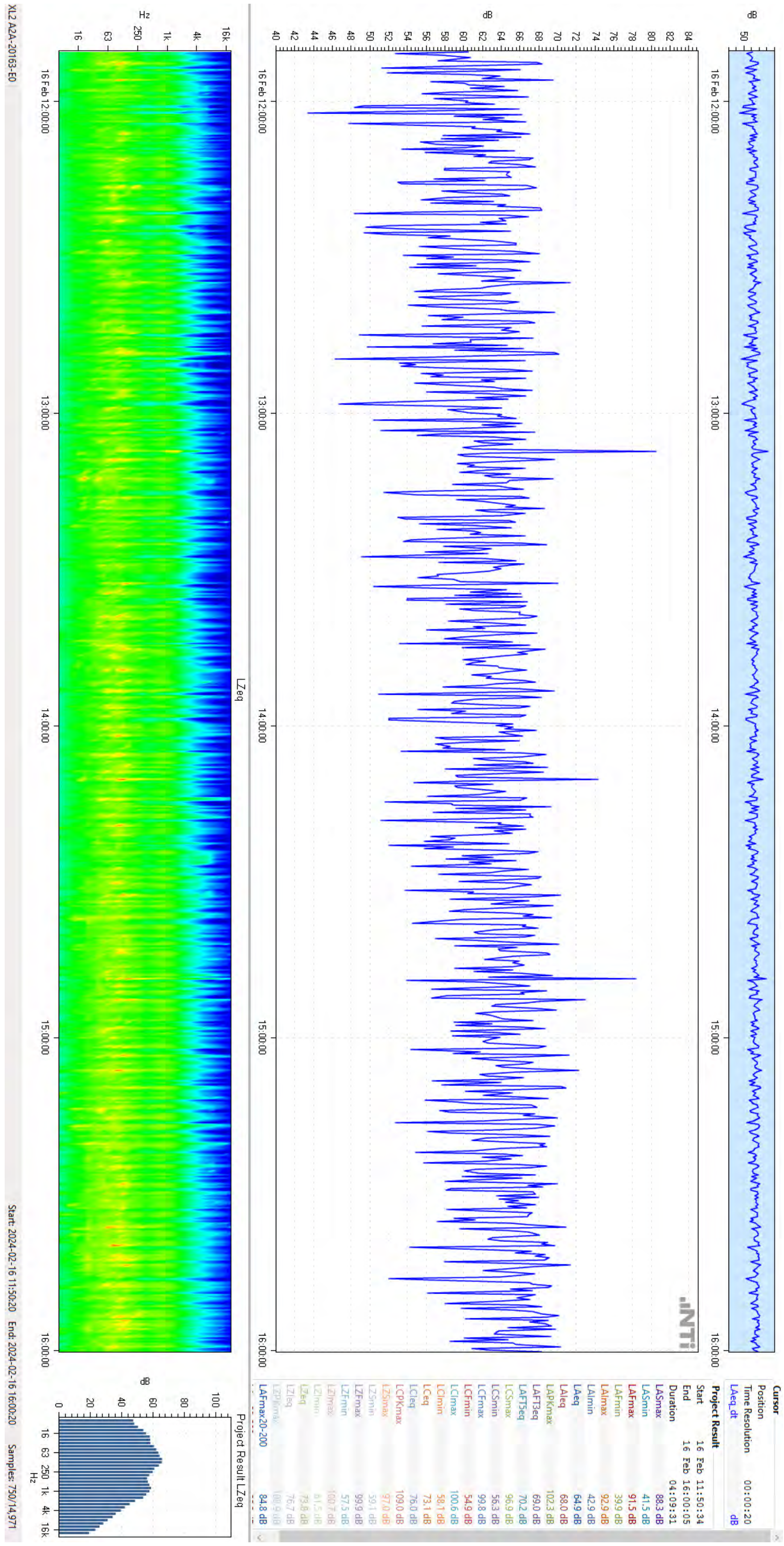
Measurement Data from Noise Monitoring Equipment (Position S1)



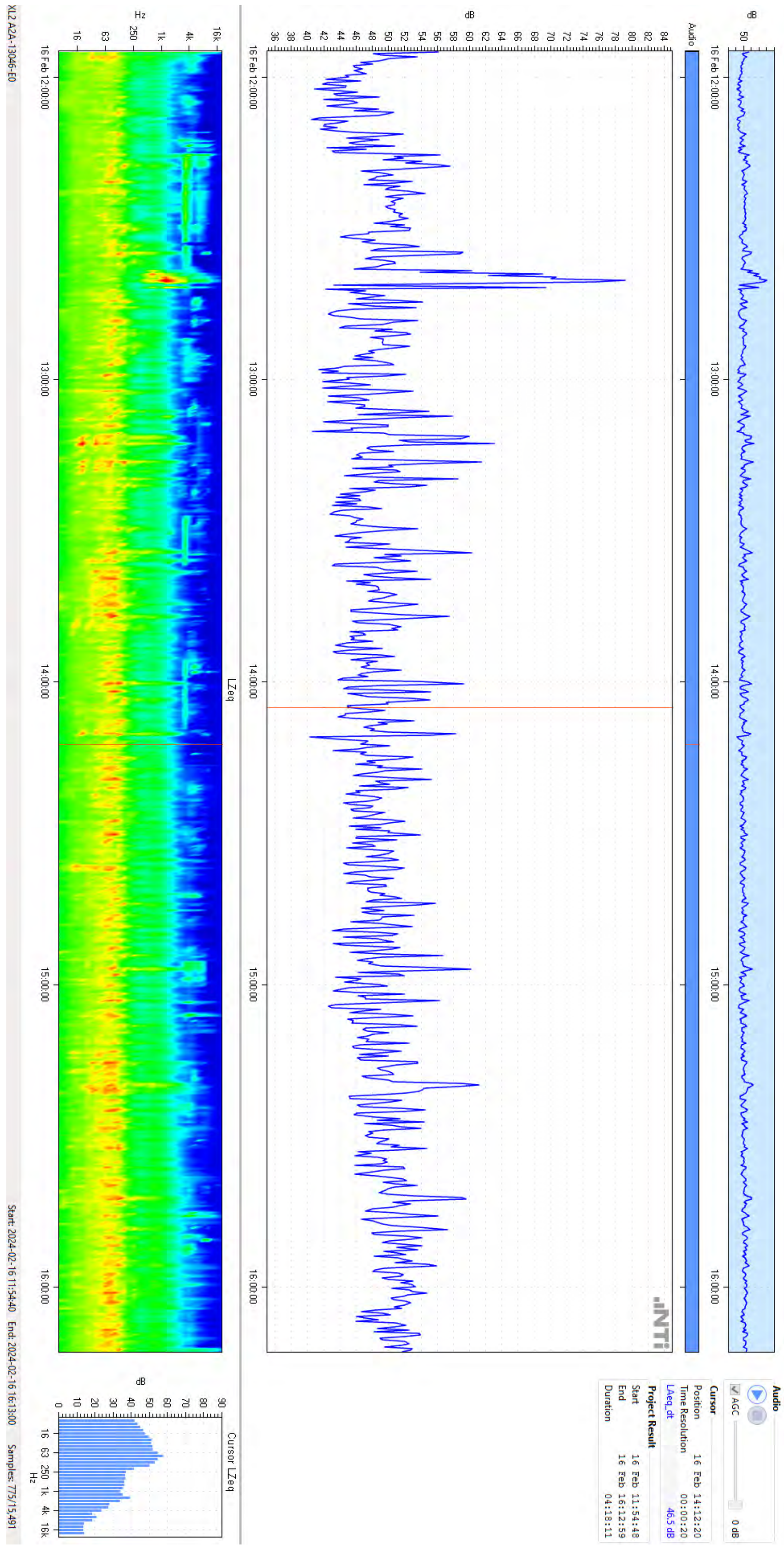
Measurement Data from Noise Monitoring Equipment (Position S2)



Measurement Data from Noise Monitoring Equipment (Position S3)



Measurement Data From Noise Monitoring Equipment (Position S4)



APPENDIX D
Construction Equipment Noise Calculation Samples

Phase 1 Site Clearence

Project City of Riverside
Project N 5798-010
Date 4/23/2024

Project criteria (dBA) 75

Calculation of sound levels - user only edits project criteria max level, equipment type and quantity, and barrier distances. If needed, manually adjust distances between source and receiver (if center point at proj

Equipment	Qty	Reference Sound Pressure Level @ 50 ft (dBA re: 20µPa)						Reference Utilization (%)			Receptor R1		Receptor R2		Receptor R3	
		Client	FTA	HWA (Predicted	HWA (Measure	VA	Used	Client	FHWA	Used	Distance to R1 (ft)	Sound Pressure Level @ R1	Distance to R2 (ft)	Sound Pressure Level @ R2	Distance to R3 (ft)	Sound Pressure Level @ R3
Chain Saw	1	0	0	85	84	0	85	N/A	20%	20%	129	70	131	70	169	67
Truck	1	0	84	0	0	88	88	N/A	N/A	100%	129	80	131	80	169	77
Shovel	1	0	82	0	0	0	82	N/A	N/A	100%	129	74	131	74	169	71
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
						Total Sound Pressure Level at Receiver NO Barrier						81		81		79
						Total Sound Pressure Level at Receiver WITH Barrie						67		67		65

