NOISE AND VIBRATION TECHNICAL REPORT

Brightline West Cajon Pass High-Speed Rail Project

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Prepared for
Federal Railroad Administration

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Abbreviations and Acronyms

ADT	average daily traffic
ANSI	American National Standards Institute
ARRIVE	Advanced Regional Rail Integrated Vision – East
BMP	best management practice
CalSTA	California State Transportation Agency
Caltrans	California Department of Transportation
CGP	Construction General Permit
CHP	California Highway Patrol
CSA	Cross-Spectrum Acoustics
dB	decibel
dBA	A-weighted decibel
EIR	Final Environmental Impact Report
EIS	Environmental Impact Statement
FDL	Force density level
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GHG	greenhouse gas
HOV	high-occupancy vehicle
HSR	high-speed rail
Hz	Hertz
I-	Interstate
in/sec	inches per second
Ldn	day night sound level
Leq	equivalent sound level
Lmax	maximum noise level
Ln	sound level exceeded n-percent of the time
LOS	level of service
LSTM	line source transfer mobility
LT	long term
Lv	vibration level
MOU	memorandum of understanding
mph	miles per hour

NAAQS	National Ambient Air Quality Standards
NIST	National Institute of Standards and Technology
PPV	peak particle velocity
Project	Cajon Pass High-Speed Rail Project
RMS	root mean square
ROW	right of way
RTP/SCS	Regional Transportation Plan/Sustainable Communities Strategy
SBCTA	San Bernardino County Transportation Authority
SCAG	Southern California Association of Governments
SCE	Southern California Edison
SCORE	Southern California Optimized Rail Expansion
SEL	sound exposure level
SR	State Route
ST	short term
TCA	temporary construction area
TM	transfer mobility
TPSS	traction power substation
U.F.	usage factor
US-395	US Highway 395
USDOT	US Department of Transportation
VdB	vibration decibel
VHT	vehicle hours traveled
VMT	vehicle miles traveled

1. Introduction

DesertXpress Enterprises, LLC (dba “Brightline West”) proposes to construct and operate the Cajon Pass High-Speed Rail Project (Project), a 49-mile train system capable of speeds up to 140 miles per hour (mph) between Victor Valley and Rancho Cucamonga, California (Project). The Project includes two railway stations—one in Hesperia, and one in Rancho Cucamonga. The station in Victor Valley would be constructed as part of a separate project that was evaluated in the DesertXpress Final Environmental Impact Statement (Final EIS; FRA 2011).

The Project would be constructed within the Interstate 15 (I-15) right-of-way for 48 miles and on existing transportation corridors for the last mile into the proposed Rancho Cucamonga station. The Project would be powered by overhead electric catenary and require construction of one new traction power substation (TPSS) in the Hesperia area. The maintenance facility that was evaluated with the Brightline West Victor Valley High-Speed Rail (HSR) Passenger Project would provide the primary maintenance functions, although layover tracks are anticipated at the Rancho Cucamonga station, which could include light maintenance capability, such as interior cleaning and daily inspection.

Trains are expected to operate daily on 45-minute headways between Victor Valley and Rancho Cucamonga. The trip between Victor Valley and Rancho Cucamonga would be approximately 35 minutes. Service would be coordinated with existing and planned Metrolink service at the Rancho Cucamonga station to provide a convenient connection between the HSR and commuter rail systems.

The Project would be constructed and operated under a lease agreement with the California Department of Transportation (Caltrans) for the use of the I-15 right-of-way and the station at Hesperia. Brightline West would secure additional agreements for Right-of-Way Use, Design & Construction Oversight and Reimbursement; and Operations & Maintenance, as necessary.
For the last mile of the project from I-15 to the Rancho Cucamonga Station, there will be Agreements with the City of Rancho Cucamonga and the San Bernardino County Transportation Authority (SBCTA) for land rights, construction, operations and maintenance.

2. Project Description

2.1. Background

Early Project coordination for HSR service from Victor Valley to Rancho Cucamonga began in 2020, with Brightline West meeting with the San Bernardino County Transportation Authority (SBCTA) to examine a connection between Victor Valley and Rancho Cucamonga. This meeting resulted in a memorandum of understanding (MOU) that was fully executed in July 2020 between Brightline West and SBCTA to study the potential of building HSR within the I-15 right-of-way between Victor Valley and Rancho Cucamonga. A separate MOU was executed in September 2020 between Brightline West and the Southern California Regional Rail Authority, which operates Metrolink, for connection to the existing Metrolink station in Rancho Cucamonga. Additionally, the California State Transportation Agency (CalSTA), Caltrans, the California High-Speed Rail Authority, and Brightline West have executed an MOU regarding the Project. The MOU reflects both the regional and statewide interest and value in the Project, including interconnectivity opportunities, and outlines how the parties will work together to advance their shared interest in the success of the Project.

2.2. Project Area

The Project would construct and operate a 49-mile train system capable of speeds up to 140 mph between Victor Valley- and Rancho Cucamonga, California. The Project includes two railway stations: one in Hesperia, and one in Rancho Cucamonga, and will connect to another Brightline West station in Victor Valley. The proposed rail alignment would be located within the median of the I-15 freeway between Victor Valley and Rancho Cucamonga except for the last mile approaching the proposed Rancho Cucamonga station. The Project area is depicted in Figure 1.

2.3. Purpose of and Need for the Project

2.3.1. Purpose

The purpose of the Project is to provide reliable and safe passenger rail transportation between the Los Angeles metropolitan region and the High Desert of San Bernardino County. The Project would provide a convenient, efficient, and environmentally sustainable alternative to automobile travel on the highly congested I-15 freeway. The Project would add capacity to the overall transportation system by introducing a new HSR service from Victor Valley to Rancho Cucamonga. The Project would reduce travel time, improve reliability, and increase the mobility options for travel between metropolitan regions. Travel time from Victor Valley to Rancho Cucamonga for Project users would be approximately 30 percent faster during normal conditions and at least twice as fast during congestion peak periods. The Project would reduce automobile vehicle miles traveled (VMT), resulting in a corresponding reduction in greenhouse gas emissions (GHG) and air quality emissions.

2.3.1.1. Multi-Modal Use of the I-15 Corridor

Operation of the Project would significantly increase the capacity of I-15 as a multi-modal corridor in Southern California. This increase in capacity would benefit freeway operations by providing an alternative to automobile travel that would reduce travel time. This shift of people from automobile to train travel along the I-15 corridor would reduce the need for programmed and/or planned freeway improvement and widening projects.

2.3.2. Need

The Project is needed to address transportation capacity deficiencies, major points of congestion, limited travel mode choices, safety deficiencies, and reduce GHG emissions.

Travel demand analysis completed on behalf of the Project in 2020 forecasts 49.1 million one-way trips between Southern California and Las Vegas in 2025, with approximately 85 percent of travelers making the trip by automobile. Most of these trips use the Cajon Pass segment of the I-15, which is capacity-constrained. Further, the freeway system leading into the I-15 from points west, east, and south, including I-10, State Route 210 (SR-210), I-215 and SR-60 have similar delays and capacity constraints. The Project would address this demand by providing a transportation alternative to vehicle travel, and it would allow access to the Brightline West service from the Greater Los Angeles and the Riverside-San Bernardino-Ontario Metropolitan areas, as well as points beyond, with a connection to the Metrolink system in Rancho Cucamonga.

The Project would also support federal and state policies focused on climate change and the need to reduce VMT and associated GHG emissions.

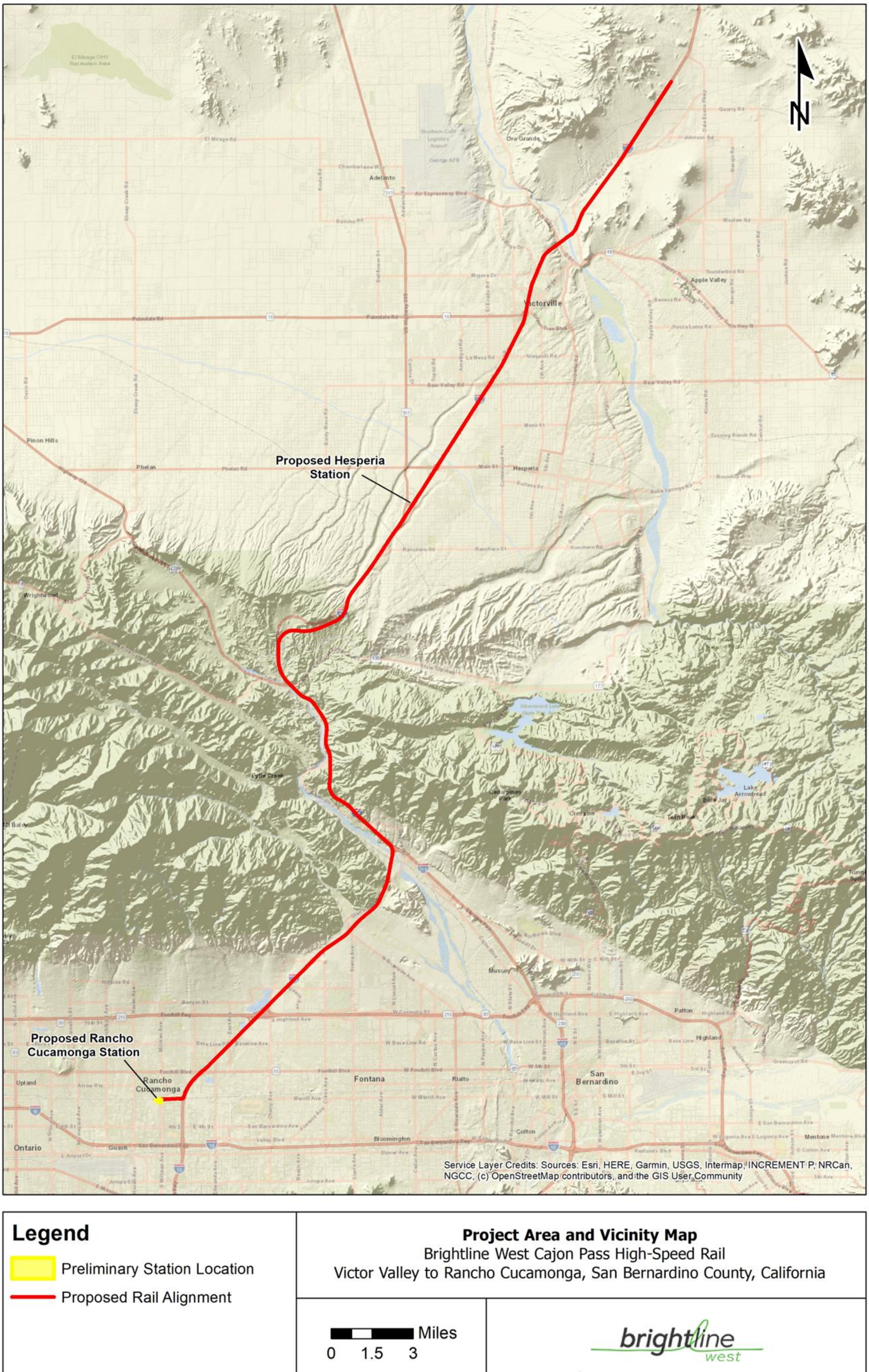

Figure 1. Project Area and Vicinity

2.3.2.1. Capacity Constraints

I-15 through the Cajon Pass is one of the most congested segments of I-15, with no alternative routes that provide comparable direct road travel capability because of the mountainous topography. Through the Cajon Pass, I-15 supports daily workforce commuters, recreational travel, and regional and interstate freight and goods movement. According to the traffic study prepared for the I-15 Corridor Project Initial Study/Environmental Assessment (Caltrans and SBCTA 2018), unreliability in travel time along segments of I-15 and surrounding roadways is caused by roadway capacity constraints, frequent accidents, and various factors that cause unanticipated congestion. Travelers using the Project would no longer need to drive through the most congested parts of the corridor in the Cajon Pass for interstate or commuter trips, thereby avoiding idling and inefficient stop-and-go traffic conditions.

By 2045, travel speeds are expected to decrease on all but one segment of I-15 between the San Bernardino Valley and Apple Valley in the AM peak period, and travel speeds on most segments would also decrease—some by more than 10 mph—in the PM peak period (SCAG 2020). Based on the Project Report for the I-15 Corridor Study (addition of express lanes), traffic volumes on I-15 between I-10 and SR-210 are expected to increase in the range of 31 to 38 percent from 2014 to 2045. The Project Report states the existing level of service (LOS) is acceptable in most locations but that there are bottlenecks in each direction of travel that degrade traffic operation, especially between Baseline Road and SR-210. Because the express lane project is increasing capacity by adding express lanes, the traffic volumes are projected to increase by an additional 27 percent. The Project Report further mentions that, although the express lane project would improve conditions in the general purpose lanes in many segments, it would cause the segment between the I-10 and Fourth Street to worsen in the PM peak hour (both directions). In the AM peak hour, the segment between Arrow Route and Fourth Street would worsen in the southbound direction. The segment between Baseline Road and SR-210 would continue to operate at over capacity conditions in all scenarios.

SCAG's Connect SoCal Goods Movement Technical Report identifies I-15 as part of the U.S. Department of Transportation's (USDOT) Primary Highway Freight Network and among the network segments that carry the highest volumes of truck traffic in the region. It also identifies the entirety of the Cajon Pass as a truck bottleneck, with over 15,000 annual vehicle hours of delay.

As documented above, given the attractiveness of the origins and destinations, the transportation capacity constraints on I-15 as described in current and predicted average daily traffic (ADT) and LOS limit reasonable highway access between Rancho Cucamonga, Hesperia, and Victor Valley.

I-10 is the primary commuter corridor from San Bernardino County and the San Gabriel Valley to Los Angeles. Based on the Final Environmental Impact Report (FEIR) by Caltrans in 2012 for I-10 high-occupancy vehicle (HOV) lanes from Puente Avenue to SR -57/SR -71, the westbound direction of I-10 experiences recurrent congestion in the AM peak hour and eastbound direction experiences recurrent congestion in the PM peak hour. Additionally, most of I-10 operates at capacity in both the AM and PM peak hour with spillbacks at the SR- 57/SR- 71 interchange and I-605 interchange. In addition, due to short spacing between interchanges, there is insufficient weaving distance leading to much lower speeds in the right lanes of the freeway. The Final EIR also indicated that even with the HOV lanes, the forecast volumes (year 2035) are generally going to result in continued recurrent congestion (Caltrans 2012).

Due to heavy congestion, both SBCTA and LA Los Angeles Metro are currently converting HOV lanes on the I-10, on which operations are degraded according to Federal standards to High-Occupancy Toll/Express Lanes (priced lanes). In addition, LA Los Angeles Metro and Metrolink are also coordinating to extend service on the Gold Line to Azusa and eventually to Montclair in San Bernardino County. The Brightline service would provide an option that addresses longer distance trips that would otherwise burden the peak travel periods on I-10 and other roadways.

2.3.2.2. *Travel Demand*

The anticipated substantial increases in population, housing, and employment in San Bernardino County will result in greater demand for transportation facilities and services, including increased travel demand that will result in congestion on roadways if capacity does not keep up with the demand. The proposed Hesperia Station would provide a convenient connection between High Desert communities and the more urbanized San Bernardino Valley and Metropolitan Los Angeles. The High Desert provides lower cost housing options for Southern California residents, while the Rancho Cucamonga/Ontario area around Ontario International Airport has become a significant employment center.

SCAG forecasts, in its 2020-2045 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS), that the population of San Bernardino County will grow to 2,815,000 by 2045, a 29 percent increase from the US Census Bureau’s 2018 population estimate of 2,180,085, and that the number of households will grow to 875,000, a 39 percent increase over the 2018 household estimate of 630,633 (US Census Bureau 2020). Additionally, the 2020-2045 RTP/SCS forecasts employment in San Bernardino County will increase to 1,064,000 by 2045, a 72 percent increase from the US Census Bureau’s estimate of 617,828 in 2018.

While the proposed Victor Valley station site would be located at the convergence of all the highways *en route* to Las Vegas for Southern California travelers, the Rancho Cucamonga station would be closer to major population centers in Southern California. Compared to the Victor Valley station, the proposed HSR station in Rancho Cucamonga, located about 45 miles east of downtown Los Angeles, would provide more direct access to the densely populated centers in Southern California for both drivers and Metrolink riders; 87 percent of the potential market for trips between Las Vegas and Southern California (equivalent to 42.7 million of the one-way, in-scope trips in 2025) live within 75 miles of the location of the proposed Rancho Cucamonga station.

The proposed station in Rancho Cucamonga, with a Metrolink connection to Los Angeles, would further meet the forecasted demand of the 49.1 million one way trips between Las Vegas and Southern California estimated in 2025. Similarly, the proposed Hesperia station would be at the convergence of US Highway 395 (US-395) and I-15, so it would serve commuters to Greater Los Angeles from the major corridors in the Victor Valley. The Project would also support SCAG’s Connect SoCal Passenger Rail Technical Report, which identifies closing connectivity gaps as a major strategy to increase mobility and improve sustainability. The Project would facilitate transit connections and would allow residents of the Greater Los Angeles and the Riverside-San Bernardino-Ontario Metropolitan areas to travel exclusively by mass transit and passenger rail to and from the High Desert of San Bernardino and connect to the BLW station at Victor Valley for a connection to Las Vegas. Southern California residents could take the Los Angeles Metro rail, regional bus systems, Amtrak, or Metrolink to Los Angeles Union Station to connect via the Metrolink San Bernardino Line to the Rancho Cucamonga station. Residents could also take the planned West Valley Connector Bus Rapid Transit service that will operate between the Pomona station on the Metrolink Riverside Line in eastern Los Angeles County and the Rancho Cucamonga station. While still in early planning and design stages, the planned Tunnel to Ontario International Airport (ONT) project may provide an additional connection from the Rancho Cucamonga station to the Ontario International Airport.

Additionally, SBCTA and SCAG's 2015 Advanced Regional Rail Integrated Vision – East (ARRIVE Corridor) plan proposes strategies for transitioning the Metrolink San Bernardino Line, which would serve the Rancho Cucamonga station, from a traditional commuter rail line to one that promotes transit-oriented development. Improvements to Metrolink, its transit connections, and additional development of the station areas with transit-supportive uses at greater densities and intensities will encourage the formation of areas that are walkable and that provide mobility options in the region. The Project would further the goals of the ARRIVE Corridor plan by increasing the activity centers that can be accessed by Southern California's rail network. Additionally, the Metrolink Southern California Optimized Rail Expansion (SCORE) program is intended to increase speeds, reliability, and capacity on Metrolink lines including on the San Gabriel Subdivision which serves the Rancho Cucamonga station. In 2010, the San Bernardino Associated Governments (the predecessor agency to SBCTA) completed the Victor Valley Long Distance Commuter Needs Assessment, which identified a phased set of commuter improvement projects. Those projects ranged from expanded park and ride facilities to an express bus service linking the Victor Valley area of the High Desert to the Rancho Cucamonga Metrolink station. The Joshua Street Park & Ride is near the Project's proposed station in Hesperia. Such commuter-focused planned improvements highlight the need for travel options that reduce the number of single occupancy automobiles on I-15 in San Bernardino County, particularly through the Cajon Pass.

FHWA's Southern California Regional Freight Study (USDOT 2020) identifies I-15 as a major interstate highway corridor that provides access to the interior of the United States for goods arriving at the ports of the Los Angeles region and ranks it among the highest truck volume corridors in the western United States. Caltrans' 2015 Interregional Transportation Strategic Plan identifies I-15 as a high priority corridor, among six nationally identified "Corridors of the Future," and a "vital link between Mexico, Southern California, and locations to the north and east of the region." I-15 also connects Southern California and the southwestern United States to the San Joaquin Valley's agricultural goods via SR-58. By providing passenger rail capacity in the corridor, the Project would help maintain freeway capacity for truck freight use by removing passenger vehicles from the roadway network.

2.3.2.3. Safety

Alternatives to automobile travel would provide improved safety conditions on the I-15 corridor with diversion of vehicle trips to HSR. On a national level, comparing miles traveled via commercial aircraft, train, and automobiles on highways, auto travel on highways has by far the highest rate of passenger fatalities per mile traveled. In 2019, the average rate of passenger fatalities from highway travel was more than 75 times the comparable rate for travel by air and 34 times the comparable rate by rail. For 2016, the Bureau of Transportation Statistics' National Transportation Statistics (USDOT 2018) reported a rate of passenger fatalities per 100 million passenger miles traveled by highway nearly 10 times greater than the rates for travel by air or rail. HSR is one of the safest forms of travel.

The California Office of Traffic Safety ranks San Bernardino County 16th-worst out of 58 counties for total fatal and injury crashes in 2018 (the most recent year of data available). According to the University of California, Berkeley, and SafeTREC's Transportation Injury Mapping System, there were 819 collisions with one or more deaths or injuries along I-15 in San Bernardino County in 2019. Of these, nearly one quarter (199) occurred in the 12 miles of the Cajon Pass, although the Cajon Pass accounts for only 6.5 percent of the length of I-15 in the county.

A study by the I-15 Mobility Alliance found that the segment of I-15 from I-215 in San Bernardino to I-40 in Barstow had a fatality rate 0.009 per million VMT, well above the alliance's performance goal of 0.003 fatalities per million. By connecting the Victor Valley to Rancho Cucamonga, the Project would allow more travelers to stay off segments of I-15.

3. Alternatives

3.1. Build Alternative

The Build Alternative (i.e., the Project) consists of a proposed HSR passenger railway with associated infrastructure, including two proposed passenger stations. Nearly all of the Project would be built within the I-15 right-of-way. Near the proposed southern terminus station in Rancho Cucamonga, approximately 1 mile of the rail alignment would be in city street, railroad, or utility rights-of-way.