Receptor R4		Receptor R5		Receptor R6		Receptor R7		Receptor R8		Receptor R9		Receptor R10	
Distance to R4 (ft)	Sound Pressure Level @ R4	Distance to R5 (ft)	Sound Pressure Level @ R5	Distance to R6 (ft)	Sound Pressure Level @ R6	Distance to R7 (ft)	Sound Pressure Level @ R7	Distance to R8 (ft)	Sound Pressure Level @ R8	Distance to R9 (ft)	Sound Pressure Level @ R9	Distance to R10 (ft)	Sound Pressure Level @ R10
105	72	143	69	185	67	99	72	80	74	177	67	186	67
105	81	143	79	185	77	99	82	80	84	177	77	186	77
105	76	143	73	185	71	99	76	80	78	177	71	186	71
105	0	143	0	185	0	99	0	80	0	177	0	186	0
105	0	143	0	185	0	99	0	80	0	177	0	186	0
105	0	143	0	185	0	99	0	80	0	177	0	186	0
105	0	143	0	185	0	99	0	80	0	177	0	186	0
105	0	143	0	185	0	99	0	80	0	177	0	186	0
105	0	143	0	185	0	99	0	80	0	177	0	186	0
105	0	143	0	185	0	99	0	80	0	177	0	186	0
	83		80		78		83		85		78		78
	69		66		64		69		71		64		64

Phase 2 Grading

Project City of Riverside
Project N 5798-010
Date 4/23/2024

Project criteria (dBA) 75

Calculation of sound levels – user only edits project criteria max level, equipment type and quantity, and barrier distances. If needed, manually adjust distances between source and receiver (if center point at p

Equipment	Qty	Reference Sound Pressure Level @ 50 ft (dBA re: 20µPa)						Reference Utilization (%)			Receptor R1		Receptor R2		Receptor R3	
		Client	FTA	HWA (Predicte	HWA (Measure	VA	Used	Client	FHWA	Used	Distance to R1 (ft)	Sound Pressure Level @ R1	Distance to R2 (ft)	Sound Pressure Level @ R2	Distance to R3 (ft)	Sound Pressure Level @ R3
Dozer	1	0	85	85	82	0	85	N/A	40%	40%	129	73	131	73	169	70
Grader	1	0	85	85	0	0	85	N/A	40%	40%	129	73	131	73	169	70
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
						Total Sound Pressure Level at Receiver NO Barrie						76		76		73
						otal Sound Pressure Level at Receiver WITH Barri						62		62		60

Receptor R4		Receptor R5		Receptor R6		Receptor R7		Receptor R8		Receptor R9		Receptor R10	
Distance to R4 (ft)	Sound Pressure Level @ R4	Distance to R5 (ft)	Sound Pressure Level @ R5	Distance to R6 (ft)	Sound Pressure Level @ R6	Distance to R7 (ft)	Sound Pressure Level @ R7	Distance to R8 (ft)	Sound Pressure Level @ R8	Distance to R9 (ft)	Sound Pressure Level @ R9	Distance to R10 (ft)	Sound Pressure Level @
105	75	143	72	185	70	57	80	74	78	177	70	186	70
105	75	143	72	185	70	57	80	74	78	177	70	186	70
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
	78		75		73		83		81		73		73
	64		61		59		68		66		59		59

Phase 3 Site Utility

Project	City of Riverside
Project N	5798-010
Date	4/23/2024

Project criteria (dBA) 75

Calculation of sound levels - user only edits project criteria max level, equipment type and quantity, and barrier distances. If needed, manually adjust distances between source and receiver (if center point at p

Equipment	Qty	Reference Sound Pressure Level @ 50 ft (dBA re: 20µPa)						Reference Utilization (%)			Receptor R1		Receptor R2		Receptor R3	
		Client	FTA	HVA (Predicte	HVA (Measure	VA	Used	Client	FHVA	Used	Distance to R1 (ft)	Sound Pressure Level @ R1	Distance to R2 (ft)	Sound Pressure Level @ R2	Distance to R3 (ft)	Sound Pressure Level @ R3
Truck	1	0	84	0	0	88	88	N/A	N/A	100%	129	80	131	80	169	77
Excavator	1	0	0	85	81	0	85	N/A	40%	40%	129	73	131	73	169	70
Front End Loader	1	0	80	80	79	78	80	N/A	40%	40%	129	68	131	68	169	65
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
						Total Sound Pressure Level at Receiver NO Barrier						81		81		78
						otal Sound Pressure Level at Receiver WITH Barri						67		67		64

Receptor R4		Receptor R5		Receptor R6		Receptor R7		Receptor R8		Receptor R9		Receptor R10	
Distance to R4 (ft)	Sound Pressure Level @ R4	Distance to R5 (ft)	Sound Pressure Level @ R5	Distance to R6 (ft)	Sound Pressure Level @ R6	Distance to R7 (ft)	Sound Pressure Level @ R7	Distance to R8 (ft)	Sound Pressure Level @ R8	Distance to R9 (ft)	Sound Pressure Level @ R9	Distance to R10 (ft)	Sound Pressure Level @
105	81	143	79	185	77	57	87	74	85	177	77	186	77
105	75	143	72	185	70	57	80	74	78	177	70	186	70
105	70	143	67	185	65	57	75	74	73	177	65	186	65
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
	83		80		78		88		86		78		78
	68		66		64		73		71		64		64

Phase 4 Foundation & Slab

Project	City of Riverside
Project N	5798-010
Date	4/23/2024

Project criteria (dBA) 75

Calculation of sound levels - user only edits project criteria max level, equipment type and quantity, and barrier distances. If needed, manually adjust distances between source and receiver (if center point at p

Equipment	Qty	Reference Sound Pressure Level @ 50 ft (dBA re: 20µPa)						Reference Utilization (%)			Receptor R1		Receptor R2		Receptor R3	
		Client	FTA	HVA (Predicte	HVA (Measure	VA	Used	Client	FHVA	Used	Distance to R1 (ft)	Sound Pressure Level @ R1	Distance to R2 (ft)	Sound Pressure Level @ R2	Distance to R3 (ft)	Sound Pressure Level @ R3
Concrete Mixer Truck	1	0	85	85	79	82	85	N/A	40%	40%	129	73	131	73	169	70
Excavator	1	0	0	85	81	0	85	N/A	40%	40%	129	73	131	73	169	70
Tractor	1	0	0	84	0	86	86	N/A	40%	40%	129	74	131	74	169	71
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
						Total Sound Pressure Level at Receiver NO Barrier						78		78		76
						otal Sound Pressure Level at Receiver WITH Barri						64		64		62

Receptor R4		Receptor R5		Receptor R6		Receptor R7		Receptor R8		Receptor R9		Receptor R10	
Distance to R4 (ft)	Sound Pressure Level @ R4	Distance to R5 (ft)	Sound Pressure Level @ R5	Distance to R6 (ft)	Sound Pressure Level @ R6	Distance to R7 (ft)	Sound Pressure Level @ R7	Distance to R8 (ft)	Sound Pressure Level @ R8	Distance to R9 (ft)	Sound Pressure Level @ R9	Distance to R10 (ft)	Sound Pressure Level @
105	75	143	72	185	70	57	80	74	78	177	70	186	70
105	75	143	72	185	70	57	80	74	78	177	70	186	70
105	75	143	73	185	71	57	81	74	79	177	71	186	71
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
	80		77		75		85		83		75		75
	66		63		61		71		68		61		61

Phase 5 Paving

Project	City of Riverside
Project N	5798-010
Date	4/23/2024

Project criteria (dBA): 75

Calculation of sound levels - user only edits project criteria max level, equipment type and quantity, and barrier distances. If needed, manually adjust distances between source and receiver (if center point at p

Equipment	Qty	Reference Sound Pressure Level @ 50 ft (dBA re: 20µPa)						Reference Utilization (%)			Receptor R1		Receptor R2		Receptor R3	
		Client	FTA	HVA (Predicte	HVA (Measure	VA	Used	Client	FHVA	Used	Distance to R1 (ft)	Sound Pressure Level @ R1	Distance to R2 (ft)	Sound Pressure Level @ R2	Distance to R3 (ft)	Sound Pressure Level @ R3
Dozer	1	0	85	85	82	0	85	N/A	40%	40%	129	73	131	73	169	70
Paver	1	0	85	85	77	88	88	N/A	50%	50%	129	77	131	77	169	74
Roller	1	0	85	85	80	74	85	N/A	20%	20%	129	70	131	70	169	67
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
						Total Sound Pressure Level at Receiver NO Barrie						79		79		76
						otal Sound Pressure Level at Receiver WITH Barri						65		65		62

Distances (ft) between a center

Receptor R4		Receptor R5		Receptor R6		Receptor R7		Receptor R8		Receptor R9		Receptor R10	
Distance to R4 (ft)	Sound Pressure Level @ R4	Distance to R5 (ft)	Sound Pressure Level @ R5	Distance to R6 (ft)	Sound Pressure Level @ R6	Distance to R7 (ft)	Sound Pressure Level @ R7	Distance to R8 (ft)	Sound Pressure Level @ R8	Distance to R9 (ft)	Sound Pressure Level @ R9	Distance to R10 (ft)	Sound Pressure Level @
105	75	143	72	185	70	57	80	74	78	177	70	186	70
105	78	143	76	185	74	57	84	74	81	177	74	186	73
105	72	143	69	185	67	57	77	74	75	177	67	186	67
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
	81		78		76		86		84		76		76
	66		64		62		71		69		62		62

Phase 6 Building Construction

Project	City of Riverside
Project N	5798-010
Date	4/23/2024

Project criteria (dBA): 75

Calculation of sound levels - user only edits project criteria max level, equipment type and quantity, and barrier distances. If needed, manually adjust distances between source and receiver (if center point at pr

Equipment	Qty	Reference Sound Pressure Level @ 50 ft (dBA re: 20µPa)						Reference Utilization (%)			Receptor R1		Receptor R2		Receptor R3	
		Client	FTA	HVA (Predicte	HVA (Measure	VA	Used	Client	FHVA	Used	Distance to R1 (ft)	Sound Pressure Level @ R1	Distance to R2 (ft)	Sound Pressure Level @ R2	Distance to R3 (ft)	Sound Pressure Level @ R3
Pneumatic Tools	1	0	85	85	85	85	85	N/A	50%	50%	129	74	131	74	169	71
Air Compressor	1	0	80	0	0	0	80	N/A	N/A	100%	129	72	131	72	169	69
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
No equipment	1	0	0	0	0	0	N/A	N/A	N/A	N/A	129	0	131	0	169	0
						Total Sound Pressure Level at Receiver NO Barrie						76		76		74
						otal Sound Pressure Level at Receiver WITH Barri						62		62		60