The proposed rail alignment would be located within the median of the I-15 freeway between Victor Valley and Rancho Cucamonga, except at the approach to the proposed Rancho Cucamonga station. The rail alignment would be predominately at grade (the same elevation as the existing freeway), with select segments of the alignment on aerial structures or in a trench to allow for grade separations (including 4 BNSF and 3 UP railroad crossings) and to provide a safe incline for train operation. The rail alignment would be predominantly single-track, with limited double-track segments in Victor Valley (2.6 miles, including 0.9 miles constructed as part of the DesertXpress High-Speed Passenger Train Project), Hesperia (5.5 miles), and Rancho Cucamonga (2.1 miles). This would allow for 45-minute headways in the opening year between Victor Valley and Rancho Cucamonga and 22.5-minute headways including 0.9 miles constructed as part of the DesertXpress High-Speed Passenger Train Project), after year 11. These headways, along with the ability to couple trains (double passenger capacity), would address projected ridership needs for the foreseeable future.

For analytical purposes, the Build Alternative is described in three sections. Sections were developed to reflect similarly developed areas with similar environmental sensitivity. The sections include:

- **Section 1:** High Desert – from the Victor Valley station, continuing south along I-15, to the I-15/Oak Hill Road interchange in Hesperia
- **Section 2:** Cajon Pass – from the I-15/Oak Hill Road interchange, continuing south along I-15, through the Cajon Pass, to the I-15/Kenwood Avenue interchange
- **Section 3:** Greater Los Angeles – from the I-15/Kenwood Avenue interchange in San Bernardino, continuing south along I-15, through the existing Metrolink station in Rancho Cucamonga to Haven Avenue

3.1.1. Section 1 – High Desert

The proposed rail alignment would connect to the DesertXpress High Speed Train alignment approximately one mile south of the Victor Valley station in Apple Valley. The Victor Valley station was proposed by the DesertXpress High Speed Train Project (DesertXpress Project) and approved in 2011 and modified by the re-evaluation in 2020. From this point, the alignment would continue south within the I-15 median. The rail alignment throughout Section 1 would be predominantly single track; however, the rail alignment would be double-track north of Stoddard Wells Road to the northern terminus of the alignment as it approaches the train platforms of the Victor Valley station. The Project would include a new structure over the existing CEMEX railroad bridge. Based on future discussion with CEMEX, the existing railroad bridge may be reconstructed as part of the DesertXpress project, in which case the alignment would run at-grade in the median under the railroad bridge.

Brightline West will build a new Southbound on ramp and bridge at South Stoddard Wells Rd. to replace similar existing facilities further south.[1] This in-turn requires modifications of I-15 up to and including the Mojave River crossing.

At the Mojave River, a new rail bridge will be constructed within the median of I-15. The existing I-15 bridge would be widened to accommodate the rail line. The alignment would then continue at grade in the I-15 median with minor roadway widenings for the remainder of Segment 1. This portion of the alignment would interface with the following interchanges: Stoddard Wells Road North, Stoddard Wells Road South, D Street/E Street, Mojave Drive, Roy Rogers Drive/Hook Road, Palmdale Road, La Mesa Road/Nisqualli Road, Bear Valley Road, Main Street/Phelan Road, Joshua Street, US-395, Ranchero Road, and Oak Hill Road.

A new substation would be constructed to support the Project along I-15, between Mesa Street and Mojave Street. The area is currently largely undeveloped, other than existing overhead power lines and utility access.

Hesperia Station

Section 1 includes a new passenger station in Hesperia, at the I-15/Joshua Street interchange. This station would serve daily travelers between the High Desert of San Bernardino County and the Los Angeles Basin. This would be a limited service for select southbound AM and northbound PM weekday on selected Brightline train coaches. The northbound on-ramp to Joshua Street would be realigned closer to the freeway, and station parking would be on the north side of Joshua Street. Parking would be accessed at the location of the existing northbound ramp intersection. To accommodate the rail alignment, the existing US-395 northbound connector and the existing Joshua Street bridge would be replaced. The Joshua Street bridge would be reconstructed at a higher elevation, requiring raising of the I-15 ramps and Mariposa Road. The passenger platform would be located within the I-15 median, with direct access from the reconstructed Joshua Street bridge at the southern end of the double-track segment in Hesperia. The Project design includes adequate parking areas to accommodate parking demand.

Design Elements

Segment 1 of the Project includes the following design elements.

- Reconstructions/Interchange Modifications: Widening portions of the I-15 freeway and modifications to interchanges at Stoddard Wells Road southbound off-ramp, D Street/E Street, Mojave Drive, Roy Rogers Drive/Hook Road, Palmdale Road, La Mesa Road/Nisqualli Road, Bear Valley Road, Main Street/ Phelan Road, US-395, Ranchero Road, Oak Hill Road, and Joshua Street

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[1] These improvements would be consistent with Caltrans' planned Interstate 15 Interchange Reconstruction (D Street, E Street, Stoddard Wells Road, and Mojave River Bridge) project, which was originally analyzed under an Initial Study / Environmental Assessment in 2008.

- New Substation: Construction of a new substation along I-15 between Mesa Street and Mojave Street
- Station Area: Hesperia station platform, station access/infrastructure, surface parking lot accommodating approximately 360 vehicles, bus pick up/drop off areas, Kiss and Ride

3.1.2. Section 2 – Cajon Pass

Beginning at the I-15/Oak Hill Road interchange and traveling south, the alignment would run on the west side of the I-15 northbound lanes at grade and within the existing I-15 right-of-way. In this area, the I-15 runs through the San Bernardino National Forest for approximately 12 miles). The rail alignment throughout Section 2 would be entirely single-track. The Project would require replacement of California Highway Patrol (CHP) emergency crossovers where the new guideway would block existing crossovers. Four new crossovers would be placed to take advantage of existing CHP access between the separated I-15 alignments in the following locations:

- West of Forestry Road crossing the northbound lanes.
- Approximately 1.25 miles in the southbound direction along I-15 from the crossover near Forestry Road, across the northbound lanes.
- West of the Baldy Mesa (Trestles) OHV Staging Area, across the northbound lanes.
- West of Perdew Canyon and approximately 1.25 miles north of Mathews Ranch Road, across both the north and southbound lanes.

The alignment would remain at grade throughout Segment 2.Where I-15 northbound and southbound lanes reconnect at the foot of the Cajon Pass, the rail alignment would be within the I-15 median. This would require widening portions of the I-15 freeway and minor realignment of ramps at the I-15/SR-138 interchange.

Design Elements

Segment 2 of the Project includes the following design elements.

- Bridges/Viaducts: None
- Reconstructions/Interchange Modifications: Widening portions of the I-15 freeway including several miles of retained fill, and realignment of ramps at the I-15/ SR-138 interchange
- Other Facilities: CHP emergency crossovers

3.1.3. Section 3 – Greater Los Angeles

Beginning at the Kenwood Avenue interchange, the proposed rail alignment would continue at grade in the I-15 median. At the I-15/I-215 interchange, the alignment would continue between the divided I-15 freeway at the same elevation as the freeway including the Devore interchange viaduct, curving to the southwest parallel to freeway. The rail alignment would require I-15 freeway and interchange ramp modifications at Baseline Avenue, SR-210, Beech Avenue, Duncan Canyon Road, Sierra Avenue and Glen Helen Parkway.

The rail alignment would transition to an aerial alignment and elevate over the I-15 southbound lanes south of Church Street and cross at Foothill Boulevard. It would continue along the west side of the I-15 freeway on an elevated alignment to enter the San Gabriel Subdivision and Eighth Street corridor. The alignment would transition onto an aerial structure and would turn west, running parallel to and partially within the existing rail corridor and partially within the Eighth Street right-of-way before entering the existing Rancho Cucamonga Metrolink station area on an elevated structure. The rail alignment would maintain a single-track configuration prior to exiting the freeway median south of Church Street, where it would transition to a double-track configuration for the remaining distance to the Rancho Cucamonga station. At the Rancho Cucamonga station, an elevated station with a center platform and tracks on either side would be constructed parallel to and above the existing eastbound Metrolink platform, extending over Milliken Avenue. A new parking structure is proposed at Rancho Cucamonga Station, and would replace existing surface parking to accommodate increased parking demand. The Project design includes adequate parking areas to accommodate parking demand in the opening year.

Design Elements

Segment 3 of the Project includes the following design elements.

- Bridges/Viaducts: Viaduct of approximately 3.5 miles to cross I-15 southbound lanes and along existing rail corridor near Rancho Cucamonga station
- Reconstructions/Interchange Modifications: I-15 freeway and interchange ramp modifications at SR-210, Beech Avenue, Duncan Canyon Road, and Glen Helen Parkway
- Station: Dedicated Brightline station adjacent to the existing Rancho Cucamonga Metrolink station, with vertical circulation down to the platform, shared access with existing Metrolink station, a share parking structure for vehicles, and a bus plaza

3.1.4. Construction

In general, construction activities would consist of clearing, grading, excavation, placing fill, stockpiling materials, constructing bridges and walls, installing drainage, installing sub-ballast and subgrade, placing and anchoring railroad ties, placing ballast material, and tamping ballast, constructing stations, substations, mobilization and demobilization. Construction equipment would likely include dump trucks, excavators, loaders, cranes, water trucks, backhoes, scrapers, rollers, ballast tampers, concrete trucks, and drill rigs.

For new and reconstructed overpasses and bridges, construction activities would include clearing, grubbing, demolition of existing structures, excavation and drilling for foundations, concrete pouring, formwork and rebar placement for foundations, falsework installation, construction of bridge decking, placement of ballast and ties, mobilization and demobilization.

Most construction activities would occur on Caltrans right-of-way. Some, for the rail stations and power substations, would occur on public property owned by the City of Rancho

Cucamonga, SBCTA, or State of California. Temporary construction areas, or TCAs, are properties that would be temporarily utilized for construction staging and storage. The Project would require TCAs along the alignment between Victor Valley and Rancho Cucamonga.

4. Methodology

4.1. Noise and Vibration Basics

4.1.1. Noise Basics

Sound is defined as small changes in air pressure above and below the standard atmospheric pressure, and noise is usually considered to be unwanted sound. The three parameters that define noise include:

- Level: The level of sound is the magnitude of air pressure change above and below atmospheric pressure and is expressed in decibels (dB). Typical sounds fall within a range between 0 dB (the approximate lower limit of human hearing) and 120 dB (the highest sound level generally experienced in the environment). A 3-dB change in sound level is perceived as a barely noticeable change outdoors, and a 10-dB change in sound level is perceived as a doubling (or halving) of loudness.
- Frequency: The frequency (pitch or tone) of sound is the rate of air pressure change and is expressed in cycles per second, or Hertz (Hz). Human ears can detect a wide range of frequencies from around 20 Hz to 20,000 Hz; however, human hearing is not as sensitive at high and low frequencies, and the A weighting system, which measures what humans hear in a more meaningful way by reducing the sound levels of higher and lower frequency sounds, is used to provide a measure (dBA) that correlates with human response to noise. Figure 2 shows typical maximum A-weighted sound levels for transit and non-transit sources. The A-weighted sound level has been widely adopted by acousticians as the most appropriate descriptor for environmental noise.
- Time Pattern: Because environmental noise is constantly changing, it is common to condense all of this information into a single number, called the "equivalent" sound level (Leq). The Leq represents the changing sound level over a period of time, typically 1 hour or 24 hours in transit noise assessments. For assessing the noise impact of rail projects at residential land uses, the day-night sound level (Ldn) is the noise descriptor commonly used, and it has been adopted by many agencies as the best way to describe how people respond to noise in their environment. Ldn is a 24-hour cumulative A-weighted noise level that includes all noises that occur during a day, with a 10-dB penalty for nighttime noise (10 pm to 7 am). This nighttime penalty means that any noise events at night are equivalent to 10 similar events during the day.

Typical Ldn values for various transit operations and environments are shown on **Figure *3***.

In addition to the Leq and Ldn, there are other metrics used to describe noise. The loudest 1-second of noise over a measurement period, or maximum A-weighted sound level (Lmax), is used in many local and state ordinances for noise emitted from private land uses and for construction noise impact evaluations. Environmental noise can also be viewed on a statistical basis using percentile sound levels (Ln), which refer to the sound level exceeded n-percent of the time.

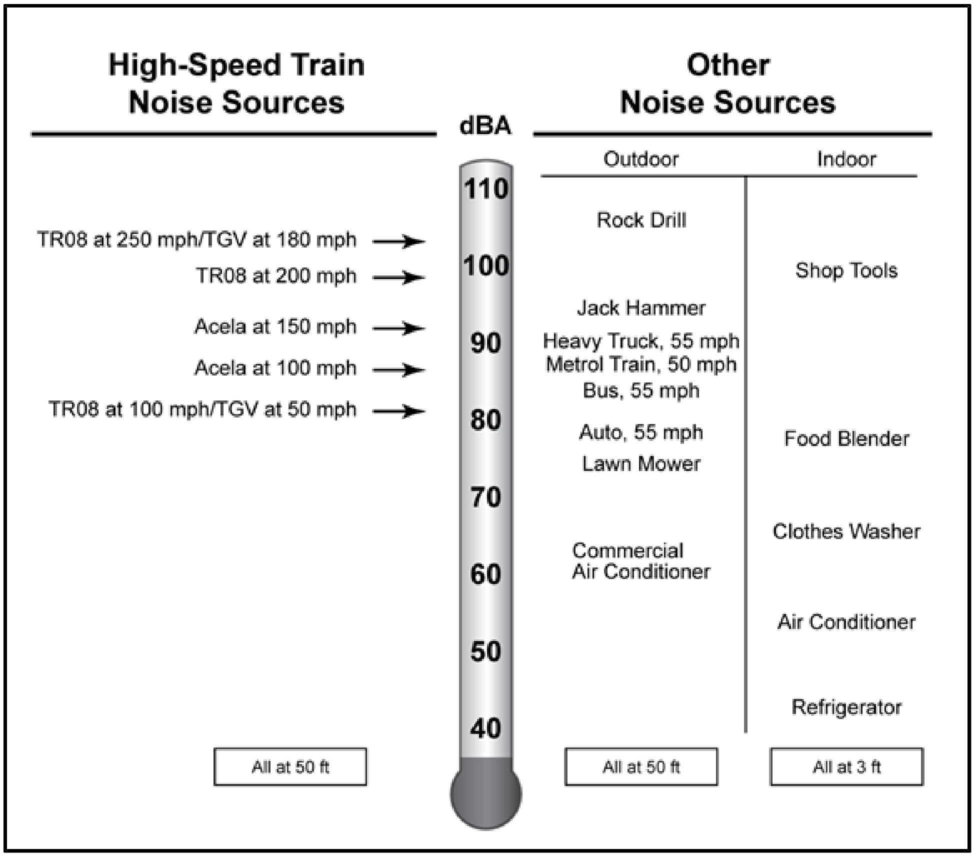

Figure 2. Typical A-Weighted Sound Levels

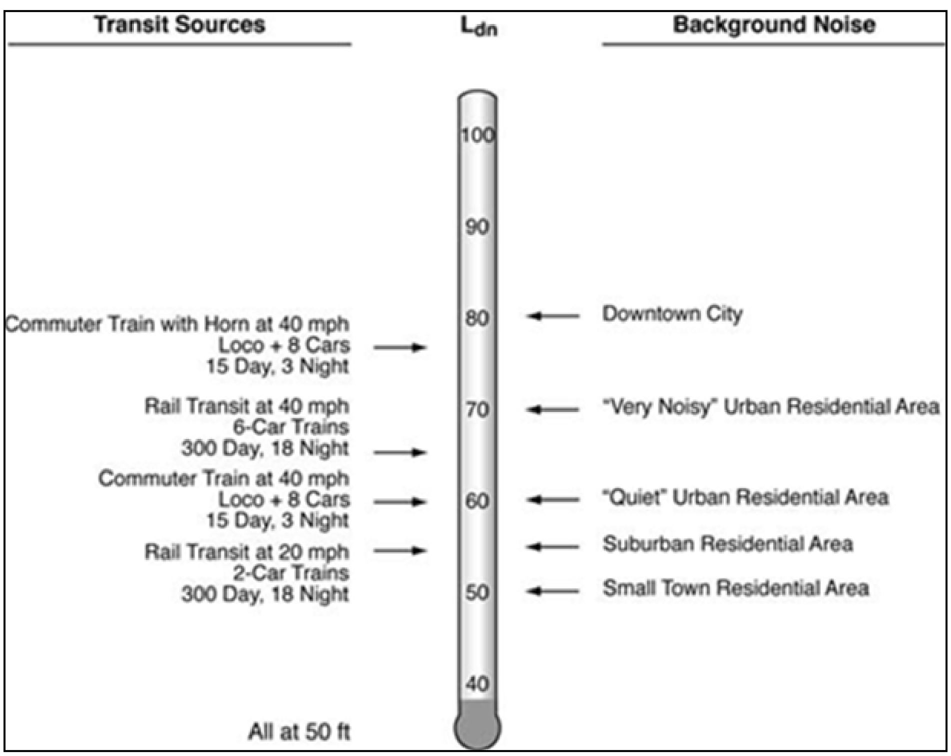

Figure 3. Typical Ldn Noise Exposure Levels

4.1.2. Vibration Basics

Ground-borne vibration from trains refers to the fluctuating or oscillatory motion experienced by persons on the ground and in buildings near railroad tracks. Vibration can be described in terms of displacement, velocity, or acceleration. Displacement is the easiest descriptor to understand. For a vibrating floor, the displacement is simply the distance that a point on the floor moves away from its static position. Velocity represents the instantaneous speed of the floor movement, and acceleration is the rate of change of the speed. Although displacement is easier to understand, the response of humans, buildings, and equipment to vibration is more accurately described using velocity or acceleration.

Two methods are used for quantifying vibration. The peak particle velocity (PPV) is defined as the maximum instantaneous positive or negative peak of the vibration signal. PPV often is used in monitoring of blasting vibration, since it is related to the stresses experienced by buildings. Although PPV is appropriate for evaluating the potential for building damage, it is not suitable for evaluating human response. It takes some time for the human body to respond to vibration impulses. In a sense, the human body responds to an average of the vibration amplitude. Because the net average of a vibration signal is zero, the root mean square (RMS) amplitude is used to describe the "smoothed" vibration amplitude.

PPV and RMS velocities are normally described in inches per second in the U.S. and in meters per second in the rest of the world. Decibel notation is in common use for vibration and has been adopted by the FRA in their guidance. Decibel notation compresses the range of numbers required to describe vibration. Vibration levels in this report are referenced to 1 x 10-6 inches per second (in/sec). The abbreviation "VdB" is used in this document for vibration decibels to reduce the potential for confusion with sound decibels. Common vibration sources and human and structural response to ground-borne vibration are illustrated in **Figure *4***. Typical vibration levels can range from below 50 VdB to 100 VdB (0.000316 in/sec to 0.1 in/sec). The human threshold of perception is approximately 65 VdB.

Ground-borne vibration can lead to ground-borne noise, which is a low-volume, low-frequency rumble inside buildings that occurs when ground vibration causes the flexible walls of the buildings to resonate and generate noise. Ground-borne noise is normally not a consideration when trains are elevated or at grade. In these situations, the airborne noise usually overwhelms ground-borne noise, so that the airborne noise level is the major consideration. However, ground-borne noise becomes an important consideration where there are sections of the corridor in a tunnel or where sensitive interior spaces are well-isolated from the airborne noise. In these situations, the airborne noise path is impeded, and ground-borne noise dominates inside buildings.

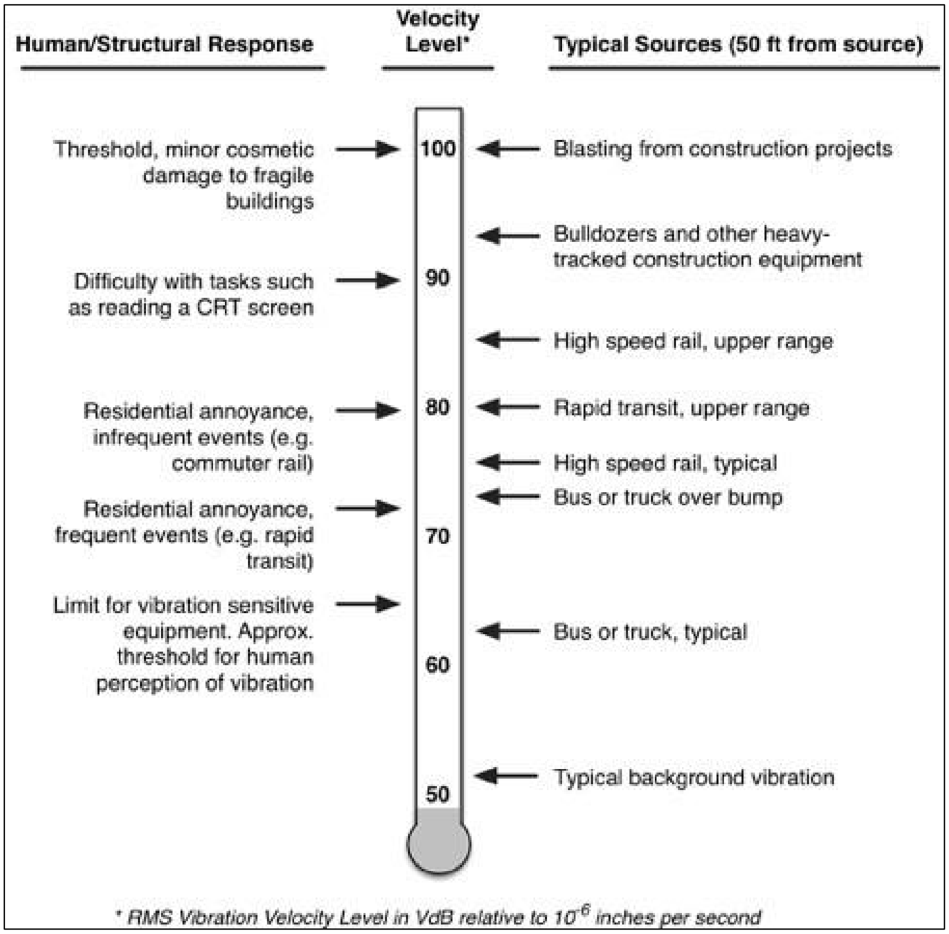

Figure 4. Typical Levels of Ground-Borne Vibration

4.2. Relevant Regulations, Plans, and Policies

4.2.1. Noise Impact Criteria

The FRA guidelines for assessing noise impacts from high-speed train operations (FRA 2012) are adapted from the same sources used to develop the FTA guidelines for rail projects and their associated stationary facilities (FTA 2018). The noise impact criteria for rail projects and their associated fixed facilities, such as storage and maintenance yards, passenger stations and terminals, parking facilities, and substations are shown graphically on Figure 5. The land use categories (1, 2, 3) shown on Figure 5 are defined in Table 1.