Distances (ft) between a center

Receptor R4		Receptor R5		Receptor R6		Receptor R7		Receptor R8		Receptor R9		Receptor R10	
Distance to R4 (ft)	Sound Pressure Level @ R4	Distance to R5 (ft)	Sound Pressure Level @ R5	Distance to R6 (ft)	Sound Pressure Level @ R6	Distance to R7 (ft)	Sound Pressure Level @ R7	Distance to R8 (ft)	Sound Pressure Level @ R8	Distance to R9 (ft)	Sound Pressure Level @ R9	Distance to R10 (ft)	Sound Pressure Level @
105	76	143	73	185	71	57	81	74	79	177	71	186	71
105	74	143	71	185	69	57	79	74	77	177	69	186	69
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
105	0	143	0	185	0	57	0	74	0	177	0	186	0
	78		75		73		83		81		73		73
	64		61		59		69		66		59		59

APPENDIX E
Construction Equipment Vibration Calculation Samples

Phase 1 Site Clearence

Project Name	City of Riverside
Project Number	5798-010
Date	4/23/2024

Edit cells in **Yellow**

Recommended Values of Exponent "n" for PPV calcs

Description	
FTA Value	1.5

Soil Class	Description of Soil Material	"n"
FTA Value	Typical value for general analysis	1.5
Caltrans Category I	Weak or soft soils: loose soils, dry or partially saturated peat and muck, mud, loose beach sand, and dune sand, recently plowed ground, soft spongy forest or jungle floor, organic soils, top soil. (shovel penetrates easily)	1.4
Caltrans Category II	Competent soils: most sands, sandy clays, silty clays, gravel, silts, weathered rock. (can dig with shovel)	1.3
Caltrans Category III	Hard soils: dense compacted sand, dry consolidated clay, consolidated glacial till, some exposed rock. (cannot dig with shovel, need pick to break up)	1.1
Caltrans Category IV	Hard, competent rock: bedrock, freshly exposed hard rock (difficult to break with hammer)	1.0

				Receptor R1			Receptor R2			Receptor R3		
				Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec
			Damage Criteria	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
			Annoyance Criteria	Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category I: Buildings where vibration would interfere with interior operations		
Annoyance Criteria	**Equipment type**	**PPV_{ref} at 25 ft**	**L_v at 25ft (VdB)**	**Distance (ft) to R1**	**PPV_{equip} at R1**	**Lv at R1**	**Distance (ft) to R2**	**PPV_{equip} at R2**	**Lv at R2**	**Distance (ft) to R3**	**PPV_{equip} at R3**	**Lv at R3**
Occasional Events: 30-70 events per	Loaded trucks	0.076	86	149	0.005	62.7	151	0.005	62.6	189	0.004	59.6
Occasional Events: 30-70 events per	Small bulldozer	0.003	58	149	0.000	34.7	151	0.000	34.6	189	0.000	31.6
Occasional Events: 30-70 events per	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Infrequent Events: <30 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Infrequent Events: <30 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
					0.005	62.7		0.005	62.6		0.004	59.7

Receptor R4			Receptor R5			Receptor R6			Receptor R7		
Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec
I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use		
Distance (ft) to R4	**PPV_{equip} at R4**	**Lv at R4**	**Distance (ft) to R5**	**PPV_{equip} at R5**	**Lv at R5**	**Distance (ft) to R6**	**PPV_{equip} at R6**	**Lv at R6**	**Distance (ft) to R7**	**PPV_{equip} at R7**	**Lv at R7**
125	0.007	65.0	163	0.005	61.6	205	0.003	58.6	77	0.014	71.3
125	0.000	37.0	163	0.000	33.6	205	0.000	30.6	77	0.001	43.3
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
	0.007	65.0		0.005	61.6		0.003	58.6		0.015	71.4

Receptor R8			Receptor R9			Receptor R10		
Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec)
I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category I: Buildings where vibration would interfere with interior operations		
Distance (ft) to R8	**PPV_{equip} at R8**	**Lv at R8**	**Distance (ft) to R9**	**PPV_{equip} at R9**	**Lv at R9**	**Distance (ft) to R10**	**PPV_{equip} at R10**	**Lv at R10**
94	0.010	68.7	197	0.003	59.1	206	0.003	58.5
94	0.000	40.7	197	0.000	31.1	206	0.000	30.5
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
	0.011	68.8		0.004	59.1		0.003	58.5

Phase 2 Grading

Project Name	City of Riverside
Project Number	5798-010
Date	4/23/2024

Edit cells in **Yellow**

Recommended Values of Exponent "n" for PPV calcs

Description	
FTA Value	1.5

Soil Class	Description of Soil Material	"n"
FTA Value	Typical value for general analysis	1.5
Caltrans Category I	Weak or soft soils: loose soils, dry or partially saturated peat and muck, mud, loose beach sand, and dune sand, recently plowed ground, soft spongy forest or jungle floor, organic soils, top soil. (shovel penetrates easily)	1.4
Caltrans Category II	Competent soils: most sands, sandy clays, silty clays, gravel, silts, weathered rock. (can dig with shovel)	1.3
Caltrans Category III	Hard soils: dense compacted sand, dry consolidated clay, consolidated glacial till, some exposed rock. (cannot dig with shovel, need pick to break up)	1.1
Caltrans Category IV	Hard, competent rock: bedrock, freshly exposed hard rock (difficult to break with hammer)	1.0

				Receptor R1			Receptor R2			Receptor R3		
				Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec
			Damage Criteria	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
			Annoyance Criteria	Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category I: Buildings where vibration would interfere with interior operations		
Annoyance Criteria	**Equipment type**	**PPV_{ref} at 25 ft**	**L_v at 25ft (VdB)**	**Distance (ft) to R1**	**PPV_{equip} at R1**	**Lv at R1**	**Distance (ft) to R2**	**PPV_{equip} at R2**	**Lv at R2**	**Distance (ft) to R3**	**PPV_{equip} at R3**	**Lv at R3**
Occasional Events: 30-70 events per	Small bulldozer	0.003	58	149	0.000	34.7	151	0.000	34.6	189	0.000	31.6
Occasional Events: 30-70 events per	Small bulldozer	0.003	58	149	0.000	34.7	151	0.000	34.6	189	0.000	31.6
Occasional Events: 30-70 events per	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Infrequent Events: <30 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Infrequent Events: <30 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
					0.0004	37.8		0.0004	37.6		0.0003	34.7

Receptor R4			Receptor R5			Receptor R6			Receptor R7		
Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec
I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use		
Distance (ft) to R4	**PPV_{equip} at R4**	**Lv at R4**	**Distance (ft) to R5**	**PPV_{equip} at R5**	**Lv at R5**	**Distance (ft) to R6**	**PPV_{equip} at R6**	**Lv at R6**	**Distance (ft) to R7**	**PPV_{equip} at R7**	**Lv at R7**
125	0.000	37.0	163	0.000	33.6	205	0.000	30.6	77	0.001	43.3
125	0.000	37.0	163	0.000	33.6	205	0.000	30.6	77	0.001	43.3
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
	0.001	40.0		0.0004	36.6		0.0003	33.6		0.001	46.4

Receptor R8			Receptor R9			Receptor R10		
Building category		Criteria PPV (in/sec)	Building category		Criteria PPV (in/sec)	Building category		Criteria PPV (in/sec)
I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category I: Buildings where vibration would interfere with interior operations		
Distance (ft) to R8	PPV_{equip} at R8	Lv at R8	Distance (ft) to R9	PPV_{equip} at R9	Lv at R9	Distance (ft) to R10	PPV_{equip} at R10	Lv at R10
94	0.000	40.7	197	0.000	31.1	206	0.000	30.5
94	0.000	40.7	197	0.000	31.1	206	0.000	30.5
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
	0.001	43.8		0.0003	34.1		0.0003	33.5

Phase 3 Site Utility

Project Name	City of Riverside
Project Number	5798-010
Date	4/23/2024

Edit cells in **Yellow**

Recommended Values of Exponent "n" for PPV calcs

Description	
FTA Value	1.5

Soil Class	Description of Soil Material	"n"
FTA Value	Typical value for general analysis	1.5
Caltrans Category I	Weak or soft soils: loose soils, dry or partially saturated peat and muck, mud, loose beach sand, and dune sand, recently plowed ground, soft spongy forest or jungle floor, organic soils, top soil. (shovel penetrates easily)	1.4
Caltrans Category II	Competent soils: most sands, sandy clays, silty clays, gravel, silts, weathered rock. (can dig with shovel)	1.3
Caltrans Category III	Hard soils: dense compacted sand, dry consolidated clay, consolidated glacial till, some exposed rock. (cannot dig with shovel, need pick to break up)	1.1
Caltrans Category IV	Hard, competent rock: bedrock, freshly exposed hard rock (difficult to break with hammer)	1.0

				Receptor R1			Receptor R2			Receptor R3		
				Building category		Criteria PPV (in/sec)	Building category		Criteria PPV (in/sec)	Building category		Criteria PPV (in/sec)
			Damage Criteria	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
			Annoyance Criteria	Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category I: Buildings where vibration would interfere with interior operations		
Annoyance Criteria	Equipment type	PPV_{ref} at 25 ft	L_v at 25ft (VdB)	Distance (ft) to R1	PPV_{equip} at R1	Lv at R1	Distance (ft) to R2	PPV_{equip} at R2	Lv at R2	Distance (ft) to R3	PPV_{equip} at R3	Lv at R3
Occasional Events: 30-70 events per	Small bulldozer	0.003	58	149	0.000	34.7	151	0.000	34.6	189	0.000	31.6
Occasional Events: 30-70 events per	Small bulldozer	0.003	58	149	0.000	34.7	151	0.000	34.6	189	0.000	31.6
Occasional Events: 30-70 events per	Loaded trucks	0.076	86	149	0.005	62.7	151	0.005	62.6	189	0.004	59.6
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Infrequent Events: <30 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Infrequent Events: <30 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
					0.006	62.8		0.006	62.6		0.004	59.7