The FRA operational noise impact criteria are based on well-documented research on community response to noise and are based on both the existing level of noise and the change in noise exposure due to a project. The FRA noise criteria compare the Project noise with the existing noise (not the no-build noise). This is because comparison of a noise projection with an existing noise condition is more accurate than comparison of a projection with another noise projection. Because background noise may increase by the time the Project is operational, this approach of using existing noise conditions is conservative.

The FRA noise criteria are based on the land use category of the sensitive receptor. The descriptors and criteria for assessing noise impact vary according to land use categories adjacent to the track. For Category 2, land uses where people live and sleep (e.g., residential neighborhoods, hospitals, and hotels), the day-night average sound level (Ldn) is the assessment parameter. For other land use types (Category 1 or 3) where there are noise-sensitive uses (e.g., outdoor concert areas, schools, and libraries), the equivalent noise level (Leq) for the loudest hour of train activity during hours of noise sensitivity is the assessment parameter. Table 1 summarizes the three land use categories.

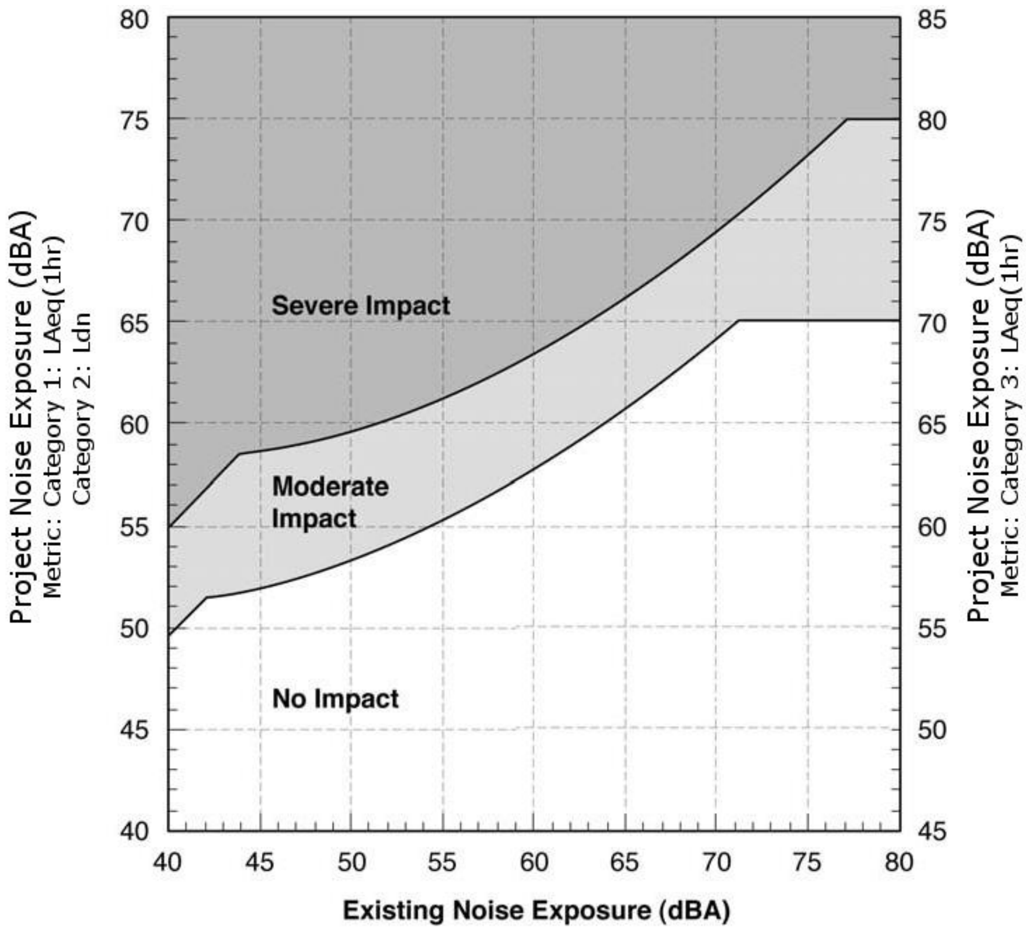

Figure 5. Noise Impact Criteria for High-Speed Rail Projects

Table 1. Land Use Categories and Metrics for Noise Impact Criteria

Land Use Category	Noise Metric (dBA)	Land Use Category
1	Outdoor $L_{eq}(h)$*	Land where quiet is an essential element of its intended purpose. Example land uses include preserved land for serenity and quiet, outdoor amphitheaters and concert pavilions, and National Historic Landmarks with considerable outdoor use. Recording studios and concert halls are also included in this category.
2	Outdoor L_{dn}	This category is applicable to all residential land use and buildings where people normally sleep, such as hotels and hospitals.
3	Outdoor $L_{eq}(h)$*	This category is applicable to institutional land uses with primarily daytime and evening use. Example land uses include schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds, and recreational facilities are also included in this category.

* L_{eq} (Equivalent Sound Level) for the noisiest hour of transit-related activity during hours of noise sensitivity.

The noise impact criteria are defined by the two curves in Figure 5, which allow increasing project noise as existing noise levels increase, up to a point at which impact is determined based on project noise alone. The FTA noise impact criteria include three levels of impact, as shown on Figure 5. The three levels of impact include:

- **No Impact:** In this range, the Project is considered to have no impact since, on average, the introduction of the Project will result in an insignificant increase in the number of people highly annoyed by the new project noise.
- **Moderate Impact:** Project-generated noise in this range is considered to cause impact at the threshold of measurable annoyance. Moderate impacts serve as an alert to project planners for potential adverse impacts and complaints from the community. Mitigation should be considered at this level of impact based on project specifics and details concerning the affected properties.
- **Severe Impact:** Project-generated noise in this range is likely to cause a high level of community annoyance. Noise mitigation should be applied for severe impacts where feasible.

Although the curves on Figure 5 are defined in terms of the project noise exposure and the existing noise exposure, the increase in the cumulative noise – when project-generated noise is added to existing noise levels – is the basis for the criteria. To illustrate this point, **Figure *6*** shows the noise impact criteria for Category 1 and Category 2 land uses in terms of the allowable increase in the cumulative noise exposure. Since Ldn and Leq are measures of total acoustic energy, any new noise source in a community will cause an increase, even if the new source level is less than the existing level. On **Figure *6***, the criterion for moderate impact allows a noise exposure increase of 10 dBA if the existing noise exposure is 42 dBA or less, but only a 1 dBA increase when the existing noise exposure is 70 dBA.

As the existing level of ambient noise increases, the allowable level of transit noise increases, but the total amount that community noise exposure is allowed to increase is reduced. This accounts for the unexpected result that a project noise exposure that is less than the existing noise exposure can still cause an impact.

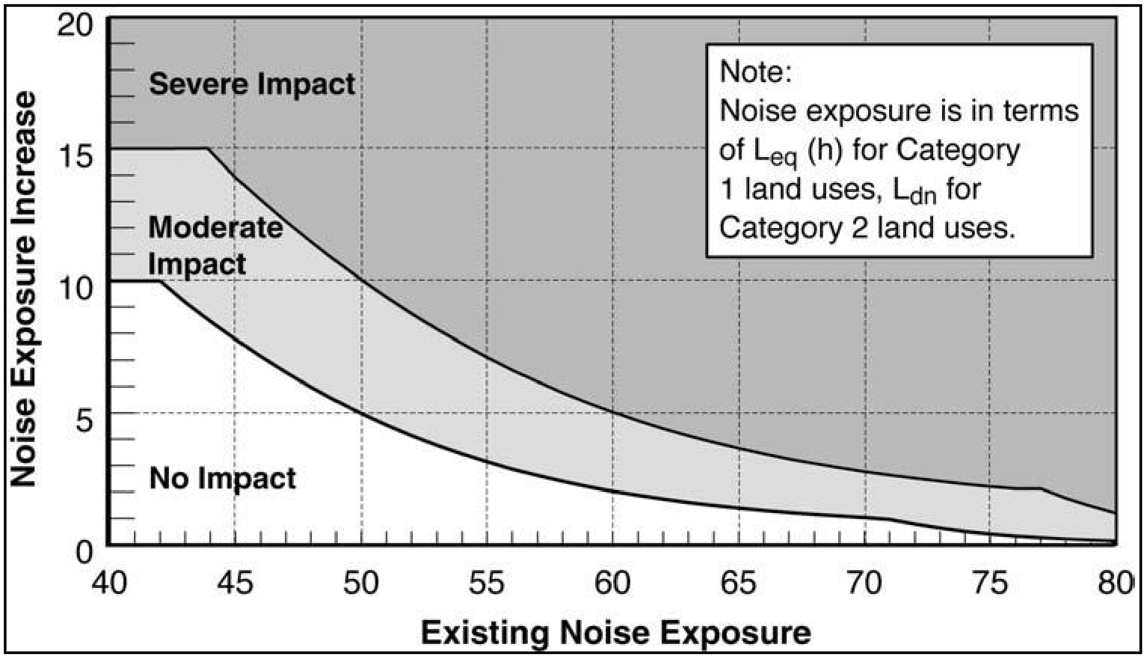

Figure 6. Allowable Increase in Cumulative Noise Levels (Categories 1 & 2)

4.2.2. Vibration Impact Criteria

The FRA guidelines (FRA 2012), which acknowledge the FTA guidance document (FTA 2018) as their basis, provide ground-borne vibration and noise criteria for a general assessment as shown in Table 2. These levels represent the maximum Root Mean Square RMS level of an event in VdB (Vibration decibels). In addition, the guidelines provide criteria for special buildings that are very sensitive to ground-borne noise and vibration. The impact criteria for these special buildings are shown in Table 3.

Both Table 2 and Table 3 differentiate the vibration impact threshold depending on the number of vibration events per day, with fewer than 30 vibration events per day considered "infrequent," between 30 and 70 vibration events considered "occasional," and more than 70 events considered "frequent" for Table 2. For Table 3, fewer than 70 vibration events per day are considered "occasional or infrequent" and more than 70 events are considered "frequent." This dividing line was originally selected so that most commuter rail or intercity rail projects would fall into the "infrequent" category and most urban transit projects (subway and light rail transit) would more typically be in the "frequent" category.

Table 2. Ground-Borne Vibration and Noise Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch /sec)			Ground-Borne Noise Impact Levels (dBA re 20 micro-Pascals)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]	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]	N/A[5]	N/A[5]	N/A[5]
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

[1] Frequent Events is defined as more than 70 vibration events of the same kind per day.
[2] Occasional Events is defined as between 30 and 70 vibration events of the same kind per day.
[3] Infrequent Events is defined as fewer than 30 vibration events of the same kind per day.
[4] This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. For vibration-sensitive manufacturing or research equipment, a Detailed Vibration Analysis must be performed.
[5] Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

Table 3. Ground-Borne Vibration and Noise Impact Criteria for Special Buildings

Type of Building or Room	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch /sec)		Ground-Borne Noise Impact Levels (dBA re 20 micro-Pascals)	
	Frequent Events[1]	Occasional or Infrequent Events[2]	Frequent Events[1]	Occasional or Infrequent Events[2]
Concert Halls	65 VdB	65 VdB	25 dBA	25 dBA
TV Studios	65 VdB	65 VdB	25 dBA	25 dBA
Recording Studios	65 VdB	65 VdB	25 dBA	25 dBA
Auditoriums	72 VdB	80 VdB	30 dBA	38 dBA
Theaters	72 VdB	80 VdB	35 dBA	43 dBA

[1] Frequent Events is defined as more than 70 vibration events per day.
[2] Occasional or Infrequent Events is defined as fewer than 70 vibration events per day.

For a detailed vibration analysis, more refined impact criteria are required than for a general assessment. Therefore, the criteria for a detailed vibration assessment are expressed in terms of one-third octave band frequency spectra, based on international and industry standards. The

FRA criteria for a detailed vibration assessment are shown on **Figure *7*** and descriptions of the curves are shown in Table 4. The curves on **Figure *7*** are applied to the projected vibration spectrum for the Project. If the vibration level at any one frequency exceeds the criteria, there is impact. Conversely, if the entire proposed vibration spectrum of the Project were below the curve, there would be no impact.

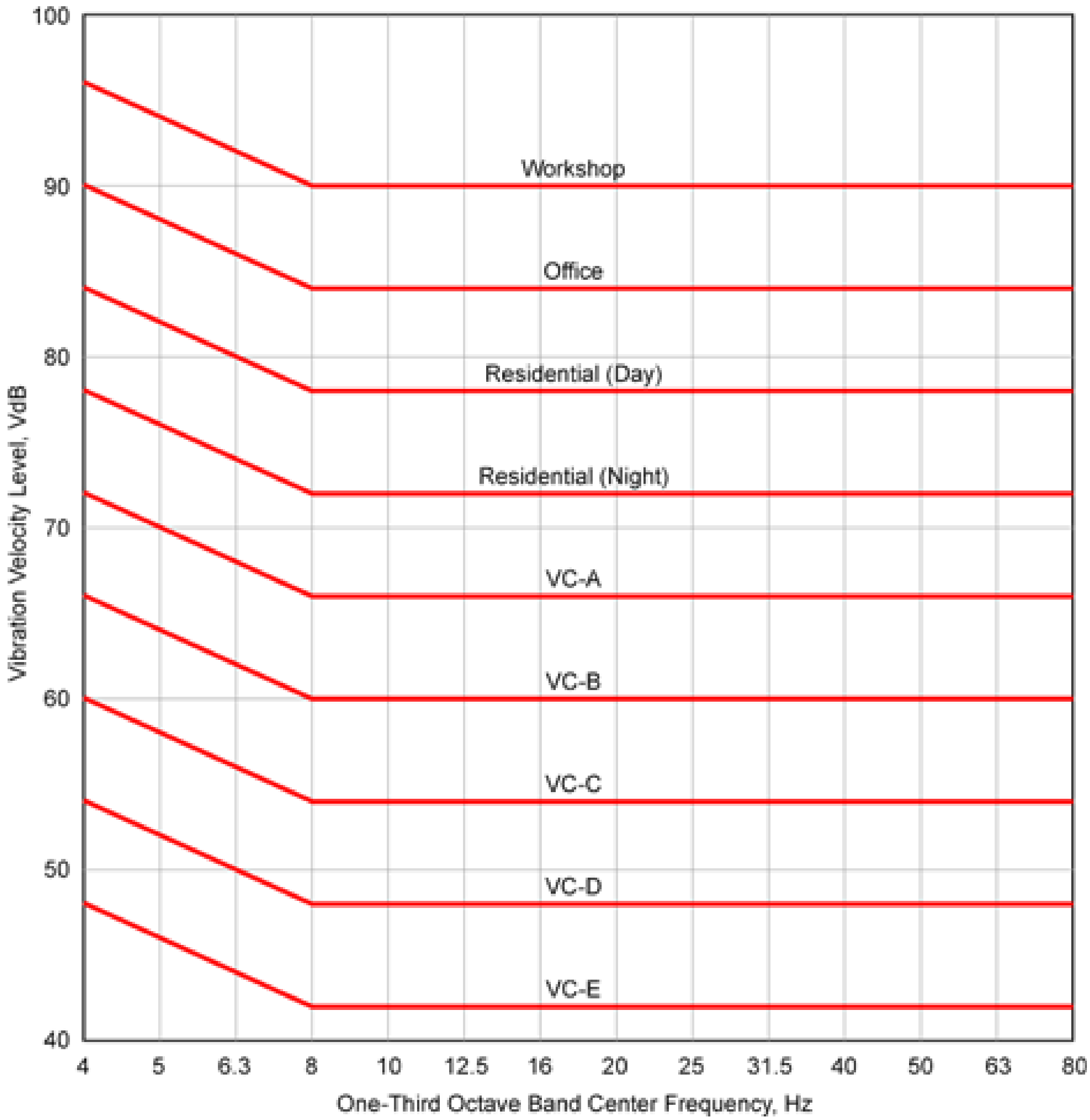

Figure 7. FRA Detailed Ground-Borne Vibration Impact Criteria

Table 4. Interpretation of Vibration Criteria for Detailed Analysis

Criterion Curve (See Fig. 3-4)	Max Lv (VdB)[1]	Description of Use
Workshop	90	Distinctly feelable vibration. Appropriate to workshops and non-sensitive areas.
Office	84	Feelable vibration. Appropriate to offices and non-sensitive areas.
Residential Day	78	Barely feelable vibration. Adequate for computer equipment and low-power optical microscopes (up to 20X).
Residential Night, Operating Rooms	72	Vibration not feelable, but ground-borne noise may be audible inside quiet rooms. Suitable for medium-power optical microscopes (100X) and other equipment of low sensitivity.
VC-A	66	Adequate for medium- to high-power optical microscopes (400X), microbalances, optical balances and similar specialized equipment.
VC-B	60	Adequate for high-power optical microscopes (1000X), inspection and lithography equipment to 3-micron line widths.
VC-C	54	Appropriate for most lithography and inspection equipment to 1-micron detail size.
VC-D	48	Suitable in most instances for the most demanding equipment, including electron microscopes operating to the limits of their capability.
VC-E	42	The most demanding criterion for extremely vibration-sensitive equipment.
[1] As measured in 1/3-octave bands of frequency over the frequency range 8 to 80 Hz.		

Source: FRA, 2012

4.2.3. Construction Noise Criteria

There are no standardized construction noise criteria from FTA or FRA for assessing noise impacts at sensitive receivers due to construction. The FTA and FRA Guidance Manuals do outline general assessment and detailed assessment criteria if local ordinances and standards are not adequate. Local ordinances and standards will always have precedence over the "reasonable guidelines" established by FRA. The "reasonable guidelines" established by the FRA are deliberately conservative in order to avoid adverse community reaction. The cities of Rancho Cucamonga, Fontana and Victorville all have ordinances that mention construction noise and which generally limit nighttime construction.

Table 5 shows the FRA noise assessment criteria for construction. The last column applies to construction activities that extend over 30 days near any given receiver. Day-night sound level, L_{dn}, is used to assess impacts in residential areas and 24-hr L_{eq} is used in commercial and industrial areas. The 8-hr L_{eq} and the 30-day average L_{dn} noise exposure from construction noise calculations use the noise emission levels of the construction equipment, their location, and operating hours. The construction noise limits are normally assessed at the noise-sensitive receiver property line.

Table 5. FRA Construction Noise Assessment Criteria

Land Use	8-hour L_{eq} (dBA)		L_{dn} (dBA)
	Day	Night	30-Day Average
Residential	80	70	75
Commercial	85	85	80*
Industrial	90	90	85*
* Twenty-four-hour L_{eq}, not L_{dn}.			

4.2.4. Construction Vibration Criteria

Guidelines in the FRA guidance manual provide the basis for the construction vibration assessment. FRA provides construction vibration criteria designed primarily to prevent building damage, and to assess whether vibration might interfere with vibration-sensitive building activities or temporarily annoy building occupants during the construction period. The FRA criteria include two ways to express vibration levels: (1) root-mean-square (RMS) VdB for annoyance and activity interference, and (2) peak particle velocity (PPV), which is the maximum instantaneous peak of a vibration signal used for assessments of damage potential.

To avoid temporary annoyance to building occupants during construction or construction interference with vibration-sensitive equipment inside special-use buildings, such as a magnetic resonance imaging (MRI) machine, FRA recommends using the long-term vibration criteria provided above in Section 4.2.

Table 6 shows the FRA building damage criteria for construction activity; the table lists PPV limits for four building categories. These limits are used to estimate potential problems that should be addressed during final design.

Table 6. FRA Construction Vibration Damage Criteria

Building Category	PPV (inch/sec)	Approximate Lv*
I. Reinforced concrete, steel, or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90
* RMS vibration velocity level in VdB relative to 1 micro-inch/second.		

4.3. Study Area

4.3.1. Noise Study Area

Along the proposed right-of-way, noise-sensitive receivers that could be affected by project-related noise needed to be identified. A screening distance was used to narrow the area within which noise-sensitive receivers may be located. The FRA has established screening distances for potential noise impacts based on existing land uses and the speed at which future high-speed trains are expected to operate. These screening distances are shown in Table 7. For the purposes of this analysis, the existing environment was considered to be "new rail corridor, urban/noisy suburban" with speeds under 170 mph, so the screening distance used was 350 feet from the track centerline. Noise-sensitive receivers were found by identifying existing noise-sensitive land uses (residences, schools, parks, libraries, and hospitals, etc.) within the noise impact screening distance for the Build Alternative.