Receptor R4			Receptor R5			Receptor R6			Receptor R7		
Building category		Criteria PPV (in/sec)	Building category		Criteria PPV (in/sec)	Building category		Criteria PPV (in/sec)	Building category		Criteria PPV (in/sec)
I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use		
Distance (ft) to R4	PPV_{equip} at R4	Lv at R4	Distance (ft) to R5	PPV_{equip} at R5	Lv at R5	Distance (ft) to R6	PPV_{equip} at R6	Lv at R6	Distance (ft) to R7	PPV_{equip} at R7	Lv at R7
125	0.000	37.0	163	0.000	33.6	205	0.000	30.6	77	0.001	43.3
125	0.000	37.0	163	0.000	33.6	205	0.000	30.6	77	0.001	43.3
125	0.007	65.0	163	0.005	61.6	205	0.003	58.6	77	0.014	71.3
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
	0.007	65.0		0.005	61.6		0.003	58.6		0.015	71.4

Receptor R8			Receptor R9			Receptor R10		
Building category		Criteria PPV (in/sec)	Building category		Criteria PPV (in/sec)	Building category		Criteria PPV (in/sec)
I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category I: Buildings where vibration would interfere with interior operations		
Distance (ft) to R8	PPV_{equip} at R8	Lv at R8	Distance (ft) to R9	PPV_{equip} at R9	Lv at R9	Distance (ft) to R10	PPV_{equip} at R10	Lv at R10
94	0.000	40.7	197	0.000	31.1	206	0.000	30.5
94	0.000	40.7	197	0.000	31.1	206	0.000	30.5
94	0.010	68.7	197	0.003	59.1	206	0.003	58.5
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
	0.011	68.8		0.004	59.1		0.003	58.5

Phase 4 Foundation & Slab

Project Name	City of Riverside
Project Number	5798-010
Date	4/23/2024

Edit cells in **Yellow**

Recommended Values of Exponent "n" for PPV calcs

Description	
FTA Value	1.5

Soil Class	Description of Soil Material	"n"
FTA Value	Typical value for general analysis	1.5
Caltrans Category I	Weak or soft soils: loose soils, dry or partially saturated peat and muck, mud, loose beach sand, and dune sand, recently plowed ground, soft spongy forest or jungle floor, organic soils, top soil. (shovel penetrates easily)	1.4
Caltrans Category II	Competent soils: most sands, sandy clays, silty clays, gravel, silts, weathered rock. (can dig with shovel)	1.3
Caltrans Category III	Hard soils: dense compacted sand, dry consolidated clay, consolidated glacial till, some exposed rock. (cannot dig with shovel, need pick to break up)	1.1
Caltrans Category IV	Hard, competent rock: bedrock, freshly exposed hard rock (difficult to break with hammer)	1.0

				Receptor R1			Receptor R2			Receptor R3		
				Building category		Criteria PPV (in/sec)	Building category		Criteria PPV (in/sec)	Building category		Criteria PPV (in/sec)
			Damage Criteria	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
			Annoyance Criteria	Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category I: Buildings where vibration would interfere with interior operations		
Annoyance Criteria	Equipment type	PPV_{ref} at 25 ft	L_v at 25ft (VdB)	Distance (ft) to R1	PPV_{equip} at R1	Lv at R1	Distance (ft) to R2	PPV_{equip} at R2	Lv at R2	Distance (ft) to R3	PPV_{equip} at R3	Lv at R3
Occasional Events: 30-70 events per	Small bulldozer	0.003	58	149	0.000	34.7	151	0.000	34.6	189	0.000	31.6
Occasional Events: 30-70 events per	Small bulldozer	0.003	58	149	0.000	34.7	151	0.000	34.6	189	0.000	31.6
Occasional Events: 30-70 events per	Loaded trucks	0.076	86	149	0.005	62.7	151	0.005	62.6	189	0.004	59.6
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Infrequent Events: <30 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Infrequent Events: <30 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
					0.006	62.8		0.006	62.6		0.004	59.7

Receptor R4			Receptor R5			Receptor R6			Receptor R7		
Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec
I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use		
Distance (ft) to R4	PPV_{equip} at R4	Lv at R4	Distance (ft) to R5	PPV_{equip} at R5	Lv at R5	Distance (ft) to R6	PPV_{equip} at R6	Lv at R6	Distance (ft) to R7	PPV_{equip} at R7	Lv at R7
125	0.000	37.0	163	0.000	33.6	205	0.000	30.6	77	0.001	43.3
125	0.000	37.0	163	0.000	33.6	205	0.000	30.6	77	0.001	43.3
125	0.007	65.0	163	0.005	61.6	205	0.003	58.6	77	0.014	71.3
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
	0.007	65.0		0.005	61.6		0.003	58.6		0.015	71.4

Receptor R8			Receptor R9			Receptor R10		
Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec)
I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category I: Buildings where vibration would interfere with interior operations		
Distance (ft) to R8	PPV_{equip} at R8	Lv at R8	Distance (ft) to R9	PPV_{equip} at R9	Lv at R9	Distance (ft) to R10	PPV_{equip} at R10	Lv at R10
94	0.000	40.7	197	0.000	31.1	206	0.000	30.5
94	0.000	40.7	197	0.000	31.1	206	0.000	30.5
94	0.010	68.7	197	0.003	59.1	206	0.003	58.5
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
	0.011	68.8		0.004	59.1		0.003	58.5

Phase 5 Paving

Project Name	City of Riverside
Project Number	5798-010
Date	4/23/2024

Edit cells in **Yellow**

Recommended Values of Exponent "n" for PPV calcs

Description	
FTA Value	1.5

Soil Class	Description of Soil Material	"n"
FTA Value	Typical value for general analysis	1.5
Caltrans Category I	Weak or soft soils: loose soils, dry or partially saturated peat and muck, mud, loose beach sand, and dune sand, recently plowed ground, soft spongy forest or jungle floor, organic soils, top soil. (shovel penetrates easily)	1.4
Caltrans Category II	Competent soils: most sands, sandy clays, silty clays, gravel, silts, weathered rock. (can dig with shovel)	1.3
Caltrans Category III	Hard soils: dense compacted sand, dry consolidated clay, consolidated glacial till, some exposed rock. (cannot dig with shovel, need pick to break up)	1.1
Caltrans Category IV	Hard, competent rock: bedrock, freshly exposed hard rock (difficult to break with hammer)	1.0

				Receptor R1			Receptor R2			Receptor R3		
				Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec
			Damage Criteria	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
			Annoyance Criteria	Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category I: Buildings where vibration would interfere with interior operations		
Annoyance Criteria	Equipment type	PPV_{ref} at 25 ft (	L_v at 25ft (VdB)	Distance (ft) to R1	PPV_{equip} at R1	Lv at R1	Distance (ft) to R2	PPV_{equip} at R2	Lv at R2	Distance (ft) to R3	PPV_{equip} at R3	Lv at R3
Occasional Events: 30-70 events per	Small bulldozer	0.003	58	149	0.000	34.7	151	0.000	34.6	189	0.000	31.6
Occasional Events: 30-70 events per	Small bulldozer	0.003	58	149	0.000	34.7	151	0.000	34.6	189	0.000	31.6
Occasional Events: 30-70 events per	Large Bulldozer	0.089	87	149	0.006	63.7	151	0.006	63.6	189	0.004	60.6
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Infrequent Events: <30 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Infrequent Events: <30 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
Frequent Events: >70 events per day	No Equipment	N/A	N/A	149	0.000	0.0	151	0.000	0.0	189	0.000	0.0
					0.0065	63.8		0.0064	63.6		0.0046	60.7

Receptor R4			Receptor R5			Receptor R6			Receptor R7		
Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec
I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use		
Distance (ft) to R4	PPV_{equip} at R4	Lv at R4	Distance (ft) to R5	PPV_{equip} at R5	Lv at R5	Distance (ft) to R6	PPV_{equip} at R6	Lv at R6	Distance (ft) to R7	PPV_{equip} at R7	Lv at R7
125	0.000	37.0	163	0.000	33.6	205	0.000	30.6	77	0.001	43.3
125	0.000	37.0	163	0.000	33.6	205	0.000	30.6	77	0.001	43.3
125	0.008	66.0	163	0.005	62.6	205	0.004	59.6	77	0.016	72.3
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
125	0.000	0.0	163	0.000	0.0	205	0.000	0.0	77	0.000	0.0
	0.008	66.0		0.0057	62.6		0.0040	59.6		0.018	72.4

Receptor R8			Receptor R9			Receptor R10		
Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec	Building category		Criteria PPV (in/sec
I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5	I. Reinforced-concrete, steel or timber (no plaster)		0.5
Category III:Institutional land uses with primarly daytime use			Category III:Institutional land uses with primarly daytime use			Category I: Buildings where vibration would interfere with interior operations		
Distance (ft) to R8	PPV_{equip} at R8	Lv at R8	Distance (ft) to R9	PPV_{equip} at R9	Lv at R9	Distance (ft) to R10	PPV_{equip} at R10	Lv at R10
94	0.000	40.7	197	0.000	31.1	206	0.000	30.5
94	0.000	40.7	197	0.000	31.1	206	0.000	30.5
94	0.012	69.7	197	0.004	60.1	206	0.004	59.5
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
94	0.000	0.0	197	0.000	0.0	206	0.000	0.0
	0.013	69.8		0.0043	60.1		0.0040	59.5

APPROVED

Vital Patel

03/13/2024

City of RIVERSIDE

City of Arts & Innovation

Public Works Department

Traffic Analysis Scoping Form

This scoping form shall be submitted to the City of Riverside Traffic Engineering Division

Project Identification:

Case Number:	DP-2023-01292
Related Cases:	
SP No.	
EIR No.	
GPA No.	
CZ No.	
Project Name:	La Sierra and Victoria
Project Address:	Southeast corner of La Sierra Avenue and Victoria Avenue, City of Riverside
Project Opening Year:	
Project Description:	49 single-family detached dwelling units

	Consultant:	Developer:
Name:	TJW Engineering, Inc.	Warmington Residential
Address:	9841 Irvine Center Drive, Suite 200	3090 Pullman Street
	Irvine, CA 92618	Costa Mesa, CA 92626
Telephone:	949-878-3509	
Fax/Email:		

Scoping & Study Fees:

Fees to be made payable to "City of Riverside" and delivered to Land Development. City Hall 3rd Floor, 3900 Main Street, Riverside, CA 92522

1) Scoping Agreement Fee (For all projects not screened from analysis): **$271.00**

2) TIA Review (For projects with both LOS & VMT analysis of any scale, or standalone LOS analyses with over 100 vehicle trips per hour): **$2671.02**

3) TIA Review (For standalone VMT analysis, or standalone LOS analyses with under 100 vehicle trips per hour): **$1288.20**

Trip Generation Information:

Trip Generation Data Source: ITE Trip Generation Manual, 11th Edition (2021)

Current General Plan Land Use: LDR - Low Density Residential (4.1 du/ac)

Proposed General Plan Land Use: LDR - Low Density Residential (4.1 du/ac)

Current Zoning: R-1-1/2 Acre - Single Family Residential

Proposed Zoning: R-1-1/2 Acre - Single Family Residential

The proposed project does not require a zone change or General Plan amendment. LDR permits up to 4.1 dwelling units per acre. The zoning is R-1-1/2 Acre. The project has a density of 4.95 units per acre which is in line with the General Plan when the state density bonus law (SDBL) is applied.

	Existing Trip Generation			Proposed Trip Generation		
	In	Out	Total	In	Out	Total
AM Trips				9	25	34
PM Trips				29	17	46

Trip Internalization: ☐ Yes ☒ No (______% Trip Discount)

Pass-By Allowance: ☐ Yes ☒ No (______% Trip Discount)

Potential Screening Checks

Is your project screened from specific analyses in accordance with City Guidelines?

Is the project screened from LOS assessment? ☒ Yes ☐ No

3900 Main Street, Riverside, CA 92522 | Phone: (951) 826-5366| **RiversideCA.gov**

LOS screening justification (see Page 6 of the guidelines): Based on the proposed project's land use, the project is expected to generate 34 AM and 46 PM Peak Hour trips. Per the City of Riverside Traffic Impact Analysis Guidelines (July 2020), any project generating less than 100 peak hour trips is not expected to affec the LOS significanlty and therefore do not require a TIA that includes a LOS analysis. As the proposed project will generate less than 100 peak hour trips a LOS analysis is not needed. The project does not require a zone change or General Plan Amendment.

Is the project screened from VMT assessment? ☐ Yes ☒ No

VMT screening justification (see Pages 23-25 of the guidelines): Based on the City of Riverside Traffic Impact Study Guidelines (July 2020) guidelines the proposed project does not screen for VMT assessment as, per the WRCOG VMT Tool, it is not in a transit priority area (TPA) or low VMT traffic analysis zone (TAZ), and it does not match any of the land use types that screen.

Level of Service Scoping

- Proposed Trip Distribution (Attach Graphic for Detailed Distribution):

North	South	East	West
N/A %	N/A %	N/A %	N/A %

- Attach list of Approved and Pending Projects that need to be considered (provided by the lead agency and adjacent agencies)
- Attach list of study intersections/roadway segments
- Attach legible site plan
- Note other specific items to be addressed:
    - Site access
    - On-site circulation
    - Parking
    - Consistency with Plans supporting Bikes/Peds/Transit
    - Other ____________________
- Date of Traffic Counts ____________________
- Attach proposed analysis scenarios (years plus proposed forecasting approach)
- Attach proposed phasing approach (if the project is phased)

VMT Scoping

For projects that are not screened, identify the following:

- Travel Demand Forecasting Model RIVCOM
- Attach WRCOG Screening VMT Assessment output or describe why it is not appropriate for use
- Attach proposed Model Land Use Inputs and Assumed Conversion Factors (attach)

Specific Issues to be addressed in the Study (in addition to the standard analysis described in the Guidelines) (To be filled out by the Public Works Traffic Engineering Division)

The site's general land-use designation is low-density residential, which permits up to 4.1 dwelling units per acre. The zoning designation for the site is R-1-1/2 Acre. Our project is designed to have a density of 4.95 units per acre, which is in line with the general plan when we apply the state density bonus law (SDBL).

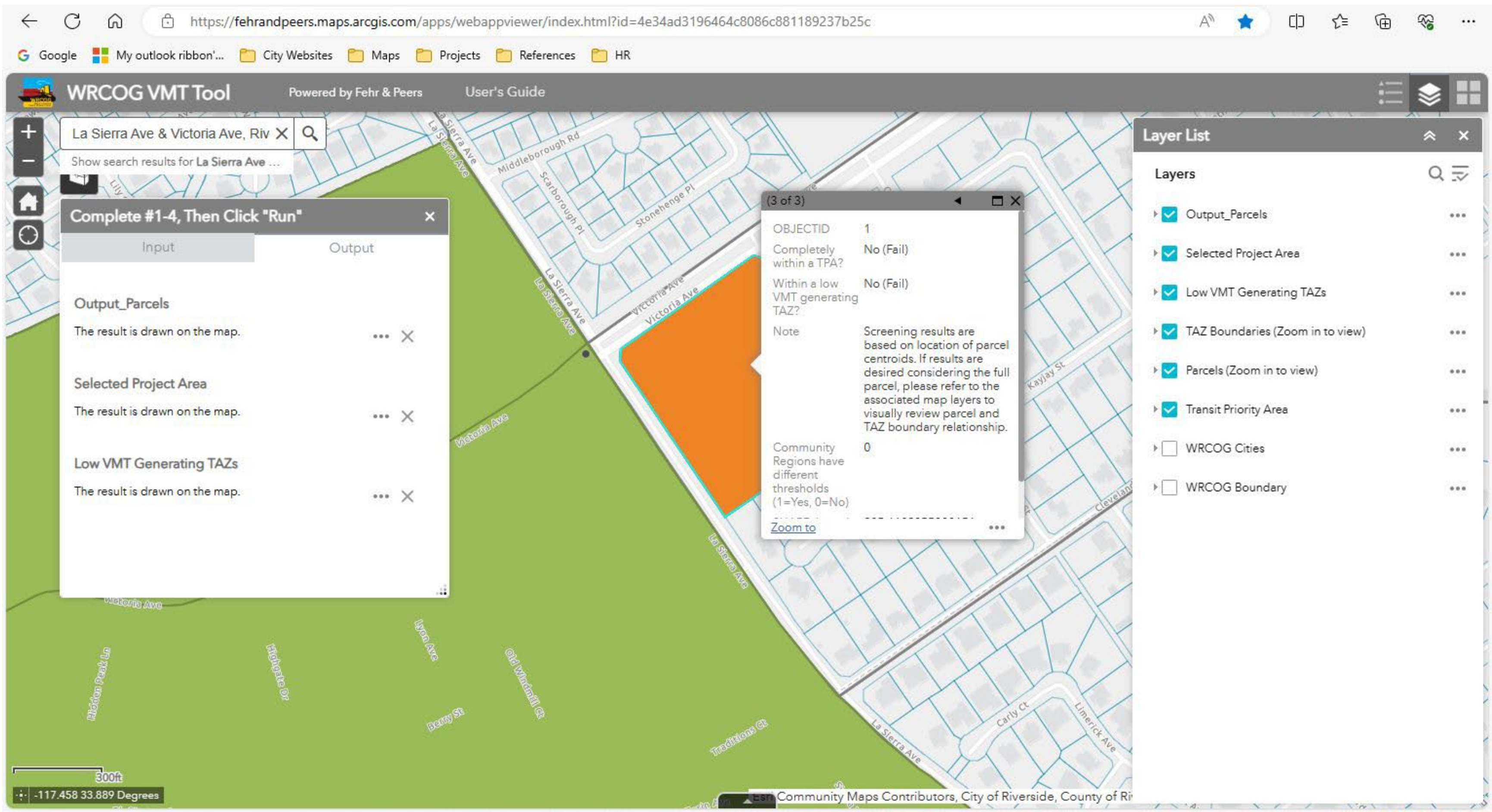
Table: Trip Generation

Proposed Land Use[1]	ITE Code	Qty	Unit[2]	Daily		AM Peak Hour					PM Peak Hour				
				Rate	Volume	Rate	In:Out Split	Volume			Rate	In:Out Split	Volume		
								In	Out	Total			In	Out	Total
Single-Family Detached Housing	210	49.0	DU	9.43	462	0.7	26:74	9	25	34	0.94	63:37	29	17	46

1: Trip generation and pass-by rates from ITE Trip Generation Manual (11th Edition, 2021).

2: DU = Dwelling Units.