Table 7. Operational Noise Screening Distances

Existing Noise Environment	Screening Distance in Feet for HSR[1]	
	90 to 170 mph	**170 mph or More**
Existing rail corridor, urban/noisy suburban – unobstructed	300 feet	700 feet
Existing rail corridor, urban/noisy suburban – obstructed[2]	200 feet	300 feet
Existing rail corridor, quiet suburban/rural	500 feet	1,200 feet
New rail corridor, urban/noisy suburban – unobstructed	350 feet	700 feet
New rail corridor, urban/noisy suburban – obstructed[2]	250 feet	350 feet
New rail corridor, quiet suburban/rural	600 feet	1,300 feet

[1] Measured from the centerline of the guideway or rail corridor. Minimum distance is assumed to be 50 feet.
[2] Rows of buildings assumed to be 200, 400, 600, 800, and 1,000 feet parallel to the guideway.
HSR = high-speed rail
mph = miles per hour

4.3.2. Vibration Study Area

Similar to the noise study area, the vibration study area is defined by screening distances established by the FRA. For this project, the vibration screening distance is 220 feet from the Project centerline for speeds up to 200 mph.

Table 8. Operational Vibration Screening Distances

Land Use	Screening Distance for HSR (feet from centerline)		
	Up to 100 mph	**Up to 200 mph**	**Up to 300 mph**
Residential	120 feet	220 feet	275 feet
Institutional	100 feet	160 feet	220 feet

4.4. Methods Used

This section summarizes the models used to project both construction noise and vibration and operational noise and vibration levels for potential sources of community impact related to the Project.

4.4.1. Operational Noise

The primary component of wayside noise from high-speed train operations for the electric multiple unit (EMU) vehicles is wheel/rail noise, which results from the steel wheels rolling on steel rails. Secondary sources, such as vehicle air-conditioning and other ancillary equipment, would sometimes be audible, but are not expected to be significant factors. The projection of wayside noise from high-speed train operations was carried out using the model specified in the FRA Guidance Manual, with the following assumptions:

- Based on centerline information provided by the Applicant, the predictions assume a 16-car EMU train using the reference levels found in Chapter 4 of the FRA Noise and Vibration Manual.
- The operating times for the proposed service would be between 5:30am and 1:00am. The operating plan for high-speed rail service specifies headways of 22.5 minutes. 16-car trains would operate throughout the day.
- Speeds were based on information provided by the Applicant, with a maximum operating speed of 140 miles per hour (mph).
- The entire Project is proposed to be grade-separated and therefore there would be no noise from horns or bells at grade-crossings.
- The majority of the proposed alignment is single track. There are several locations with passing tracks, where turnouts or crossovers would be utilized. For receivers near crossovers, 6 dB is added to the noise assessment to account for the additional noise from wheels running over the gap in the tracks, however there are no receivers located near any of the crossover locations.
- For receivers near elevated structures, 4 dB is added to the noise assessment relative to at-grade locations.
- To provide enough room for the HSR tracks in the median of the interstate, the interstate travel lanes will be shifted toward the outside of the interstate right-of-way in some locations. The change in noise levels due to the shift on the traffic lanes was assessed in the following manner:
    - For locations with no sensitive noise receptors, no assessment was conducted.
    - For locations with existing noise barriers, it was assumed that the small increase in noise would be offset by an increase in the effectiveness of the barriers, since the noise source would be moving closer to the barriers.

  - For locations with noise sensitive receivers and no barriers, the change in noise was assessed based on the change in the distance from the middle of the existing traffic lanes to the middle of the new traffic lanes.
- Based on FRA criteria, the potential for surprise (i.e. startle) effects for humans standing near the tracks would be limited to areas within 27 feet of the track.
- Startle effects for wildlife would be limited to areas within 40 feet of the track centerline, which in almost all cases would be within the I-15 right-of-way.

4.4.2. Traffic Noise

For operational traffic noise near stations, traffic volumes for the no action alternative and proposed Project were used to identify locations where the change in traffic volume would result in an increase in noise of 3 decibels (dB) or greater, which represents a noticeable change in noise level. A 3 dB change in noise represents a doubling of traffic volume due to the Project. For locations where there would be a substantial increase in traffic and where there are sensitive receptors, a noise assessment was conducted, using a screening distance of 100 feet for station access roads. For any locations with sensitive receptors within that screening distance, a general noise assessment was conducted.

4.4.3. Operational Vibration

The potential vibration impact from high-speed rail operations was assessed using the detailed FRA criteria. The following factors were used in determining potential vibration impacts along the proposed rail alignment:

- Vibration propagation tests were conducted at six sites along the corridor near sensitive receptors (See **Figure *11*** for locations of vibration propagation tests). These tests measured the response of the ground to an input force. The results of these tests were combined with vibration source data for the X2000 high-speed rail vehicle, which was deemed to be the most similar vehicle to the EMU (based on their similar configurations and maximum speeds) for which data are available in the literature, to project vibration levels from vehicles operating along the Project corridor.
- The assumed vehicle vibration characteristics were combined with the ground vibration propagation test results to project vibration levels as a function of distance from the tracks.
- Speeds were based on information provided by the Applicant, with a maximum operating speed of 140 mph.
- The majority of the proposed alignment is single track. There are several locations with passing tracks, where turnouts or crossovers would be utilized. For receivers near crossovers, 10 VdB is added to the vibration assessment to account for the additional vibration from wheels running over the gap in the tracks, however there are no receivers located near any of the crossover locations.

- For receivers near elevated structures, 10 VdB is subtracted from vibration assessment relative to at-grade locations.
- Based on the detailed vibration criteria for residential nighttime occupancy, a vibration criterion of 72 vibration decibels (VdB) (on a 1/3-octave band basis) was used for the assessment.

The assumed vehicle vibration characteristics are represented by the force density levels (FDL) spectrum at 150 mph in **Figure *8***. The force density is the vehicle input force, by frequency, which is measured for vehicles operating on different track structures. The results were combined with the ground vibration propagation test results (represented by transfer mobility spectra shown in Appendix C) to project vibration levels as a function of distance. The formula for calculating the future vibration levels is as follows:

Lv = FDL + LSTM

Where:

Lv = projected train vibration level,

FDL = vehicle force density, and

LSTM = line source transfer mobility at a given site.

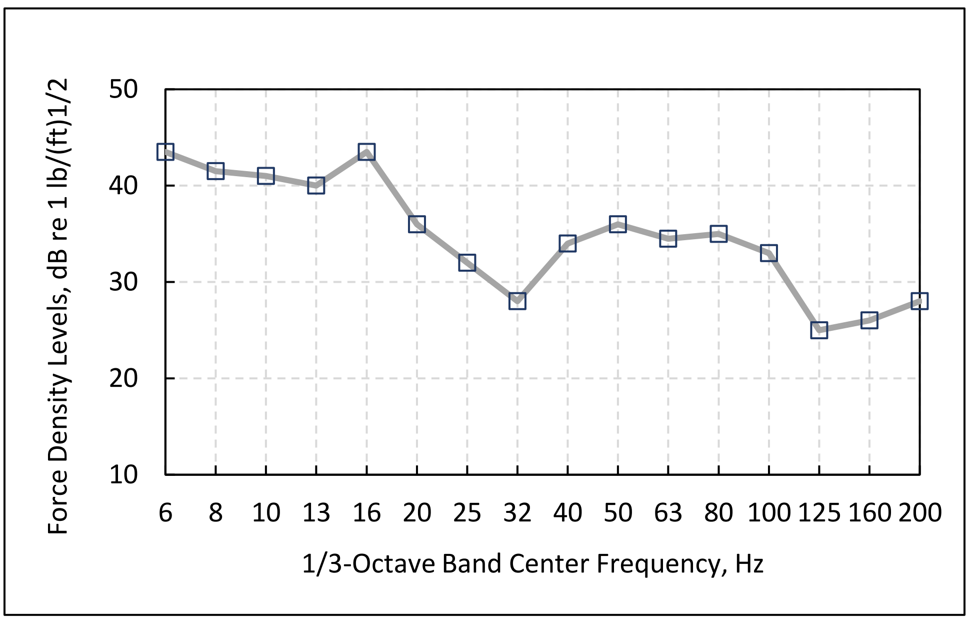

Figure 8. High-Speed Rail Vehicle Force Density Level at 150 mph

4.4.4. Construction Noise

Construction noise and impacts are assessed using a combination of the methods and construction source data contained in the FRA guidance (FRA, 2012) and the FHWA Roadway Construction Noise Model User's Guide (FHWA, 2006). Typical noise levels generated by representative pieces of equipment and their typical usage factors are listed in Table 9.

The noise exposure at a receiver location may be calculated by using decibel addition of all operating construction equipment using the following equation:

$$Leq(n) = Lmax + 10\times Log(U.F.) - 20\times Log(D/50) - A_{shielding}$$

where:

Leq(n) = noise exposure at a receiver resulting from the operation of a single piece of equipment over n hours,

L_{max} = noise emission level of the particular piece of equipment at the reference distance of 50 feet (taken from Table 21),

$A_{shielding}$ = shielding provided by barriers, building, or terrain,

D = distance from the receiver to the piece of equipment in feet, and

U.F. = usage factor that accounts for the fraction of time that the equipment is in use over the specified time period. For Leq (1) assume a U.F. equal to 100%, and for 8 hours or more use the values in Table 9.

The combination of noise from several pieces of equipment operating during the same time period is obtained from decibel addition of the Leq of each single piece of equipment calculated using the above equations.

Table 9. Construction Equipment Noise Emission Levels

Equipment	Typical Noise Level (dBA) 50 feet From Source	Typical Usage Factor (%)
Air Compressor	80	40
Backhoe	80	40
Ballast Equalizer	82	50
Ballast Tamper	83	50
Compactor	82	20
Concrete Mixer	85	40
Concrete Pump	82	20
Concrete Vibrator	76	20
Crane, Derrick	88	16
Crane, Mobile	83	16
Dozer	85	16
Generator	82	50
Grader	85	40
Impact Wrench	85	50

Equipment	Typical Noise Level (dBA) 50 feet From Source	Typical Usage Factor (%)
Jack Hammer	88	20
Loader	80	40
Paver	85	50
Pile Driver (Impact)	101	20
Pile Driver (Vibratory)	95	20
Pneumatic Tool	85	50
Pump	77	50
Rail Saw	90	20
Rock Drill	85	20
Roller	85	20
Saw	76	20
Scarifier	83	20
Scraper	85	40
Shovel	82	40
Spike Driver	77	20
Tie Cutter	84	20
Tie Handler	80	20
Tie Inserter	85	20
Truck	84	40

4.4.5. Construction Vibration

Construction vibration is assessed for areas where there is a potential for impact from construction activities. Such activities include blasting, pile driving, demolition, and drilling or excavation in close proximity to sensitive structures. Typical vibration levels generated by representative pieces of equipment are listed in Table 10. For damage assessment, the following equation is used:

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

where:

PPV_{equip} = the peak particle velocity in in/sec of the equipment adjusted for distance,

PPV_{ref} = the reference vibration level in in/sec at 25 feet from Table 10, and

D = the distance from the equipment to the receiver in feet.

For annoyance assessment, the following equation is used:

$$Lv(D) = Lv(25\ ft) - 30 \times \log(D/25)$$

where:

Lv(D) = RMS vibration level at distance D,

Lv(25 ft) = RMS vibration level at 25 feet from Table 10, and

D = the distance from the equipment to the receiver in feet.

Table 10. Vibration Source Levels for Construction Equipment

Equipment		PPV at 25 feet (in/sec)	Approximate Lv [a] at 25 feet
Pile Driver (impact)	upper range	1.518	112
	typical	0.644	104
Pile Driver (vibratory)	upper range	0.734	105
	typical	0.170	93
Clam shovel drop (slurry wall)		0.202	94
Hydromill (slurry wall)	in soil	0.008	66
	in rock	0.017	75
Vibratory roller		0.210	94
Hoe ram		0.089	87
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58

Lv = vibration velocity level in dB

5. Affected Environment

The affected noise and vibration environment in the vicinity of the Project was investigated based on a review of current project and land use information, GIS data, a windshield survey, and measurements conducted during November 2021. Land use in the study area includes a combination of residential, institutional, commercial, and industrial zones. Noise-sensitive and vibration-sensitive land uses in the study area were identified based on alignment drawings, aerial photographs, visual surveys, and land use information. Sensitive receptors located near the Project include single-family and multi-family residences, hotels, schools, parks and places of worship.

5.1. Noise

Existing ambient noise levels in the Project area were characterized through direct measurements at selected sites along the proposed Project during November 2021. Estimating existing noise exposure is an important step in the noise impact assessment since, as indicated above, the thresholds for noise impact are based on the existing levels of noise exposure. The measurements consisted of long-term (24-hour) and short-term (one-hour) monitoring of the A-weighted sound level at representative noise-sensitive locations.

All of the measurement sites were located in noise-sensitive areas and were selected to represent a range of existing noise conditions along the corridor. Figure 9 shows the general locations of the eight long-term (LT) and six short-term (ST) measurement sites. Photographs of the measurement sites are included in Appendix A, and detailed noise measurement data are presented in Appendix C.

At each site, the measurement microphone was positioned to characterize the exposure of the site to the dominant noise sources in the area. For example, microphones were located at the approximate setback lines of the receptors from adjacent existing roads or rail lines, and were positioned to avoid acoustic shielding by landscaping, fences or other obstructions. At each of the measurement sites, the A-weighted sound levels were continuously monitored during the measurement periods. The noise measurements were performed with NTi Audio model XL2 noise monitors that conform to American National Standards Institute (ANSI) Standard S1.4 for Type 1 (Precision) sound level meters. Calibrations, traceable to the U.S. National Institute of Standards and Technology (NIST), were carried out in the field before and after each set of measurements using an acoustical calibrator.

The results of the existing ambient noise measurements, summarized in Table 11 serve as the basis for determining the existing noise conditions at all noise-sensitive receptors along the proposed rail alignment. The results at each site are described below.

Figure 9. Noise Measurement Site Locations

Table 11. Summary of Noise Measurement Results

Site No.	Measurement Location	Start of Measurement		Meas. Duration	Nosie Level (dBA)	
		Date	Time	(hrs)	Leq	Ldn
LT-2	7420 Bungalow Way, Rancho Cucamonga	10/27/2021	16:00	24	65.1	71.4
LT-3	15165 Crane Street, Fontana	11/1/2021	19:00	24	64.6	70.9
LT-4	3733 Bur Oak Road, San Bernardino	10/27/2021	15:00	24	66.1	71.6
LT-5	13296 Amargosa Road, Victorville	11/2/2021	16:00	24	72.3	76.4
LT-6	15665 Kingswood Drive, Victorville	11/2/2021	17:00	24	66.6	71.8
LT-7	14983 S Culver Road, Victorville	11/2/2021	17:00	24	59.3	68.3
LT-8	15410 La Paz Drive, Victorville	11/3/2021	12:00	24	76.7	80.5
LT-9	17251 Dante Street, Victorville	11/3/2021	12:00	24	51.8	65.0
ST-2	7950 Etiwanda Avenue, Rancho Cucamonga	10/28/2021	15:42	1	65.6	71.9*
ST-3	Nedlee Avenue, San Bernardino	10/28/2021	12:40	1	68.0	72.7*
ST-5	Farmington Street and Mariposa Road, Hesperia	11/4/2021	14:09	1	69.2	67.2*
ST-6	11335 Verde Avenue, Hesperia	11/4/2021	9:00	1	61.3	66.0*
ST-7	16424 E Street, Victorville	11/4/2021	15:47	1	66.7	64.7
ST-8	15834 Joshua Street, Victorville	11/4/2021	15:45	1	54.5	52.5

** At these locations, the Ldn was estimated based on the Leq measurements and similar long-term noise measurement sites nearby.

5.1.1. Section 1 – High Desert

Victor Valley Station to North D Street: The land use in this area is primarily rural open space with some single-family and multi-family residences near Dante Street and E Street. There are three hotels and the Shady Oasis Campground adjacent to I-15 on Stoddard Wells Rd. There are no institutional land uses in this area.

North D Street to Mojave Drive: The land use in this area is a mix of industrial, suburban single-family, and multi-family residences. The High Desert Apartments, Summer Ridge Apartments, and Days Inn by Wyndam Victorville hotel are included in this area. There are no institutional land uses in this area.

Mojave Drive to Palmdale Road: The land use in this area is primarily commercial with a few residential areas adjacent to I-15 along South Culver Road, including the Mojave Mobile Home Park and the Victorville Fire Department.

Palmdale Road to La Mesa Road: The land use in this area is a mix of commercial and suburban single-family residences adjacent to I-15 near Burning Tree Drive and east of Amargosa Road. The Red Roof Inn Victorville hotel is included in this area. Institutional land uses in this area include Grace Christian Preschool and Victor Valley Apostolic Church.

La Mesa Road to Main Street: The land use in the area between La Mesa Road and Bear Valley Road in Victorville, CA is a mix of commercial and suburban single-family residences along Snake River Drive, Santa Fe Trail, and Pony Trail Road/Court. The Home2 Suites by Hilton Victorville hotel is included in this area. South of Bear Valley Road in Hesperia, CA the land use is characterized by mostly open space with a mix of commercial, industrial, and residential spaces. Some single-family residences are set back from I-15 along Mariposa Road. Institutional land use in this area includes the Desert View Memorial Park cemetery.

Main Street to Oak Hill Road: The land use in this area is primarily open space in San Bernardino County with a mix of commercial and rural single-family residences. Noise-sensitive land uses include the San Bernardino County Fire Station 305 along Caliente Road and single-family residences near Oak Ridge Drive, Oak Hill Drive, and Lantry Lane. There are no institutional land uses in this area.

The noise sites that are used to represent this area, which are described below, are LT-5, LT-6, LT-7, LT-8, LT-9, ST-5, ST-6, ST-7, and ST-8.

Site LT-5: The Ldn measured at this location was 76 dBA. Noise levels were measured for 24 hours in the front yard of the Family Beauty Salon adjacent to residences along Amargosa Road. The dominant noise sources were traffic on the Interstate 15 (I-15) freeway and Amargosa Road. This noise measurement site is representative of noise-sensitive land uses between Yates Road in Victorville, CA and Sycamore Street in Hesperia, CA.

Site LT-6: The Ldn measured at this location was 72 dBA. Noise levels were measured for 24 hours in the front yard of the single-family residence on Kingwood Drive. The dominant noise sources were traffic on the Interstate 15 (I-15) freeway and Mariposa Road. This noise measurement site is representative of noise-sensitive land uses between Roy Rogers Drive in and Yates Road in Victorville, CA.

Site LT-7: The Ldn measured at this location was 68 dBA. Noise levels were measured for 24 hours in the back yard of this residence along Culver Road. The dominant noise source was traffic on the Interstate 15 (I-15) freeway. This noise measurement site is representative of noise-sensitive land uses between Mojave Drive and Roy Rogers Drive in Victorville, CA.

Site LT-8: The Ldn measured at this location was 81 dBA. Noise levels were measured for 24 hours at the Summer Ridge Apartments adjacent to I-15. The dominant noise source was traffic on the Interstate 15 (I-15) freeway. This noise measurement site is representative of noise-sensitive land uses in close proximity to I-15 between Fresno Street and Mojave Drive in Victorville, CA.

Site LT-9: Ldn measured at this location was 65 dBA. Noise levels were measured for 24 hours at the Northgate Village Apartments. The dominant noise sources were traffic on the Interstate 15 (I-15) freeway and local community noise. This noise measurement site is representative of noise-sensitive land uses along I-15 between Victor Valley Station and Stoddard Wells Road in Victorville, CA.

Site ST-5: The Leq measured at this location was 69 dBA. Noise levels were measured for 1 hour at the corner of Farmington Street and Mariposa Road. The dominant noise sources were traffic on the Interstate 15 (I-15) freeway and Mariposa Road. This noise measurement site is representative of noise-sensitive land uses along I-15 between Main Street and Oak Hill Road in Hesperia, CA.

Site ST-6: The Leq measured at this location was 61 dBA. Noise levels were measured for 1 hour adjacent to the single-family residences on Verde Avenue/Boxwood Avenue. The dominant noise sources were traffic on the Interstate 15 (I-15) freeway and Mariposa Road. This noise measurement site is representative of noise-sensitive land uses along I-15 between Sycamore Street and Main Street in Hesperia, CA, including the Desert View Memorial Park cemetery.

Site ST-7: The Leq measured at this location was 67 dBA. Noise levels were measured for 1 hour adjacent to the residences along E and D Streets. The dominant noise sources were traffic on the Interstate 15 (I-15) freeway and local traffic on D and E Streets. This noise measurement site is representative of noise-sensitive land uses along I-15 between the E and D Street interchanges and Stoddard Wells Road in Victorville, CA.

Site ST-8: The Leq measured at this location was 55 dBA. Noise levels were measured for 1 hour at the cul-de-sac of Joshua Street adjacent to I-15. The dominant noise source was traffic on the Interstate 15 (I-15) freeway. This noise measurement site is representative of noise-sensitive land uses between D Street and Mojave Drive in Victorville, CA that are shielded from I-15 by and noise barrier.

5.1.2. Section 2 – Cajon Pass

Oak Hill Road to West Kenwood Avenue: No noise sensitive land uses are within the screening distance, and no noise measurements were conducted in this Project section.

5.1.3. Section 3 – Greater Los Angeles

West Kenwood Avenue to Sierra Avenue: The land use in this area is primarily rural open space with some single-family residences to the northeast of I-15 near Kenwood Avenue, Greenwood Avenue, Woodlawn Avenue, Kimbark Avenue and Marion Avenue. There is also an area of suburban single-family residences along Bur Oak Road and Comfrey Drive. There are no institutional land uses in this area.

Sierra Avenue to Route 210: The land use in this area is primarily rural open space to the north of Duncan Canyon Road with a few single-family residences along Lytle Creek Road. South of Duncan Canyon Road, there is a mix of commercial and residential land uses with areas of suburban single-family residences adjacent to I-15 along Coyote Canyon Road, Beech Avenue, and Summit Avenue. Coyote Canyon Park and San Bernardino County Fire Station 79 are included in this area. Institutional land uses in this area include Summit Water of Life Church.

Route 210 to Base Line Road: The land use in this area is a mix of commercial and residential land uses with areas of suburban single-family residences adjacent to I-15 along Williamson

Road, Windy Grove Drive, Smithfield Court, Ashland Lane, and Marysville Place. Noise-sensitive land uses in this area also include the multi-family residences near Shooting Star Way and Comfort Inn Fontana. There are no institutional land uses in this area.

Base Line Road to Arrow Route: The land use in this area is primarily dense suburban residential space between Base Line Road and Church Street/Miller Avenue. South of Church Street, the land use is primarily commercial with a few residential areas, including single-family residences along Canopy Court and Grape Harvest Drive, and the Barrington Place Apartments between I-15 and Etiwanda Avenue. Institutional land uses in this area include Sacred Heart Parish School.

Arrow Route to Rancho Cucamonga Station: The land use in this area is a mix of commercial and industrial uses. There are no noise sensitive land uses in this area.

The noise sites that are used to represent this section, which are described below, are LT-2, LT-3, LT-4, ST-2, and ST-3.

Site LT-2: The Ldn measured at this location was 71 dBA. Noise levels were measured for 24 hours in the front yard of this single-family residence along Bungalow Way. The dominant noise source was traffic on the Interstate 15 (I-15) freeway. This noise measurement site is representative of noise-sensitive land uses south of Route 210 in Rancho Cucamonga, CA.

Site LT-3: The Ldn measured at this location was 71 dBA. Noise levels were measured for 24 hours in the back yard of the single-family residence on Crane Street. The dominant noise sources were traffic on the Interstate 15 (I-15) freeway and Coyote Canyon Road. This noise measurement site is representative of noise-sensitive land uses between Sierra Avenue and Route 210 in Fontana, CA, including Summit Water of Life Church.

Site LT-4: The Ldn measured at this location was 72 dBA. Noise levels were measured for 24 hours in the back yard of the single-family residence on Bur Oak Road. The dominant noise sources were traffic on the Interstate 15 (I-15) freeway and local community noise in the Bur Oak Road neighborhood. This noise measurement site is representative of noise-sensitive land uses between the Glen Helen Pkwy and Sierra Ave in San Bernardino, CA.

Site ST-2: The Leq measured at this location was 66 dBA. Noise levels were measured for 1 hour at the Barrington Place Apartments off Etiwanda Avenue. The dominant noise source was traffic on the Interstate 15 (I-15) freeway. This noise measurement site is representative of noise conditions at the Barrington Place Apartments and the Sacred Heart Parish School in Rancho Cucamonga, CA.

Site ST-3: The Leq measured at this location was 68 dBA. Noise levels were measured for 1 hour at a typical residential building setback distance from I-15 at the cul-de-sac at the west end of Nedlee Avenue in this rural residential neighborhood. The dominant noise source was traffic on the Interstate 15 (I-15) freeway. This noise measurement site is representative of noise-sensitive land uses along I-15 between Kenwood Avenue and Glen Helen Pkwy.

5.2. Vibration

Vibration propagation measurements were conducted during November 2021 to determine the vibration response characteristics of the ground near vibration-sensitive locations located near the proposed mainline track options. A custom-built instrumented hammer was used to impart an impulsive force to the ground to determine the ground response. The magnitude of the force was calculated based on the acceleration and mass of the falling hammer. The resulting vibration signals were measured using high-sensitivity accelerometers (PCB Model 393C and 393B05) mounted in a vertical direction on pavement or on steel spikes driven into the ground. The signals from the hammer and accelerometers were recorded using Data Translation DT9837A digital acquisition hardware. Data Translation's QuickDAQ software, running on a laptop computer, was used to review the measurement data.

The vibration propagation test procedure is shown schematically in **Figure *10***. The instrumented hammer was used to generate impulses at specific locations spaced 15 feet apart along a line on or parallel to the proposed alignment. A line of accelerometers was placed perpendicular to the line of impacts as shown in the figure. The relationship between the input force and the resulting vibration measured by the accelerometers, called the transfer mobility (TM), was calculated using proprietary software in the Cross-Spectrum Acoustics (CSA) laboratory. The transfer mobility represents the vibration propagation characteristics of the ground at the measurement site and along the mainline track options.

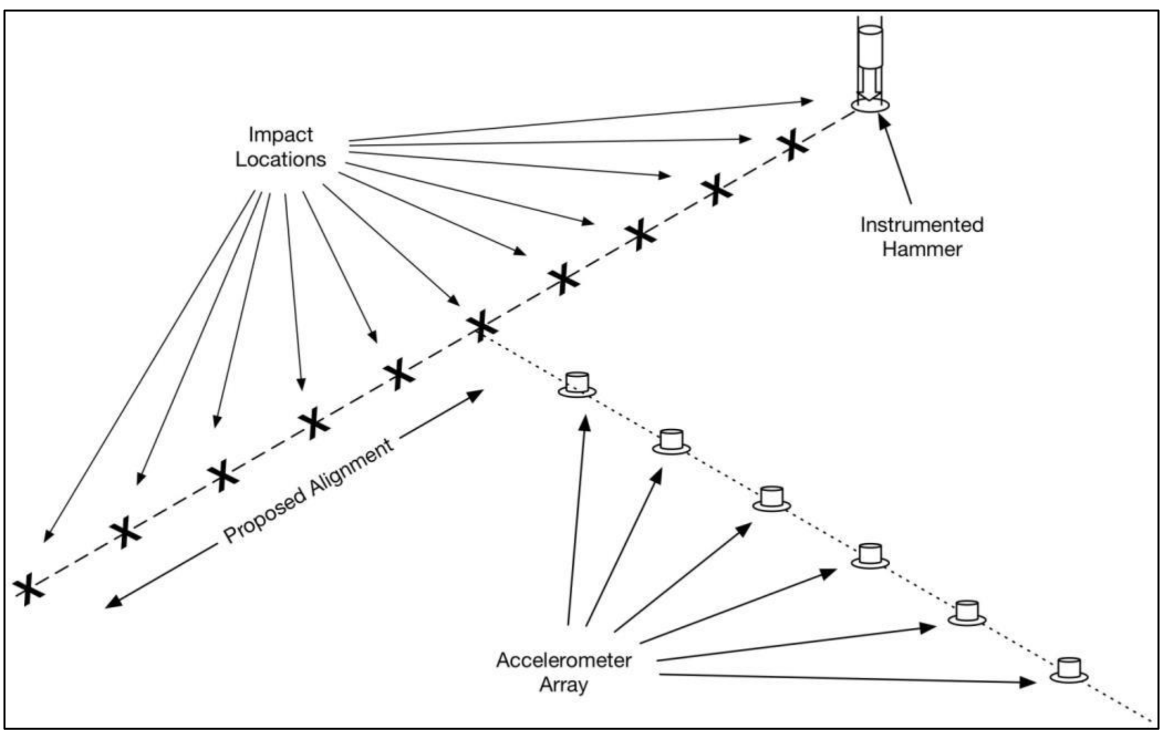

Figure 10. Vibration Propagation Measurement Schematic

Figure 11. Vibration Measurement Site Locations

Six vibration propagation test sites were selected for measurements for the Project. The locations of the sites are shown on **Figure *11***, site photographs are included in Appendix B, and detailed propagation information is included in Appendix D. **Figure *12*** shows the results of the vibration propagation tests at 100 feet for each of the test sites.

The vibration-sensitive land use for the Project is the same as the noise-sensitive land use described above. Descriptions of the vibration propagation test sites are as follows:

5.2.1. Section 1 High Desert

Site VP-4 was located in the empty lot to the east of the Starbucks located at 11412 Fashion Court in Hesperia, CA. The vibration measurements at this location are representative of the areas between Main Street and Oak Hill Road in Hesperia, CA.

Site VP-5 was located at the intersection of Santa Fe Trail and Fox Trail in Victorville, CA. The vibration measurements at this location are representative of the areas between Roy Rogers Drive in Victorville, CA and Main Street in Hesperia, CA.

Site VP-6 was located at Avalon Park in Victorville, CA. The vibration measurements at this location are representative of the areas between Victor Valley Station and Roy Rogers Drive in Victorville, CA.

5.2.2. Section 2 – Cajon Pass

Oak Hill Road to West Kenwood Avenue: No vibration sensitive land uses are within the screening distance, and no vibration measurements were conducted in this Project section.

5.2.3. Section 3 Greater Los Angeles

Site VP-1 was located at the intersection of Crawford Place and Candlewood Street in Rancho Cucamonga, CA. The vibration measurements at this location are representative of the areas between Route 210 and the Rancho Cucamonga Station in Rancho Cucamonga, CA.

Site VP-2 was located at Coyote Canyon Park in Fontana, CA. The vibration measurements at this location are representative of the areas between Sierra Avenue and Route 210 in Fontana, CA.

Site VP-3 was located at the intersection of Bur Oak Road and Anise Drive in San Bernardino, CA. The vibration measurements at this location are representative of the areas between Kenwood Avenue and Sierra Avenue in San Bernardino, CA.

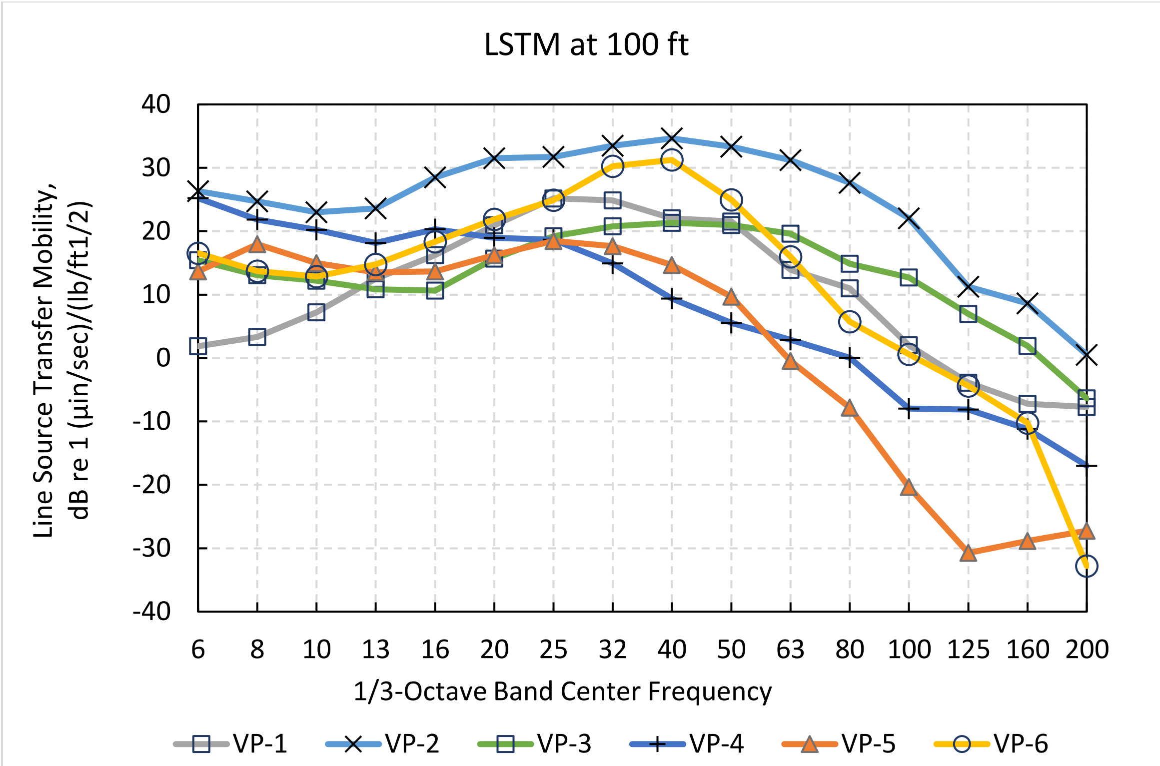

Figure 12. Vibration Measurement Results at 100 feet

6. Environmental Consequences and Mitigation

6.1. Build Alternative

Detailed noise and vibration impact assessments were performed based on the criteria discussed in Section 4.2 and the prediction methodology described in Section 5.4. The assessment results are presented in this section. The FRA guidance manual is the primary source for the noise methodology. The noise and vibration assessments included the following steps:

- Noise- and vibration-sensitive land uses were identified using aerial photography, GIS data, and field surveys. See Section 5.1.
- Existing noise levels along the corridor were measured at sensitive receptors. See Section 5.1.
- Vibration-propagation characteristics of the soil along the corridor were measured near representative sensitive receptors. See Section 5.2.
- Project noise and vibration levels from high-speed rail operations and highway noise were predicted using Project drawings and information on speeds, headways, track type and vehicle type.
- The noise impact from operations was assessed by comparing the Project noise with the existing noise (not the No Build Alternative noise) using the FRA noise impact criteria. See Figure 5.
- The vibration impact from operations was assessed by comparing the Project vibration levels with the FRA vibration impact criteria in **Figure *7***.
- Mitigation was recommended at locations where Project noise or vibration levels exceed the impact criteria.

6.1.1. Noise

6.1.1.1. Construction Effects

Elevated noise levels from construction activities are, to a degree, unavoidable for this type of project. For most construction equipment, diesel engines are typically the dominant noise source. For other activities, such as impact pile driving and jackhammering, noise generated by the actual process dominates. Short-term noise during construction of the Project can be intrusive to residents near the construction sites. Most of the construction will consist of site preparation and laying new tracks, and should occur primarily during daytime hours, except when required and within applicable noise ordinance procedures for a waiver. At some locations, more extensive work will occur, such as pile driving for elevated structures and retaining walls.

Table 12 shows noise levels of typical construction equipment from the FTA guidance manual, in terms of the maximum levels at 50 feet. Construction noise predictions at noise-sensitive locations depend on the amount of noise during each construction phase, the duration of the noise, and the distance from the construction activities to the sensitive receptor. Conducting a construction noise impact assessment requires knowledge of the equipment likely to be used, the duration of its use, and the way it will be used by a contractor. Table 12 provides an example of a construction noise projection for typical at-grade track construction. Construction noise projections for other project features, such as station or parking facilities, would have similar results. Under this scenario, an 8-hour Leq of 88 dBA would be projected at a distance of 50 feet from the construction site.

Using the criteria in Section 4.2.3 and the example for at-grade construction in Table 12, screening distances for at-grade track construction noise impact can be determined. For this example at residential land uses, the potential for short-term at-grade track construction noise impact could extend to approximately 120 feet from the corridor; however, if nighttime construction is conducted, the potential for short-term noise impact from at-grade construction could extend to approximately 380 feet from the corridor With this typical example, because the majority of the alignment would be in the center of I-15, construction effects would be limited to three locations at the northern end of the alignment: two hotels near Stoddard Wells Road and one single family residence on Pepper Tree Drive.

For elevated structure construction, the distances could be larger, depending on the type of piling that could occur. When a specific piling method is determined, a screening distance could be calculated.

Table 12. Typical Construction Scenario

Equipment Type	Typical Noise Level at 50 feet (dBA)	Equipment Utilization Factor (%)	Leq (dBA)
Grader	85	50	82
Backhoe	80	40	76
Compactor	82	20	75
Loader	85	20	78
Roller	74	20	67
Truck	88	40	84
Crane, Mobile	83	20	76
Total 8-hour workday Leq at 50 feet:			88

6.1.1.2. Operation Effects

Railway Noise

The assessment of noise impact from high-speed rail operations is based on a comparison of existing and Project noise for different land use categories. Detailed comparisons of the existing and future noise levels are presented in Table 13 for residential land uses and Table 14 for institutional land uses below. In addition to the location (or name for institutional land uses) and distance to the near track, each table includes the train speed, the existing noise level, the projected noise level from high-speed rail operations, and the impact criteria for each receptor or receptor group. Each table also includes an inventory of the number of impacts and severe impacts at each sensitive receptor location. The noise impact locations are shown in **Figure *13*** through **Error! Reference source not found.** and described in detail below.

Table 13. Summary of Residential Noise Impacts from HSR Operations

Location	Side of Track	Dist to Near Track (ft)	Max Train Speed (mph)	Existing Noise Level (Ldn, dBA)	Noise Level (Ldn, dBA)			Type and # of Impacts	
					Project	Impact Criteria Mod.	Impact Criteria Sev.	Mod.	Sev.
Section 1 – High Desert									
Victor Valley Station to N D St	NB	359	100	65	57	61	66	0	0
Victor Valley Station to N D St	SB	165	100	65	62	61	66	2	0
N D St to Mojave Dr	NB	122	90	81	63	65	75	0	0
N D St to Mojave Dr	SB	137	90	81	62	65	75	0	0
Mojave Dr to Palmdale Rd	NB	No noise sensitive receivers.							
Mojave Dr to Palmdale Rd	SB	129	80	68	62	63	68	0	0
Palmdale Rd to La Mesa Rd	NB	160	140	72	65	65	71	0	0
Palmdale Rd to La Mesa Rd	SB	202	140	76	63	65	74	0	0
La Mesa Rd to Main St	NB	163	140	76	65	65	74	0	0
La Mesa Rd to Main St	SB	272	140	76	61	65	74	0	0
Main St to Oak Hill Rd	NB	422	120	67	57	62	68	0	0
Main St to Oak Hill Rd	SB	231	80	67	58	62	68	0	0
Section 2 – Cajon Pass									
Oak Hill Rd to W Kenwood Ave	NB	No noise sensitive receivers.							

Oak Hill Rd to W Kenwood Ave	SB	No noise sensitive receivers.							
Section 3 – Greater Los Angeles									
W Kenwood Ave to Sierra Ave	NB	212	140	72	63	65	71	0	0
W Kenwood Ave to Sierra Ave	SB	No noise sensitive receivers.							
Sierra Ave to Rt 210	NB	No noise sensitive receivers.							
Sierra Ave to Rt 210	SB	256	140	71	61	65	70	0	0
Rt 210 to Base Line Rd	NB	245	140	71	62	65	70	0	0
Rt 210 to Base Line Rd	SB	217	140	71	63	65	70	0	0
Base Line Rd to Arrow Route	NB	177	140	71	64	65	70	0	0
Base Line Rd to Arrow Route	SB	164	140	71	65	65	70	0	0
Arrow Route to Rancho Cucamonga Station	NB	No noise sensitive receivers.							
Arrow Route to Rancho Cucamonga Station	SB	No noise sensitive receivers.							
Total:								2	0

Victor Valley Station to N D St (SB): There are two hotels along the southbound side of the proposed alignment between the Victor Valley Station and N D St projected to have moderate noise impacts. These impacts are due to the proximity of the hotels to the tracks.

In addition to the noise from HSR operations, the noise from the shifting of the lanes on I-15 was also assessed, as described in Section 4.4.1. This change in traffic noise due to the shift of the lanes will add approximately 1 dB of noise at receivers in the locations described below.

At all locations, the impacts due to the HSR operations and change in traffic noise are in the low end of the moderate impact range.

Mojave Dr to N D St (NB): There are 40 single and multi-family homes along the northbound side of the proposed alignment between Mojave Dr and N D St projected to have moderate noise impacts.

Mojave Dr to N D St (SB): There are 9 single family homes along the southbound side of the proposed alignment between Mojave Dr and N D St projected to have moderate noise impacts.

La Mesa Rd to Palmdale Rd (NB): There is one hotel along the northbound side of the proposed alignment between La Mesa Rd and Palmdale Rd projected to have a moderate noise impact.

Main St to La Mesa Rd (NB): There are two hotels and 22 single-family homes along the northbound side of the proposed alignment between Main St and La Mesa Rd projected to have moderate noise impacts.

Arrow Rd to Base Line Rd (NB): There are 9 single-family homes along the northbound side of the proposed alignment between Arrow Rd and Base Line Rd projected to have moderate noise impacts.

Table 14. Summary of Institutional Noise Impacts from HSR Operations

Name	Location	Side of Track	Dist to Near Track (ft)	Max Train Speed (mph)	Existing Noise Level (Leq, dBA)	Noise Level (Leq, dBA)			Type and # of Impacts	
						Project	Impact Criteria Mod.	Impact Criteria Sev.	Mod.	Sev.
Section 1 – High Desert										
Grace Christian Preschool	Palmdale Rd to La Mesa Rd	SB	423	140	72	57	70	76	0	0
Victor Valley Apostolic Church	Palmdale Rd to La Mesa Rd	SB	430	140	72	56	70	76	0	0
Desert View Memorial Park	La Mesa Rd to Main St	SB	161	120	61	61	63	69	0	0
Section 3 – Greater Los Angeles*										
Summit Water of Life Church	Sierra Ave to Rt 210	NB	329	140	65	58	65	71	0	0
Sacred Heart Parish School	Base Line Rd to Arrow Route	NB	239	80	66	56	66	72	0	0
*There are no institutional receptors in Section 2.										

There are no noise impacts predicted at institutional land uses for the Project.