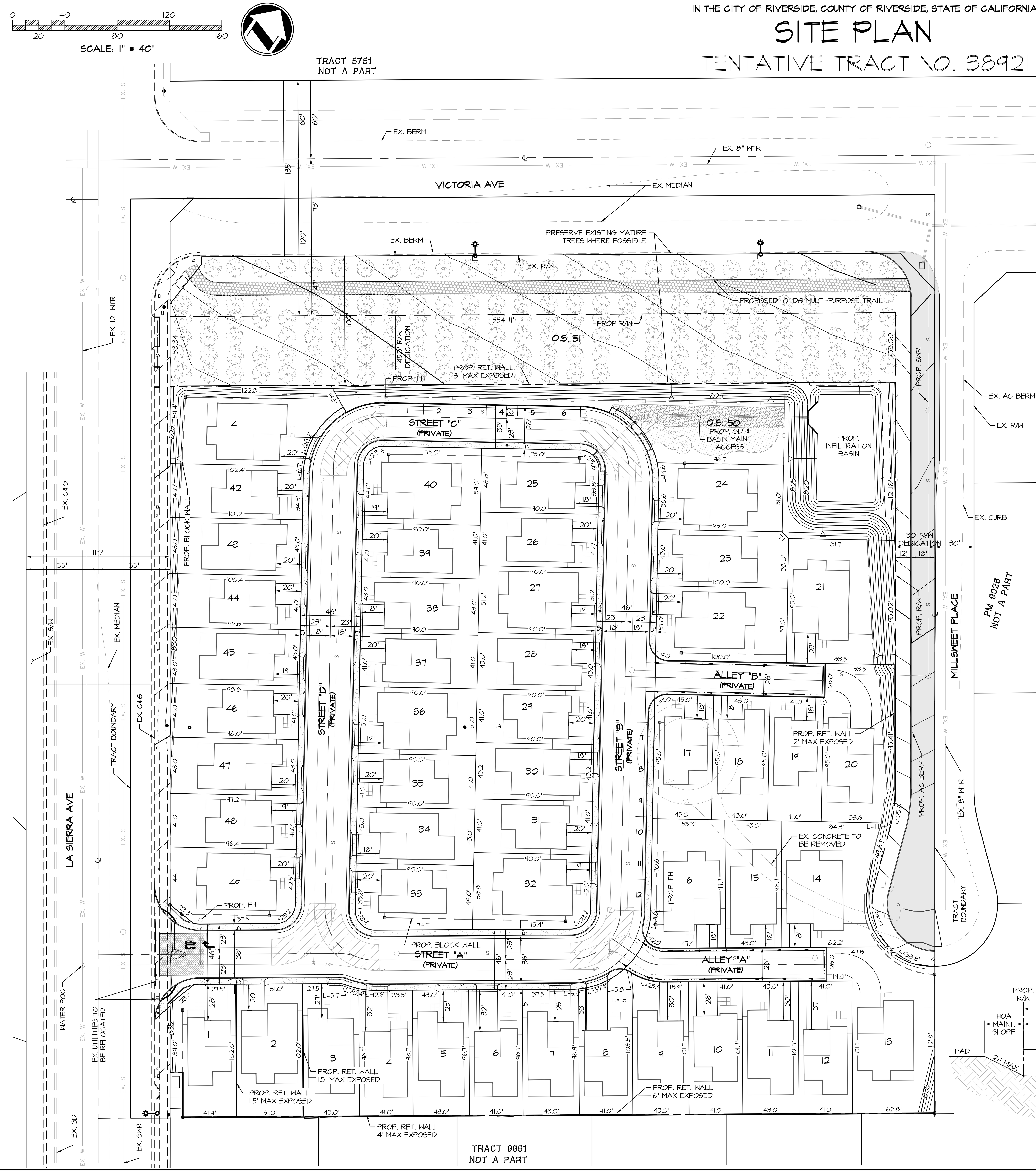
Proposed Project Site TAZ Location
WRCOG VMT Tool (arcgis.com)



IN THE CITY OF RIVERSIDE, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA

SITE PLAN

TENTATIVE TRACT NO. 38921



OWNER
LA SIERRA VICTORIA DEVELOPMENT LLC
19215 WILD MUSTANG COURT
APPLE VALLEY, CA 92307

APPLICANT
WARMINGTON RESIDENTIAL
3090 PULLMAN ST
COSTA MESA, CA 92626
CONTACT: MATTHEW ESQUIVEL
EMAIL: MESQUIVEL@WARMINGTONGROUP.COM

UTILITY PURVEYORS

WATER:	CITY OF RIVERSIDE
SEWER:	CITY OF RIVERSIDE
GAS:	SOCAL GAS COMPANY
ELECTRICITY:	CITY OF RIVERSIDE
TELEPHONE:	SBC
SCHOOL:	ALVORD UNIFIED
CATV:	CHARTER CABLE

SITE SUMMARY
GROSS PROJECT SIZE: 10.8 ACRES
NET PROJECT SIZE: 7.85 ACRES
RESIDENTIAL LOTS: 49
OPEN SPACE LOTS: 2
PROJECT DENSITY: 6.2 DU/AC
INFILTRATION BASIN: 0.08 ACRES
LOT SETBACKS:
FRONT:
HOUSE: 10 FT MIN
GARAGE FACE: 18 FT MIN
SIDE: 4 FT
REAR: 15 FT
LOT DEPTH: 90 FT MIN
LOT WIDTH: 41 FT MIN.
LOT AREA: 3690 SQ. FT MIN
PARALLEL PARKING ON STREET (8'X24'): 12
FOOTPRINT MATRIX:
PLAN 1: 19
PLAN 2: 17
PLAN 3: 13

ENGINEER
adkan ENGINEERS
6820 AIRPORT DRIVE
RIVERSIDE, CA. 92504
951-688-0241

ZONING/LAND USE

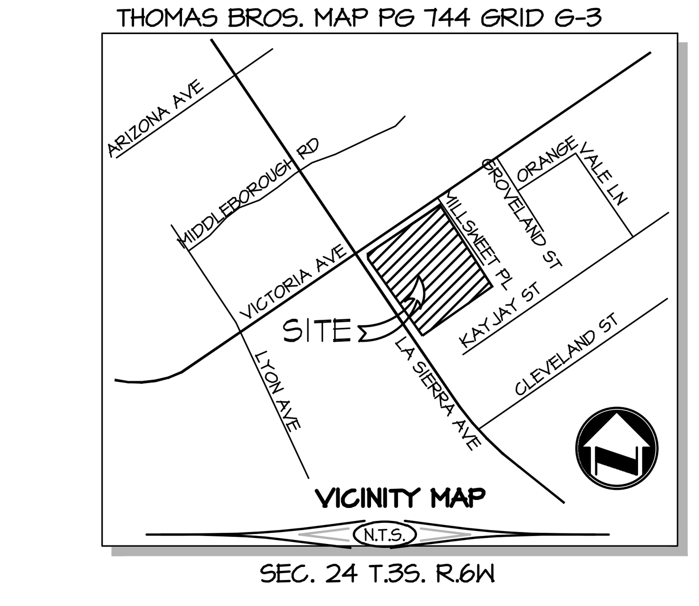
EXISTING ZONING:	R-1-1/2 ACRE
PROPOSED ZONING:	R-1-1/2 ACRE
EXISTING LAND USE:	LDR
PROPOSED LAND USE:	LDR

ASSESSORS PARCEL NUMBER
136-220-016

LEGAL DESCRIPTION
LOT 6 IN BLOCK 12 OF THE RESUBDIVISION OF LANDS OF J. F. MOULTON AND H. B. PRAED, AS SHOWN BY MAP ON FILE IN BOOK 1 PAGES 49 AND 50 OF MAPS, IN THE OFFICE OF THE COUNTY RECORDER OF THE COUNTY OF RIVERSIDE.

BASIS OF BEARING
THE CENTERLINE OF VICTORIA AVENUE BEING NORTH 55°35'00" EAST PER TRACT NO. 21979, FILED IN BOOK 175 MAPS, AT PAGES 46 AND 47, RECORDS OF RIVERSIDE COUNTY, WAS HELD AS THE BASIS OF BEARING FOR THIS MAP.

THOMAS BROS. MAP PG 744 GRID G-3

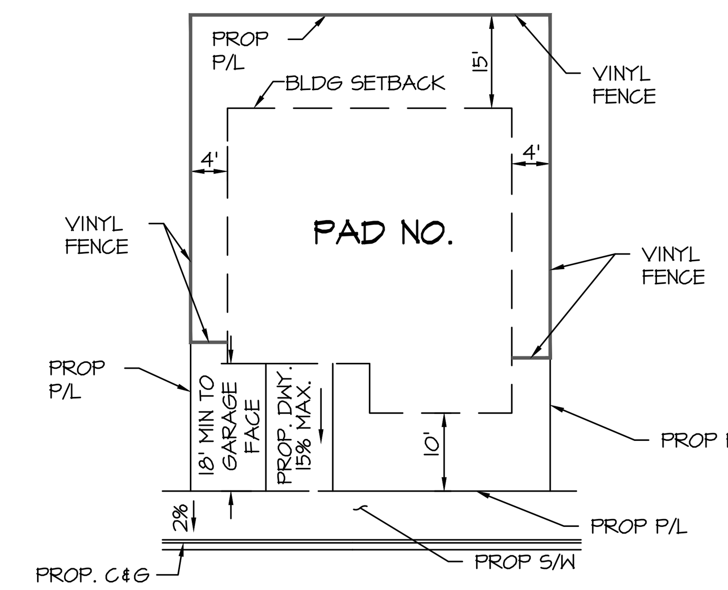


VICINITY MAP
N.T.S.
SEC. 24 T.3S, R.6W

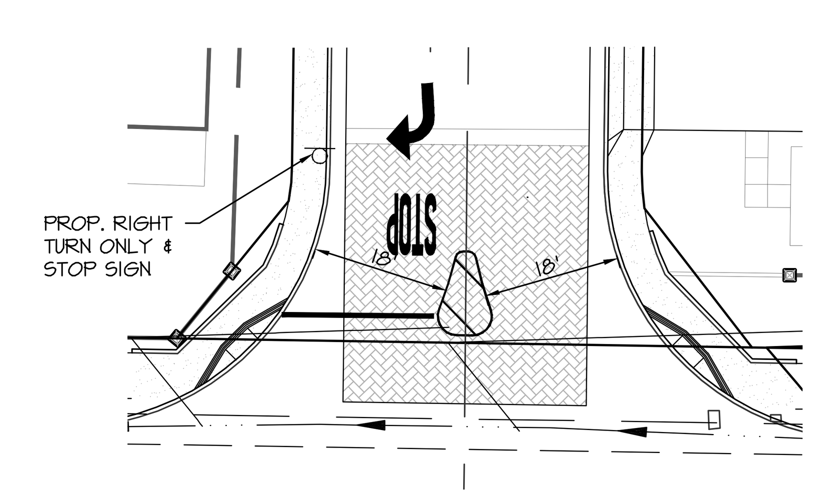
LEGEND

BOUNDARY	EX. STORM DRAIN
RIGHT OF WAY	EX. MAJOR CONTOUR
CENTERLINE	EX. MINOR CONTOUR
PROPERTY LINE	6' BLOCK WALL
EASEMENT	6' STEEL TUBULAR FENCE
PROP. CURB & GUTTER	4' STEEL TUBULAR FENCE
EX. CURB & GUTTER	6' VINYL FENCE
PROP. SIDEWALK	RETAINING WALL
EX. SIDEWALK	
UNDERGROUND STORAGE	
PROP. DOMESTIC WATER	
EX. DOMESTIC WATER	
PROP. RECYCLED WATER	
PROP. SEWER	
EX. SEWER	
PROP. STORM DRAIN	

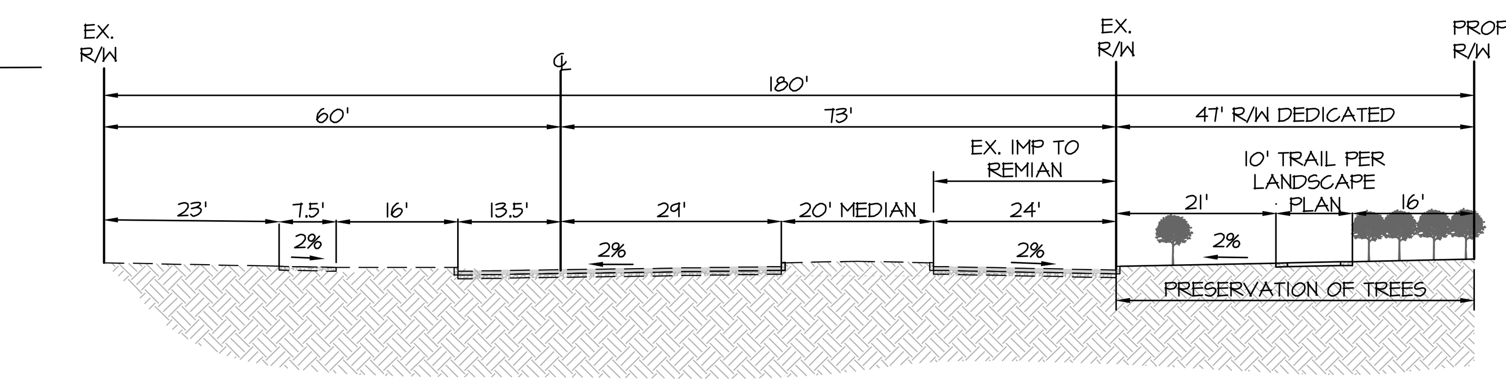
EX.	EXISTING
PROP.	PROPOSED
S/W	SIDEWALK
R/W	RIGHT OF WAY
R&R	REPLACE AND REPAIR
P/L	PROPERTY LINE
C&G	CURB & GUTTER
O.S.	OPEN SPACE
EVA	EMERGENCY VEHICLE ACCESS
SWR	SEWER
WTR	WATER
SD	STORM DRAIN
CB	CATCH BASIN
TBR	TO BE REMOVED
TYP.	TYPICAL



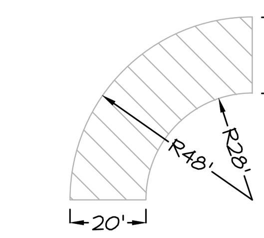
TYPICAL LOT DETAIL
N.T.S.



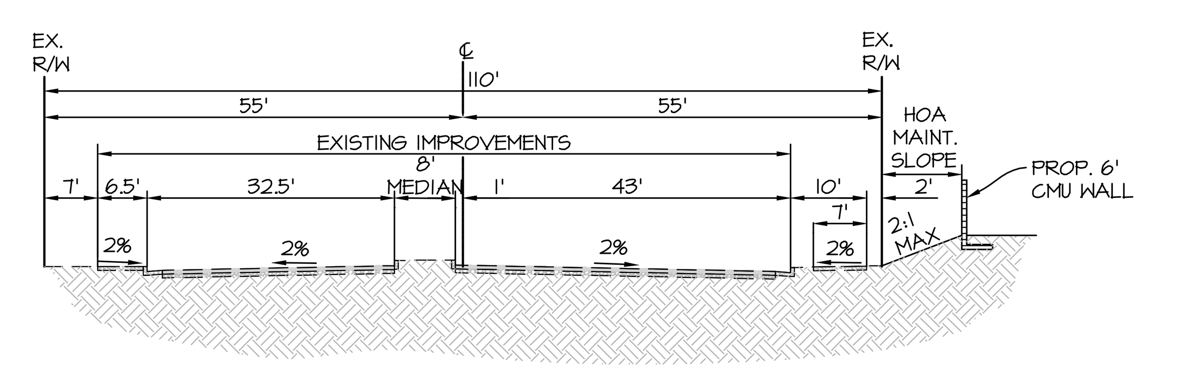
CHANNELIZING ISLAND DETAIL
SCALE: 1"=20'



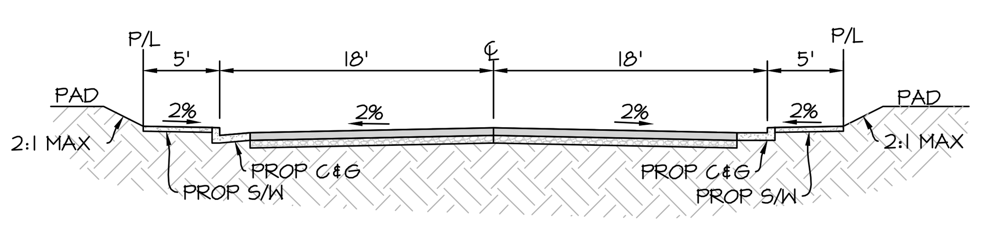
VICTORIA AVENUE
N.T.S.



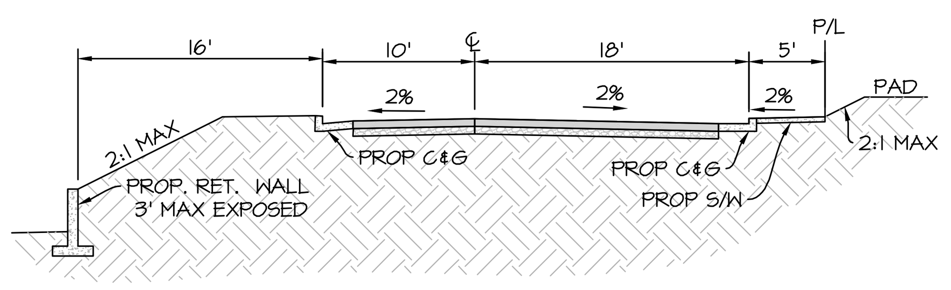
FIRE DEPARTMENT TURNING RADIUS
CITY OF RIVERSIDE FIRE DEPARTMENT
TURNING RAIDUS PER RIVERSIDE MUNICIPAL
CODE CHAPTER 16.32 AND 2022 CALIFORNIA
FIRE CODE SECTION 503.



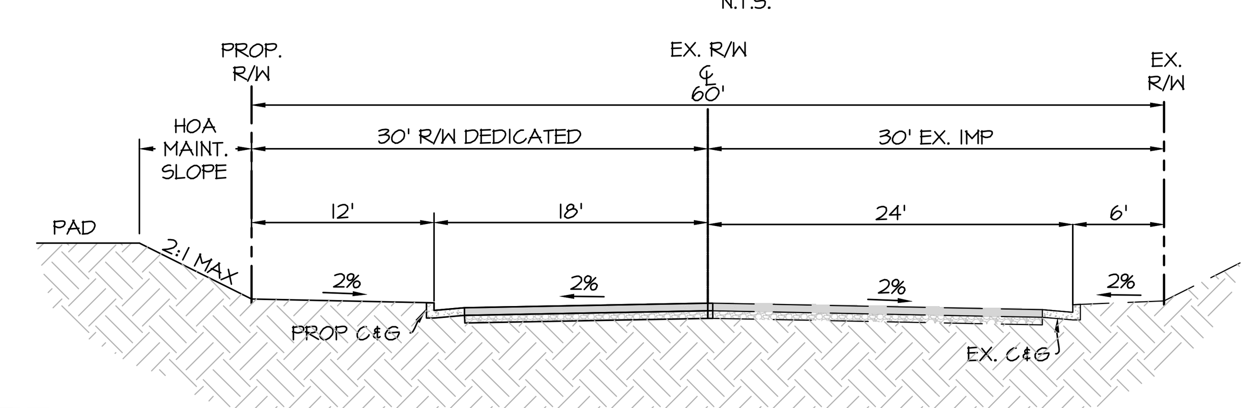
LA SIERRA AVENUE
N.T.S.



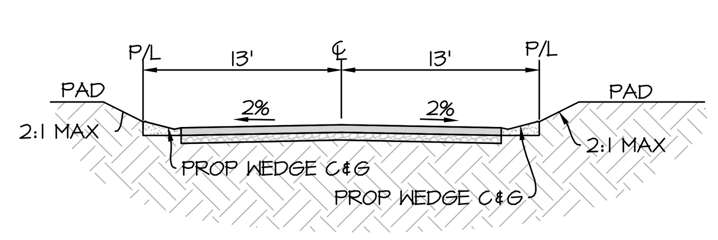
TYPICAL ONSITE STREET (A,B&D)
N.T.S.



TYPICAL ONSITE STREET (C)
N.T.S.



MILLSWEET PLACE
N.T.S.



TYPICAL ALLEY
N.T.S.