Hesperia Station

There would be no noise impacts associated with the Hesperia Station. There are no sensitive receptors located near the proposed station site.

Rancho Cucamonga Station

There would be no noise impacts associated with the Rancho Cucamonga Station. There are no sensitive receptors located near the proposed station site.

Traffic Noise

There are no locations where the changes in the traffic volumes due to the Project exceed the threshold in Section 4.4.2, so no traffic noise impacts are projected.

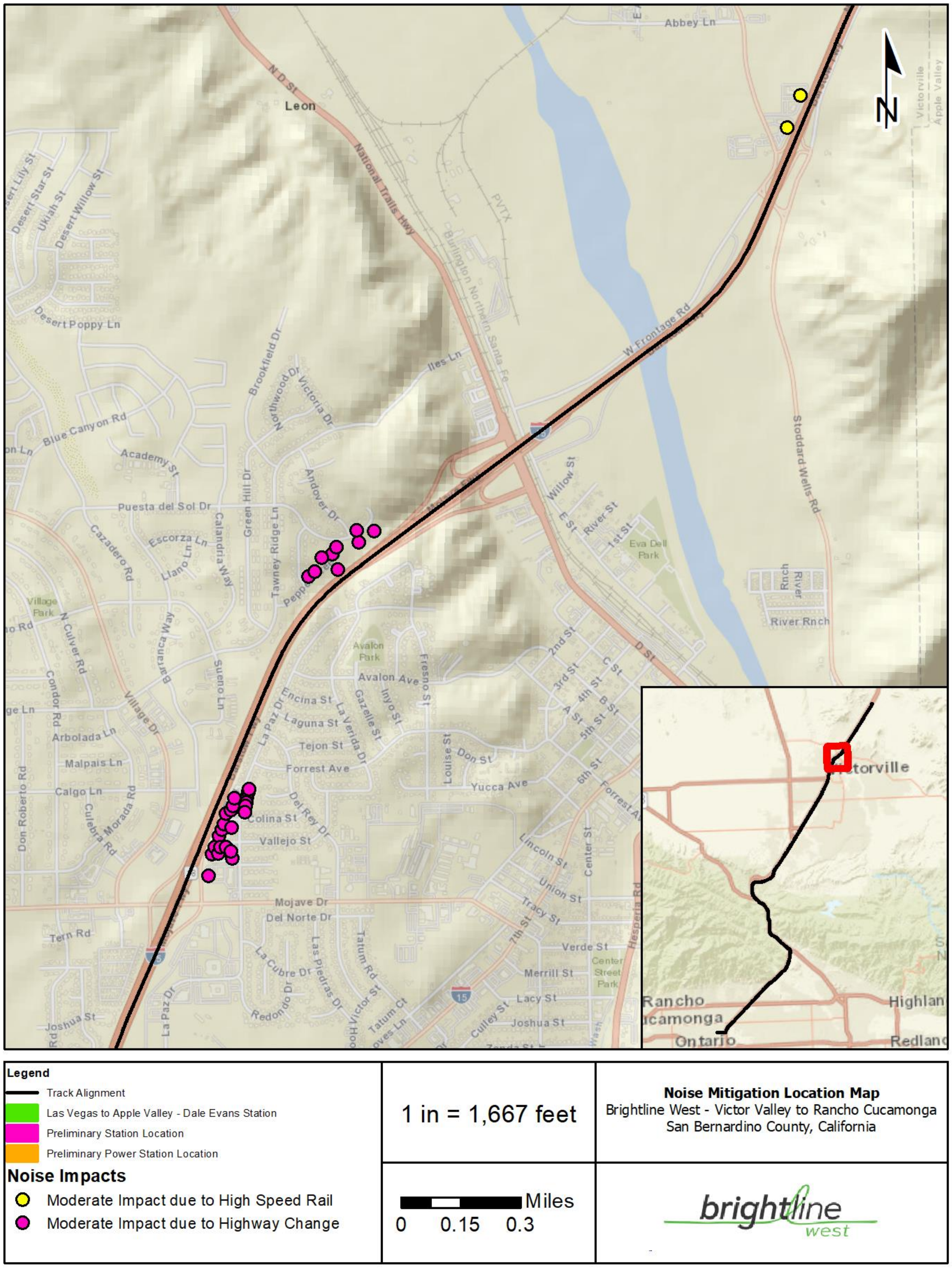

Figure 13. Noise Impact Locations 1 of 3

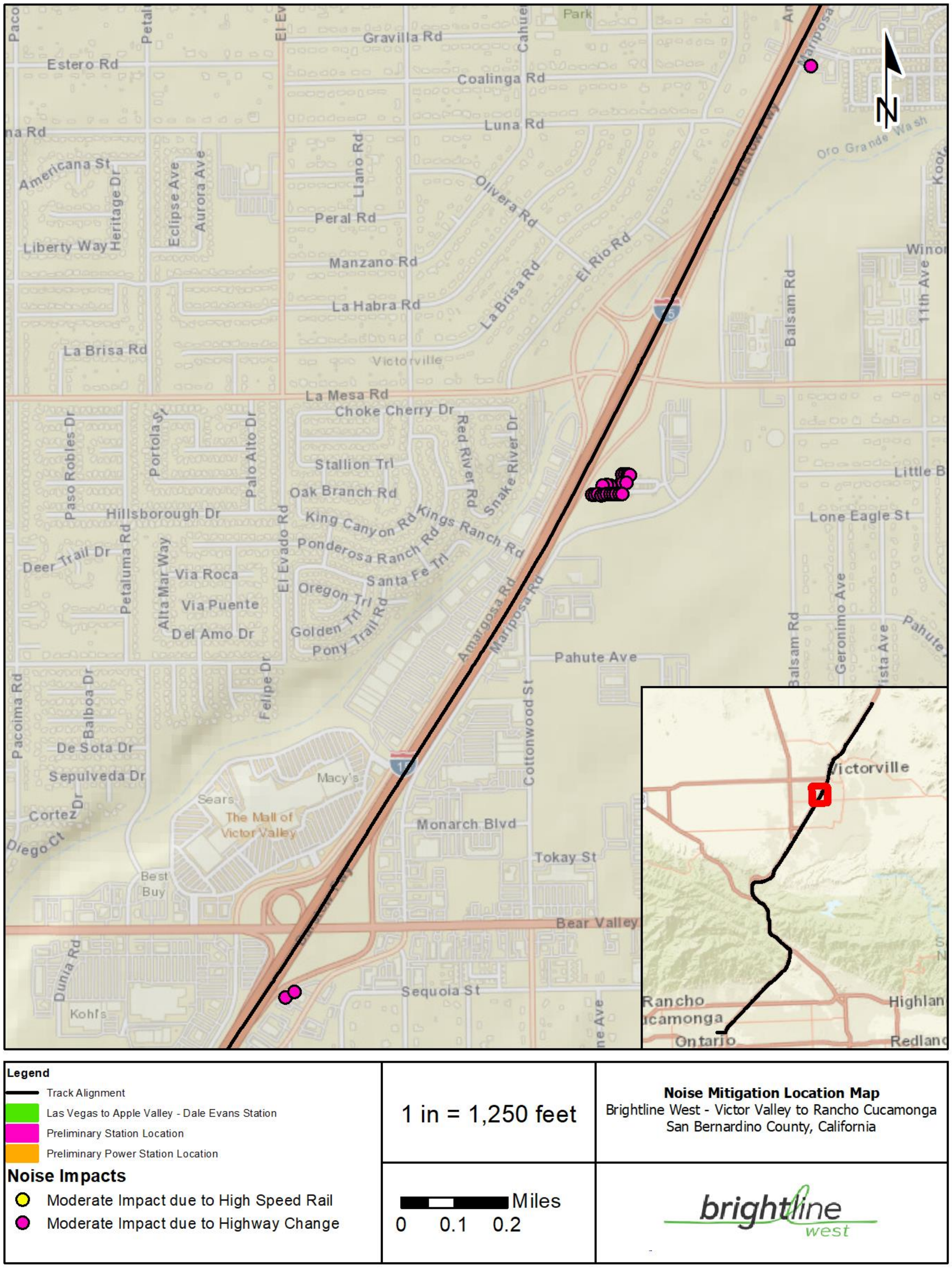

Figure 14. Noise Impact Locations 2 of 3

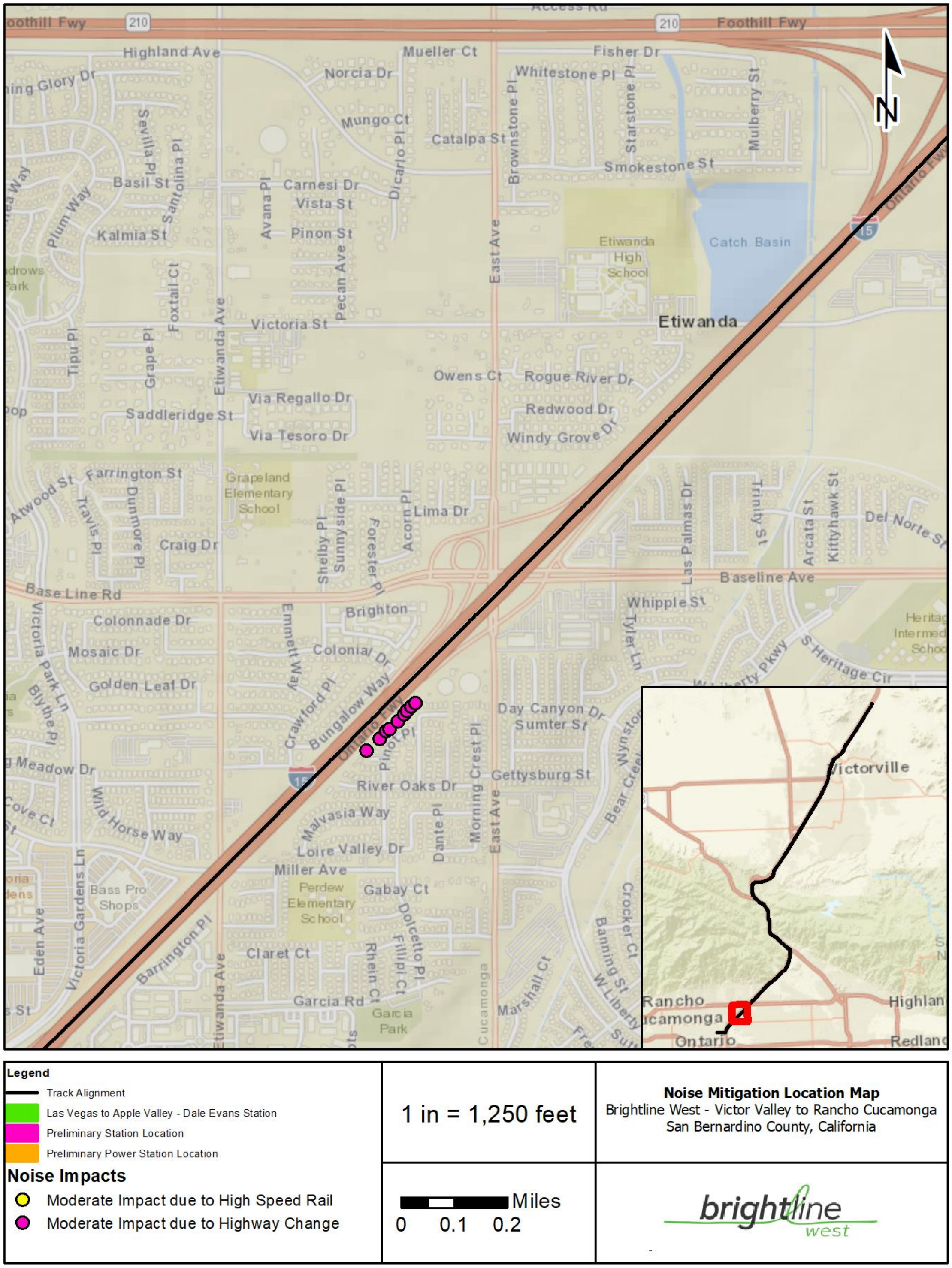

Figure 15. Noise Impact Locations 3 of 3

6.1.2. Vibration

6.1.2.1. Construction Effects

Unlike typical rail operations, there is the potential for damage to nearby structures at close distances due to construction vibration from activities, such as pile driving, hoe rams, vibratory compaction, and loaded trucks. Most limits on construction vibration are based on reducing the potential for damage to nearby structures. Although construction vibrations are only temporary, it is still reasonable to assess the potential for human annoyance and damage.

As a conservative approach, the non-engineered timber and masonry construction category (Category III) has been used to assess the potential for construction vibration impacts. A vibration criterion of 94 VdB has been used to assess potential damage impact, and 72 VdB has been used to assess potential vibration annoyance from construction activities. Vibration source levels at 25 feet and the distances to potential residential annoyance and potential damage are shown in Table 15. With the exception of impact pile driving, the potential for damage is limited to within 25 feet of construction activities. For impact pile driving, the distance for the potential for damage is up to 55 feet but would depend on the piling method chosen.

Because the exact location of construction equipment is important in projecting vibration levels, a more detailed assessment of potential vibration damage will be performed during final design when more accurate equipment locations are known. It is important to note that this assessment does not address potential damage to structures due to soil settlement or displacement due to construction activities.

Table 15. Summary of Potential Construction Vibration Impacts

Equipment Type	Typical Vibration Level at 25 feet (VdB)	Distance for Potential Damage (ft)	Distance for Potential Annoyance (ft)
Impact Pile Driving	104	55	290
Push Piling	84	25	125
Hoe Ram	87	15	80
Caisson Drilling	87	15	80
Loaded Trucks	86	15	75
Clam Shovel	94	25	135
Vibratory Roller	94	25	135

6.1.2.2. Operation Effects

The potential vibration impact from Project operations was assessed on an absolute basis using the FRA criterion of 72 VdB for residential land uses with frequent events. The approach used for assessing vibration impact generally follows the approach used for the noise impact, except that existing vibration is not considered when evaluating impact. For the Project, the estimated root mean square (RMS) velocity levels (VdB re 1 µin./sec) for sensitive receptors at the receptor closest to the tracks in each location is presented in Table 16 for residential land uses and Table 17 for institutional land uses. Each table lists the locations of the closest receptor for each location, the distance to the near track, the train speed, and the projected vibration level in each location. The proposed Project would not result in vibration impact at any residential or institutional locations.

Table 16. Summary of Residential Vibration Impacts

Location	Side of Track	Dist to Near Track (ft)	Max Train Speed (mph)	Project Levels (VdB)	Impact Criteria (VdB)	# of Impacts
Section 1 – High Desert						
Victor Valley Station to N D St	NB	192	100	57	72	0
Victor Valley Station to N D St	SB	165	100	58	72	0
N D St to Mojave Dr	NB	No vibration sensitive receivers.				
N D St to Mojave Dr	SB	137	90	58	72	0
Mojave Dr to Palmdale Rd	NB	No vibration sensitive receivers.				
Mojave Dr to Palmdale Rd	SB	129	80	57	72	0
Palmdale Rd to La Mesa Rd	NB	160	140	60	72	0
Palmdale Rd to La Mesa Rd	SB	202	140	60	72	0
La Mesa Rd to Main St	NB	163	140	60	72	0
La Mesa Rd to Main St	SB	272	140	59	72	0
Main St to Oak Hill Rd	NB	422	120	68	72	0
Main St to Oak Hill Rd	SB	477	120	68	72	0
Section 2 – Cajon Pass						
Oak Hill Rd to W Kenwood Ave	NB	No vibration sensitive receivers.				
Oak Hill Rd to W Kenwood Ave	SB	No vibration sensitive receivers.				
Section 3 – Greater Los Angeles						
W Kenwood Ave to Sierra Ave	NB	212	140	58	72	0
W Kenwood Ave to Sierra Ave	SB	No vibration sensitive receivers.				
Sierra Ave to Rt 210	NB	No vibration sensitive receivers.				
Sierra Ave to Rt 210	SB	256	140	69	72	0
Rt 210 to Base Line Rd	NB	245	140	50	72	0

Rt 210 to Base Line Rd	SB	217	140	52	72	0
Base Line Rd to Arrow Route	NB	177	140	54	72	0
Base Line Rd to Arrow Route	SB	164	140	55	72	0
Arrow Route to Rancho Cucamonga Station	NB	No vibration sensitive receivers.				
Arrow Route to Rancho Cucamonga Station	SB	No vibration sensitive receivers.				
Total:						0

Table 17. Summary of Institutional Vibration Impacts

Name	Location	Side of Track	Dist to Near Track (ft)	Max Train Speed (mph)	Project Levels (VdB)	Criteria	# of Impacts
Section 1 – High Desert							
Grace Christian Preschool	Palmdale Rd to La Mesa Rd	SB	423	140	59	83	0
Victor Valley Apostolic Church	Palmdale Rd to La Mesa Rd	SB	430	140	58	83	0
Desert View Memorial Park	La Mesa Rd to Main St	SB	161	120	59	83	0
Section 3 – Greater Los Angeles*							
Summit Water of Life Church	Sierra Ave to Rt 210	NB	329	140	68	83	0
Sacred Heart Parish School	Base Line Rd to Arrow Route	NB	239	80	46	83	0
*There are no institutional receptors in Section 2.							

Hesperia Station

There would be no vibration impacts associated with the Hesperia Station. There are no sensitive receptors located near the proposed station site.

Rancho Cucamonga Station

There would be no vibration impacts associated with the Rancho Cucamonga Station. There are no sensitive receptors located near the proposed station site.

6.1.3. Cumulative Effects

In general, noise levels would increase in the future due to increases in population and accompanying development as well as potential transportation projects. Overall, community exposure to noise will increase as traffic levels increase. The noise analysis compares project noise levels with the existing noise levels, which is conservative because noise is expected to be higher in the future with population growth and expanded highways. However, highway or rail improvements would need to double their capacity to noticeably increase noise levels for the average person (i.e., an increase of 3 dBA). This is not expected to occur. Project-related construction noise, construction vibration, and operational vibration are expected to be highly localized and are therefore not anticipated to contribute to any significant noise effects. Overall, the Project section's contribution to significant cumulative construction and operational noise and vibration effects is not anticipated to be cumulatively considerable.

6.2. No Build Alternative

6.2.1. Construction Effects

The No Build Alternative does not include any construction and, therefore, would result in no impacts related to construction.

6.2.2. Operation Effects

The No Build Alternative would not result in any noise or vibration impacts. There would likely be increases in highway and local roadway noise due to increased traffic volumes.

6.2.3. Cumulative Effects

The No Build Alternative would not result in any cumulative noise or vibration impacts. There would likely be increases in highway and local roadway noise due to increased traffic volumes.

6.3. Avoidance, Minimization, and/or Mitigation Measures

6.3.1. Construction

Construction activities will be carried out in compliance with all applicable local noise regulations. The following mitigation measures will be applied as needed to minimize temporary construction noise and vibration impacts:

- Avoiding nighttime construction in residential neighborhoods
- Locating stationary construction equipment as far as possible from noise-sensitive sites
- Constructing noise barriers, such as temporary walls or piles of excavated material, between noisy activities and noise-sensitive receivers
- Routing construction-related truck traffic to roadways that will cause the least disturbance to residents, and
- Using alternative construction methods to minimize the use of impact and vibratory equipment (e.g., pile-drivers and compactors).

Contractors would also be required to prepare a detailed Noise Control Plan. A noise control engineer or acoustician will work with the contractor to prepare a Noise Control Plan in conjunction with the contractor's specific equipment and methods of construction. Key elements of a Plan include:

- Contractor's specific equipment types
- Schedule and methods of construction
- Maximum noise limits for each piece of equipment with certification testing
- Prohibitions on certain types of equipment and processes during the nighttime hours without local agency coordination and approved variances
- Identification of specific sensitive sites where near construction sites
- Methods for projecting construction noise levels
- Implementation of noise control measures where appropriate
- Methods for responding to community complaints.

6.3.2. Operational Noise

Because all of the noise impacts are in the low end of the moderate noise impact range, the impacts would not be considered adverse under NEPA, and no mitigation would be required. However, Caltrans and Brightline will work together as a part of Caltrans permitting and approvals process as the project moves into the design state to investigate locations where mitigation might be an option. Measures could include noise barriers along the rail alignment, noise barriers along the highway right of way, or other methods to minimize residential noise effects.

6.3.3. Operational Vibration

No vibration impacts have been identified for the Project, so no vibration mitigation is recommended.

7. References

Federal Highway Administration (FHWA). 2006. FHWA Construction Noise Handbook. Final Report FHWA-HEP-06-015.

Federal Transit Administration (FTA). 2018. Transit Noise and Vibration Impact Assessment Manual. FTA Report No. 0123. Federal Transit Administration, John A. Volpe National Transportation System Center and Cross-Spectrum Acoustics Inc.

Federal Railroad Administration (FRA). 2012. *High-Speed Ground Transportation Noise and Vibration Impact Assessment. Final Report DOT/FRA/ORD-12/15*.

Federal Railroad Administration (FRA). 2020. *National Environmental Policy Act Reevaluation for the DesertXpress Enterprises, LLC Xpresswest High-Speed Train Project, Apple Valley, CA to Las Vegas, NV*. September 2020.