PLANS PREPARED BY:
adkan ENGINEERS
Civil Engineering · Surveying · Planning
6879 Airport Drive, Riverside, CA 92504
Tel:(951) 688-0241 · Fax:(951) 688-0599

July 16, 2024

TJW ENGINEERING, INC.
TRAFFIC ENGINEERING &
TRANSPORTATION PLANNING
CONSULTANTS

Matthew Esquivel
WARMINGTON RESIDENTIAL
3090 Pullman Street
Costa Mesa, CA 92626

SUBJECT: La Sierra and Victoria Vehicle Miles Traveled (VMT) Analysis

Matthew Esquivel,

*TJW Engineering, Inc. (*TJW*)* is pleased to submit this Vehicle Miles Traveled (VMT) Analysis for the proposed project located at the corner of La Sierra and Victoria in the City of Riverside. The purpose of this memorandum is to satisfy the requirements for disclosure of potential impacts and mitigation measures per the California Environmental Quality Act (CEQA). This analysis has been conducted using guidance from the *City of Riverside Traffic Impact Analysis Guidelines for Vehicle Miles Traveled and Level of Service Assessment (July 2020).*

PROJECT DESCRIPTION

The proposed project is located at the corner of La Sierra and Victoria in the City of Riverside. The proposed project includes 49 townhome dwelling units with access from La Sierra Avenue. The project site plan is attached for reference.

BACKGROUND

Senate Bill 743 (SB-743), which was codified in Public Resources Code section 21099, was signed by the Governor in 2013 and directed the Governor's OPR to identify alternative metrics for evaluating transportation impacts under CEQA. Based on this, delay-based analysis (level of service) has been replaced by VMT. Pursuant to Section 21099, the criteria for determining the significance of transportation impacts must "promote the reduction of greenhouse gas emissions, the development of multimodal transportation networks, and a diversity of land uses." Recently adopted changes to the CEQA Guidelines in response to Section 21099 include a new section (15064.3) that specifies that VMT is the most appropriate measure of transportation impacts. A separate Technical Advisory issued by OPR provides additional technical details on calculating VMT and assessing transportation impacts for various types of projects.

THRESHOLDS

The City guidelines outline two thresholds for determination of a significant impact. For residential projects, the following thresholds of significance are identified:

1. The baseline or cumulative project-generated VMT per capita exceeds 15% below the current jurisdictional baseline VMT per capita.
2. For projects inconsistent with the General Plan, the baseline or cumulative link-level boundary VMT per capita (City) increase under the plus project condition compared to the no project condition.

As the project is consistent with the General Plan, a link-level boundary VMT analysis is not applicable to this project. However, the project-generated VMT per capita was conducted following the City guidelines.

METHODOLOGY AND ANALYSIS

A VMT analysis was prepared using the City's guidelines for VMT analysis. The analysis was prepared using the Riverside County Travel Demand Model (RIVCOM).

The project is located within Traffic Analysis Zone (TAZ) 1956. The potential population generated by the project was calculated using a factor of 3.34 persons per household as noted in the County of Riverside General Plan, Appendix E – Socioeconomic Build-Out Assumptions and Methodology (2017).[1] Based on this data, the proposed residential project would have a population of 164 people (49 dwelling units x 3.34 persons per household). The existing base socioeconomic data moved from the project TAZ and added to adjacent TAZ's. The project TAZ was then populated with the project population.

VMT data for years between 2018 and 2045 can be extrapolated using linear interpolation between the 2018 and 2045 model outputs. The model was completed for base year 2018 and plan year 2045 without and with project conditions (total four model runs). Based on the residential land use and as per City guidelines, project VMT/resident was compared to the County's VMT/capita threshold for project opening year 2028.

[1] Lake Mathews/Woodcrest Plan Area was utilized due to the project's close proximity and similar characteristics to the Plan Area.

Table 1: VMT Analysis of Project Impact

	2018	2045	2028
Project VMT	2,494	2,513	2,498
Project Population	164	164	164
Project VMT/Resident	15.2	15.4	15.3
City of Riverside VMT	3,951,373	5,021,447	4,189,167
City Population	323,856	404,570	341,792
City VMT/Resident	12.2	12.4	12.3
City 15% Threshold	10.4	10.6	10.4
VMT Threshold	**Project VMT/Resident**	**% Above/Below Threshold**	**VMT Impact?**
10.4	15.3	46.15%	Yes

MITIGATION MEASURES

The City of Riverside outlines for residential projects an impact would occur for residential projects if the VMT per resident exceeds 15% below the citywide VMT per resident. In this case, the project exceeds the threshold by 4.9 VMT per resident (approximately 47% over the City threshold).

To mitigate the project VMT impacts and per the City guidelines, the *California Air Pollution Control Officers Association (CAPCOA) Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equality (December 2021)* was considered. The CAPCOA manual includes various measures to reduce VMT. Among the various measures identified, three (3) measures were deemed applicable to the proposed project.

Measure T-1: Increase Residential Density

This measure accounts for the VMT reduction achieved by a project that is designed with a higher density of dwelling units. The relevant pages from the CAPCOA manual are attached.

The VMT reduction resulting from a project that is designed with a higher density of dwelling units is calculated using the following equation: A=((B-C)/C)*D, where A is the percent reduction in VMT, B is the residential density of the project development, C is the residential density of a typical development, and D is the elasticity of VMT with respect to residential density (constant of -0.22). The project proposes a density of 4.94 dwelling units per acre and the general plan land use designation of 1-½ acre Single Dwelling is up to 2 dwelling units per acre. The resulting reduction in VMT is determined to exceed the CAPCOA greenhouse gas emissions maximum potential of 30%. Therefore, the T-1 mitigation is shown to result in a 30% VMT reduction, shown in Table 2.

Measure T-3: Provide Transit-Oriented Development

This measure accounts for VMT reduction in the study area relative to the same project sited in a non-transit oriented (TOD) development location. To qualify as a TOD, the proposed project must be a residential project near a high frequency transit station. The project falls within these parameters, as the project provides a 10-minute pedestrian friendly pathway to a high frequency transit station. The high frequency transit station is the nearby Metrolink station that provides access to Los Angeles and Orange County, two major employment centers.

The VMT reduction resulting from a project that qualifies as a TOD is calculated using the following equation: A=(B*C)/(-D), where A is the percent reduction in VMT, B and D are respectively the transit and vehicle mode share in the surrounding city as calculated by the National Household Travel Survey of the Federal Highway Administration (2017), and C is the ratio of transit mode share for TOD area with measure compared to existing transit mode share in the surrounding city (constant is 4.9). The resulting VMT reduction is determined to be 6.93%, shown in Table 2.

Measure T-4: Integrate Affordable and Below Market Rate Housing

This measure accounts for VMT reduction achieved with projects that provide affordable housing units. The relevant pages from the CAPCOA manual are attached.

The VMT reduction resulting from a project that is designed with affordable housing units is calculated using the following equation: A=B*C, where A is the percent reduction in VMT, B is the percent of affordable housing units, and C is the percent reduction in VMT for qualified units compared to market rate units (constant of -28.6%). The project proposes 3 out of 49 units at affordable and below market rate. The resulting reduction in VMT is determined to be 1.75%, shown in Table 2.

Measure T-15: Limited Residential Parking Supply

This measure addresses VMT reduction by limiting the amount of available parking, thus disincentivizing driving as a mode of transportation.

The VMT reduction resulting from a project that limits the amount of available parking spaces is calculated using the following equation: A=(-(B-C)/B)D*E*F, where A is the percent reduction in VMT, B is the residential parking demand (constant of 2.6 spaces/unit for single family homes, multiplied by the number of units proposed), C is the proposed number of parking spaces on the site (2 garage spaces per unit, plus 12 spaces along the project's private streets)[2], D is the percentage of project VMT generated by residents (100% for the proposed residential projects), E is the percent of household VMT that is commute based (constant of 37%), and F is the percent reduction in commute mode share by driving among households in areas with scarce parking (also constant of 37%). The resulting reduction in VMT is determined to be 1.93%, shown in Table 2.

[2] Due to subpar street widths, the project will not be providing on-street parking throughout the community as is typical with residential developments. Therefore, the project would provide limited residential parking.

Measure T-18: Provide Pedestrian Network Improvement

This measure is described as increasing the sidewalk coverage to improve pedestrian access. The relevant pages from the CAPCOA manual are attached.

The VMT reduction resulting from construction of additional sidewalks is calculated using the following equation: A = ((C/B)-1) x D, where A is the percent reduction in VMT, B is the existing sidewalk length in the study area, C is the sidewalk length in the study area with measure, and D is the elasticity of household VMT with respect to the ratio of sidewalks-to-streets (constant of-.0.05). The study area used for this calculation is within the boundaries of TAZ 1956. There are approximately 1,288 linear feet of existing sidewalk along La Sierra Avenue between Cleveland Avenue and Victoria Avenue and the project would construct 2,295 linear feet within the project site. Exhibit 1 shows the location of these sidewalks. The resulting reduction in VMT comes out to be 8.9%, however, based on the CAPCOA manual, there's a maximum of a 6.4% reduction. Therefore, the project would result in a decrease in VMT of 6.40%, shown in Table 2.

Table 2: VMT Analysis with Mitigation

Project % Above City Threshold	46.15%
CAPCOA VMT Reductions	
T-1 – Increase Residential Density	-30.00%
T-3 – Provide Transit-Oriented Development	-6.93%
T-4 – Integrate Affordable Housing	-1.75%
T-15 – Limited Residential Parking Supply	-1.93%
T-18 – Pedestrian Network Improvement	-6.40%
Sub-Total	*-47.01%*
Project % Above/Below Threshold	**-0.85%**

POTENTIAL VMT REDUCING FEATURES

Additional improvements not covered in the CAPCOA Manual will encourage residents to utilize alternative means of transportation.

Currently, along the project's northern border, Victoria Boulevard provides eastbound access to passenger vehicles and trucks only. A current trail on this side of the street and east of the project ends just before the project site around Millsweet Place. The project proposes that the trail end be extended to the intersection of La Sierra Avenue and Victoria Boulevard. As the trail is shared by pedestrians and bicycles, this extension will expand the multi-modal network, thus encouraging residents to walk and/or bicycle instead of drive.