Appendix A

Noise Measurement Site Photographs

Figure A-1: Long-Term Noise Measurement Site LT-2 7420 Bungalow Way

Figure A-2: Long-Term Noise Measurement Site LT-3 15165 Crane Street

Figure A-3: Long-Term Noise Measurement Site LT-4 3733 Bur Oak Road

Figure A-4: Long-Term Noise Measurement Site LT-5 13296 Amargesa Road

Figure A-5: Long-Term Noise Measurement Site LT-6 15665 Kingswood Drive

Figure A-6: Long-Term Noise Measurement Site LT-7 14983 S Culver Road

Figure A-7: Long-Term Noise Measurement Site LT-8 15410 La Paz Drive

Figure A-8: Long-Term Noise Measurement Site LT-9 17251 Dante Street

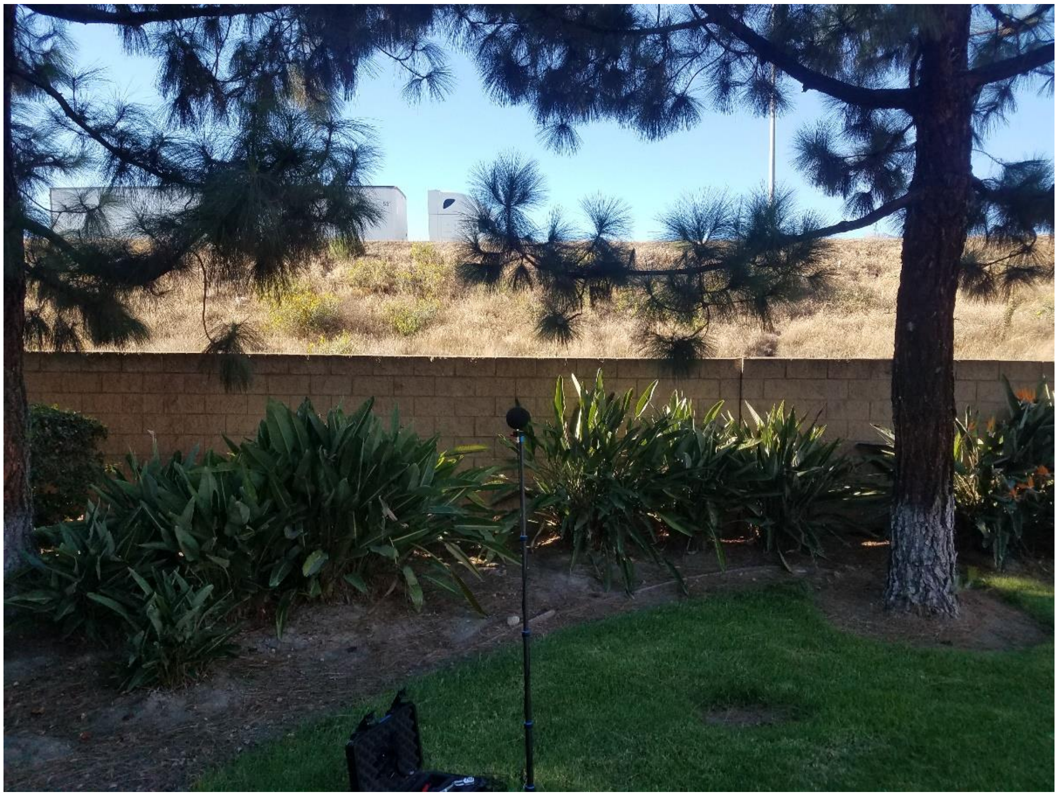

Figure A-9: Short-Term Noise Measurement Site ST-2 7950 Etiwanda Avenue

Figure A-10: Short-Term Noise Measurement Site ST-3 Needle Avenue

Figure A-11: Short-Term Noise Measurement Site ST-5 Farmington Street and Mariposa Road

Figure A-12: Short-Term Noise Measurement Site ST-6 11335 Verde Avenue

Figure A-13: Short-Term Noise Measurement Site ST-7 16424 E Street

Figure A-14: Short-Term Noise Measurement Site ST-8 15834 Joshua Street

Appendix B

Vibration Measurement Site Photographs

Figure B-1: Transfer Mobility Measurement Site V-1 7540 Crawford Place

Figure B-2: Transfer Mobility Measurement Site V-2 5065 Coyote Canyon Road

Figure B-3: Transfer Mobility Measurement Site V-3 Bur Oak Road at Anise Drive

Figure B-4: Transfer Mobility Measurement Site V-4 11412 Fashion Court

Figure B-5: Transfer Mobility Measurement Site V-5 Fox Trail and Santa Fe Trail

Figure B-6: Transfer Mobility Measurement Site V-6 16338 Avalon Avenue (Avalon Park)

Appendix C

Noise Measurement Data

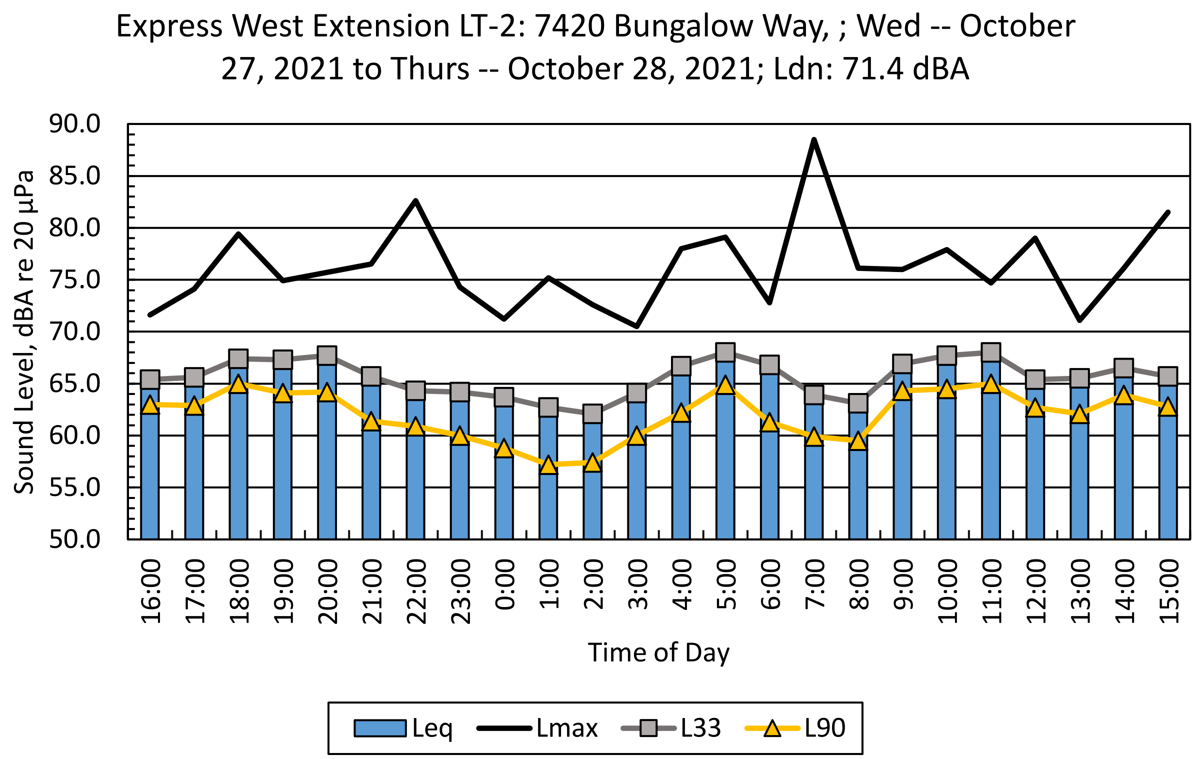

Figure C-1: Long-Term Noise Measurement Site LT-2 7420 Bungalow Way

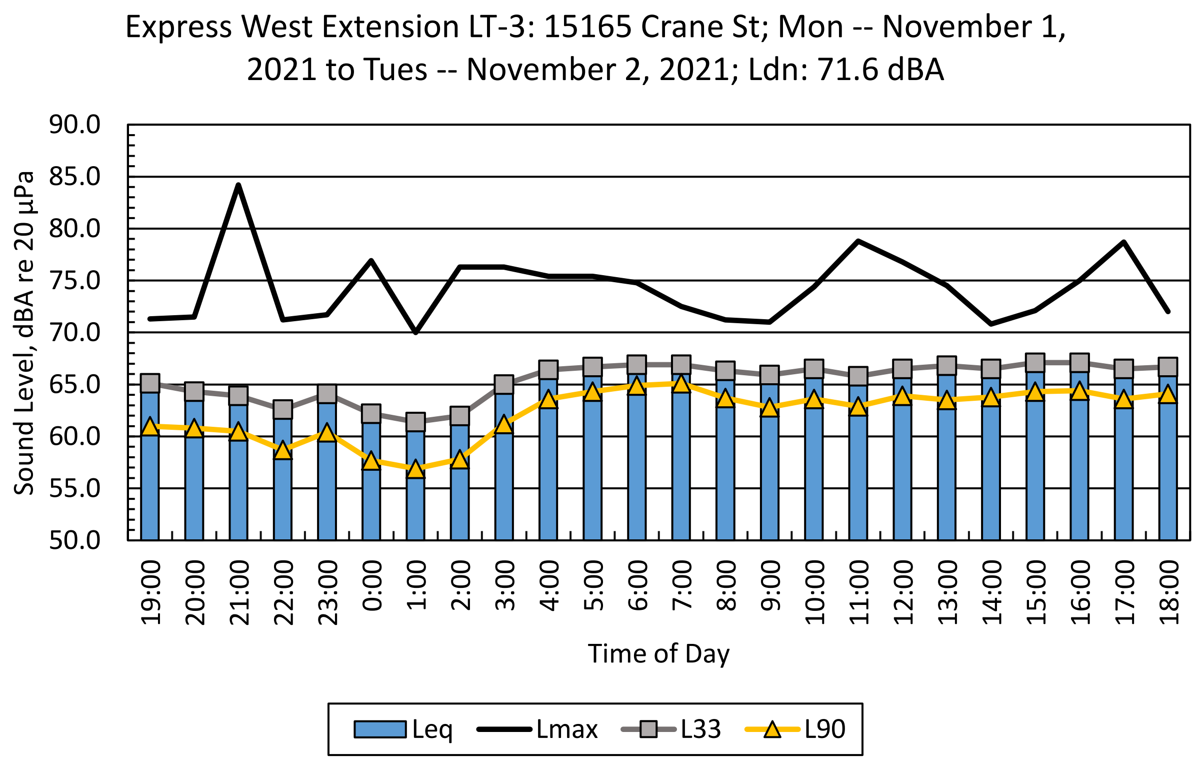

Figure C-2: Long-Term Noise Measurement Site LT-3 15165 Crane Street

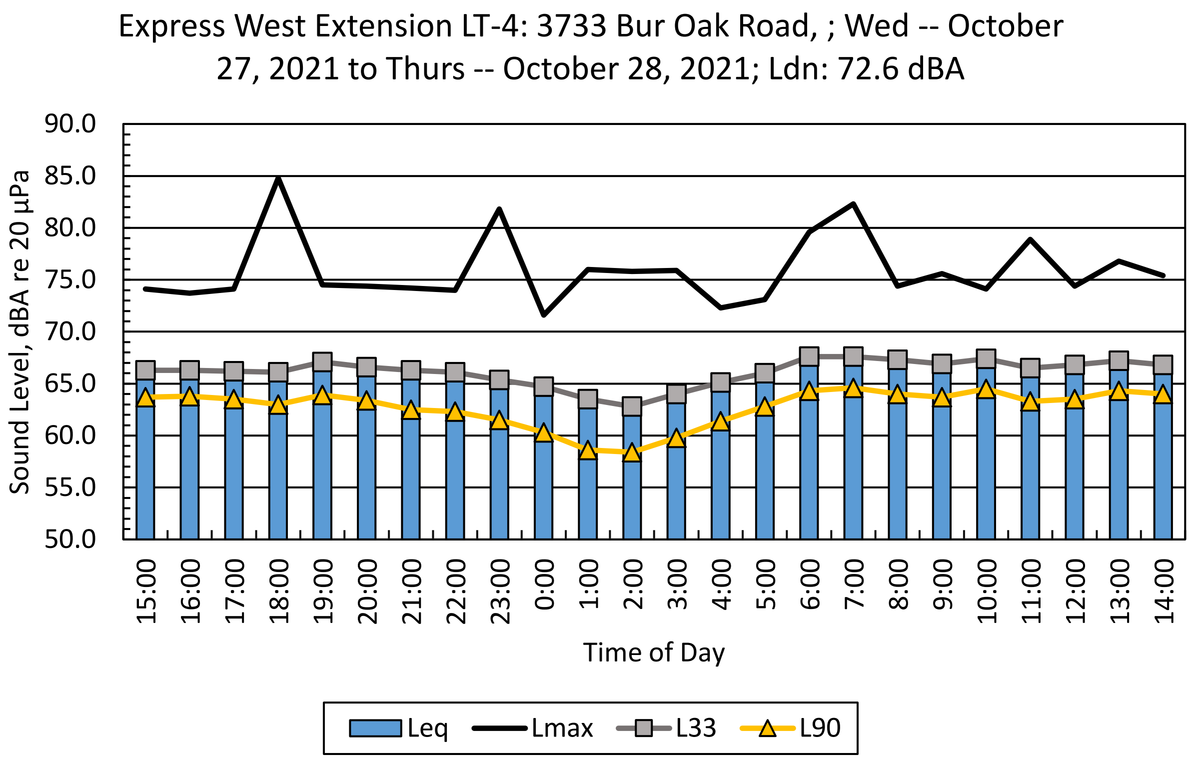

Figure C-3: Long-Term Noise Measurement Site LT-4 3733 Bur Oak Road

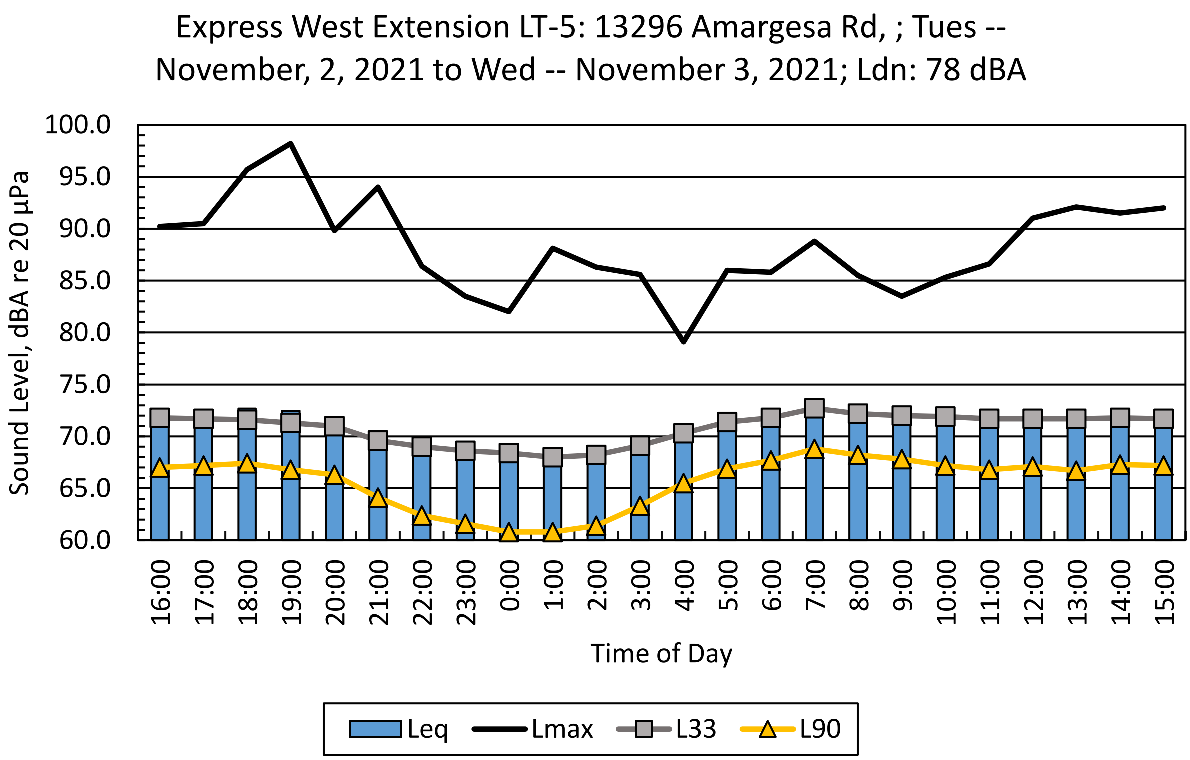

Figure C-4: Long-Term Noise Measurement Site LT-5 13296 Amargesa Road

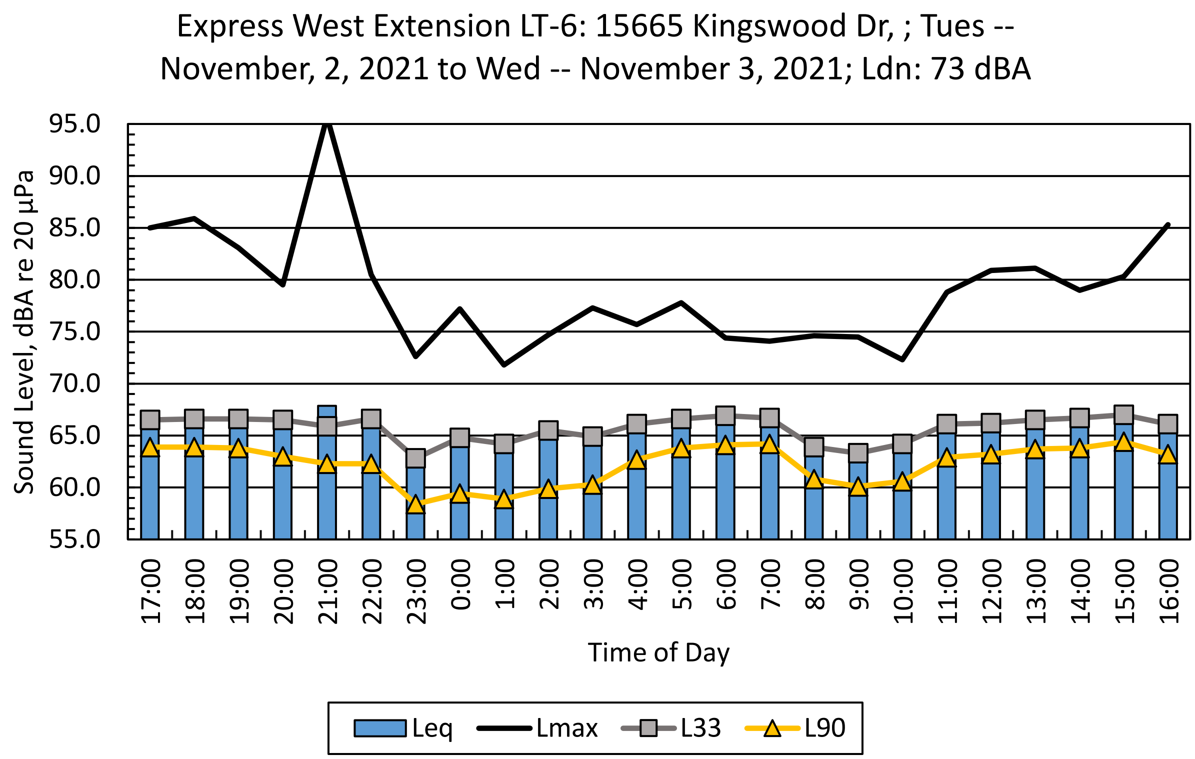

Figure C-5: Long-Term Noise Measurement Site LT-6 15665 Kingswood Drive

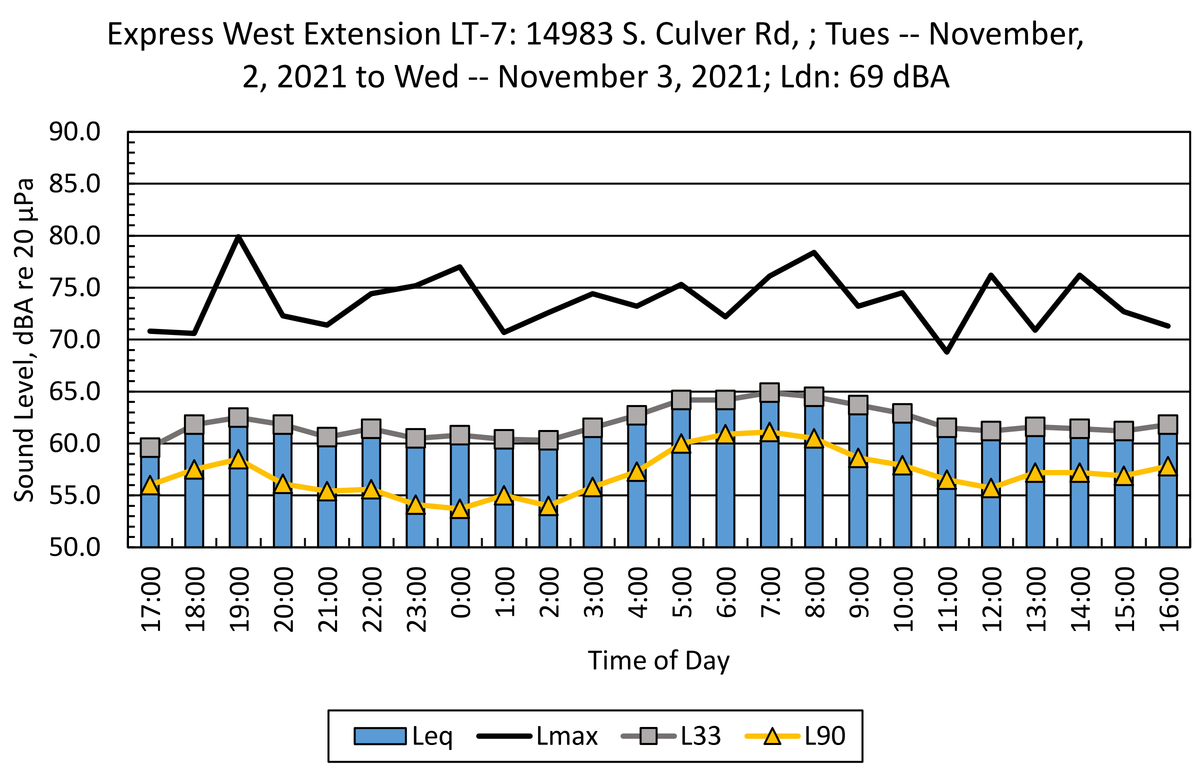

Figure C-6: Long-Term Noise Measurement Site LT-7 14983 S Culver Road

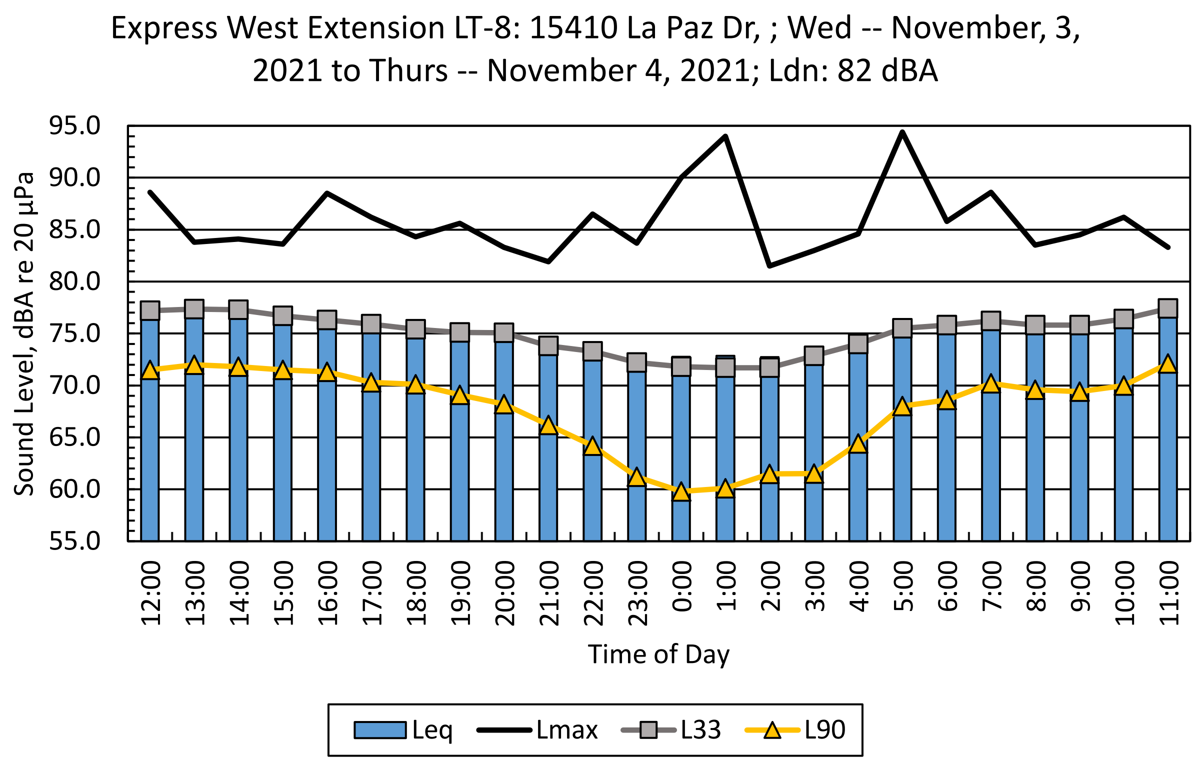

Figure C-7: Long-Term Noise Measurement Site LT-8 15410 La Paz Drive

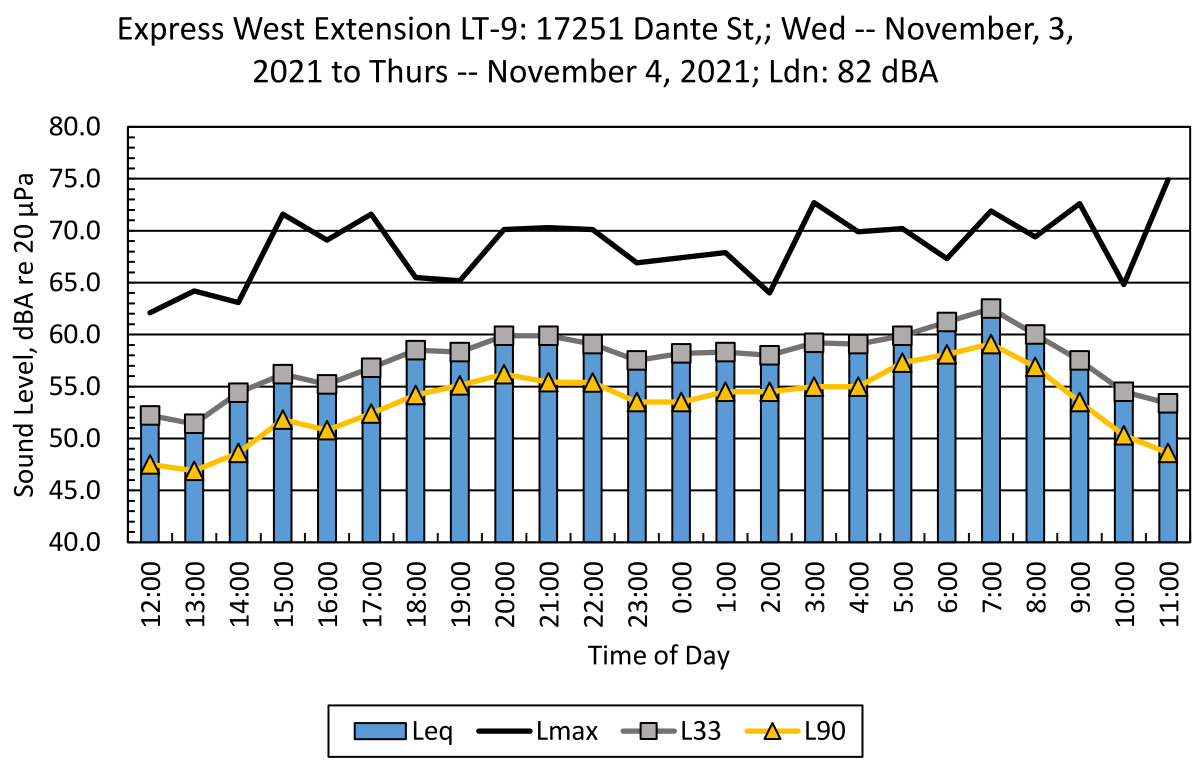

Figure C-8: Long-Term Noise Measurement Site LT-9 17251 Dante Street

Appendix D

Vibration Measurement Data

Table D-1: Site V-1 7540 Crawford Place 1/3-Octave Band Transfer Mobility Coefficients

Coeff.	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	107.3	101.5	92.2	79.9	72.7	75.9	79.6	91.7	101.7	101.2	123.2	128.2	149.2	149.1	147.6	105.7
B	-52.7	-49.1	-42.5	-33.7	-28.2	-27.5	-27.2	-33.4	-39.8	-39.8	-54.6	-58.6	-73.6	-76.5	-77.4	-56.7
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$LSTM = A + B * \log(dist) + C * \log(dist)^2$$

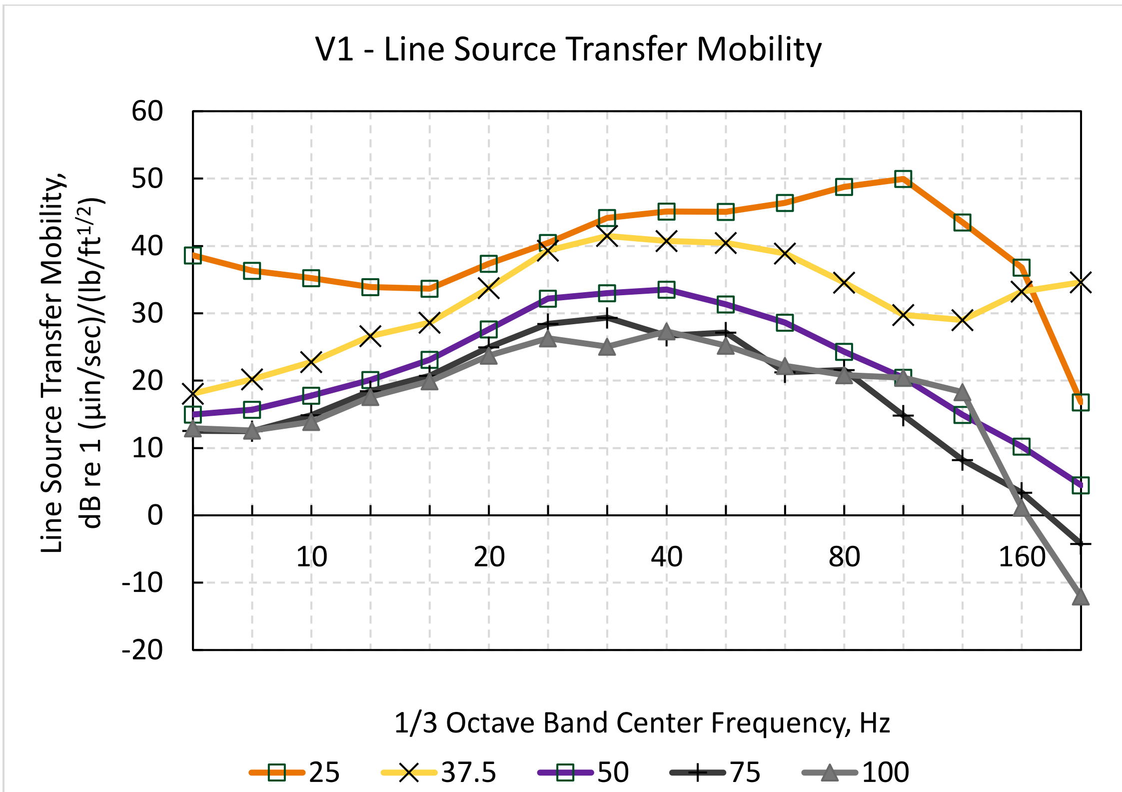

Figure D-1: Line Source Transfer Mobility Site V-1 7540 Crawford Place

Table D-2: Site V-2 2065 Coyote Canyon Road 1/3-Octave Band Transfer Mobility Coefficients

Coeff.	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	62.1	68.8	51.4	44.4	50.5	73.9	55.1	63.9	74.2	86.1	92.3	89.7	87.7	88.4	74.4	60.2
B	-17.9	-22.0	-14.2	-10.4	-11.0	-21.2	-11.7	-15.2	-19.8	-26.4	-30.5	-31.0	-32.8	-38.6	-32.9	-29.8
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$LSTM = A + B * \log(dist) + C * \log(dist)^2$$

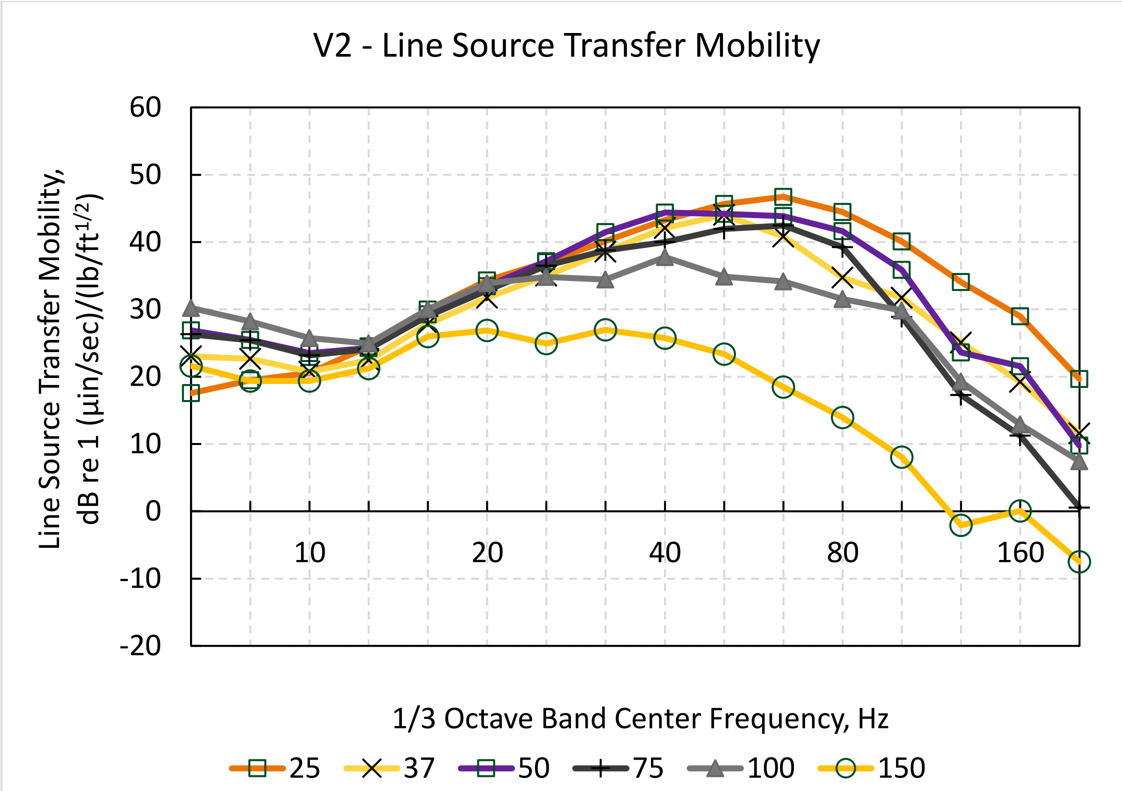

Figure D-2: Line Source Transfer Mobility Measurement Site V-2 5065 Coyote Canyon Road

Table D-3: Site V-3 Bur Oak Road at Anise Drive 1/3-Octave Band Transfer Mobility Coefficients

Coeff.	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	30.8	25.4	31.5	33.6	38.9	36.4	46.6	58.3	69.8	80.0	89.9	108.5	113.2	109.2	110.1	117.9
B	-7.7	-6.2	-9.7	-11.4	-14.2	-10.3	-13.7	-18.8	-24.2	-29.5	-35.1	-46.8	-50.2	-51.1	-54.1	-62.1
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$LSTM = A + B * \log(dist) + C * \log(dist)^2$$

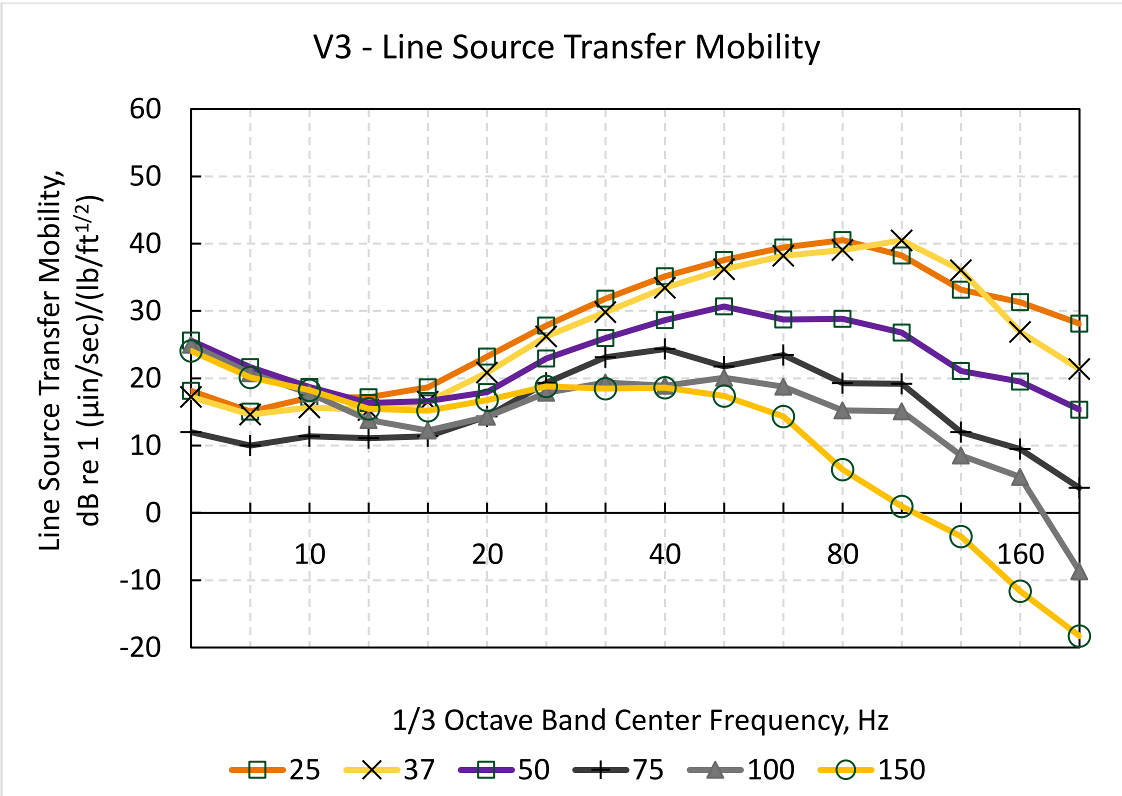

Figure D-3: Line Source Transfer Mobility Measurement Site V-3 Bur Oak Road at Anise Drive

Table D-4: Site V-4 11412 Fashion Court 1/3-Octave Band Transfer Mobility Coefficients

Coeff.	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	28.6	27.1	24.3	41.9	48.6	59.7	71.8	84.5	85.8	85.7	88.9	89.8	104.1	95.9	98.7	103.0
B	-1.7	-2.6	-2.0	-11.9	-14.1	-20.4	-26.6	-34.8	-38.2	-40.1	-43.0	-44.9	-56.0	-52.0	-55.0	-60.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$LSTM = A + B * \log(dist) + C * \log(dist)^2$$

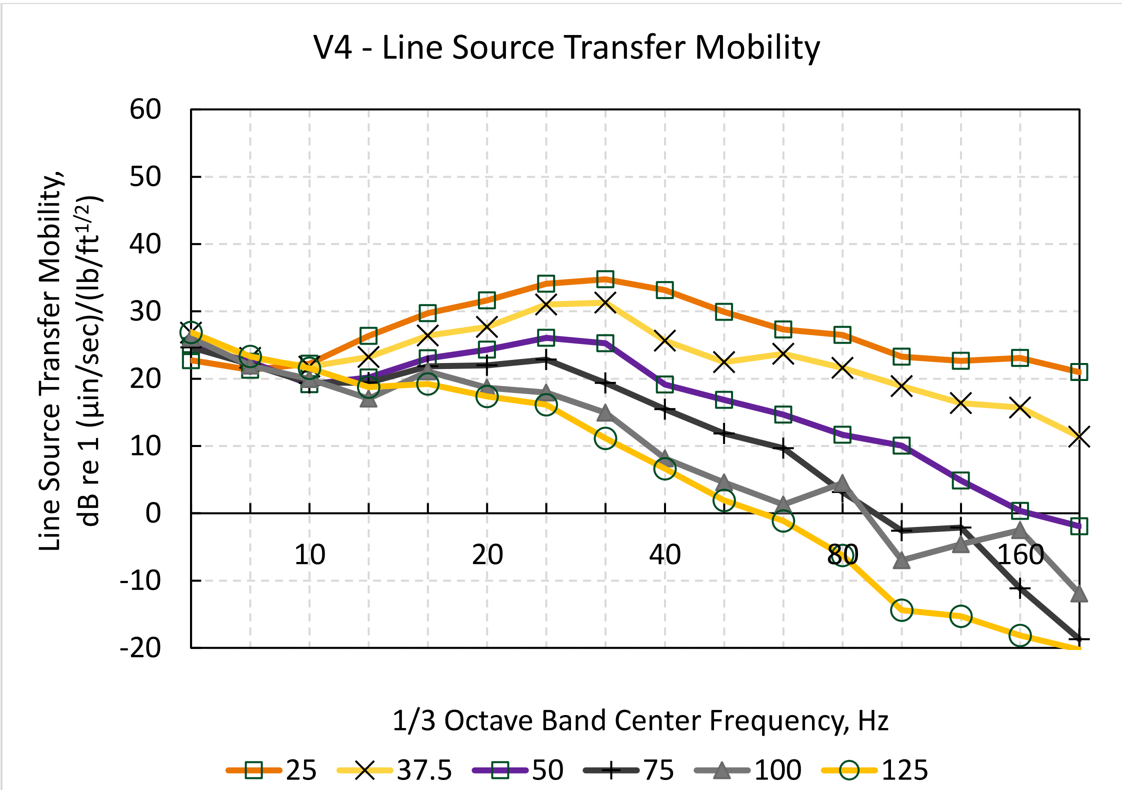

Figure D-4: Line Source Transfer Mobility Measurement Site V-4 11412 Fashion Court

Table D-5: Site V-5 Fox Trail and Santa Fe Trail 1/3-Octave Band Transfer Mobility Coefficients

Coeff.	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	89.8	25.5	18.5	30.8	41.4	46.2	49.2	61.5	71.8	83.7	99.4	96.4	110.2	97.0	77.4	78.0
B	-38.1	-3.8	-1.8	-8.6	-13.9	-15.0	-15.4	-21.9	-28.6	-37.0	-49.9	-52.1	-65.3	-63.9	-53.1	-52.6
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$LSTM = A + B * \log(dist) + C * \log{(dist)}^2$$

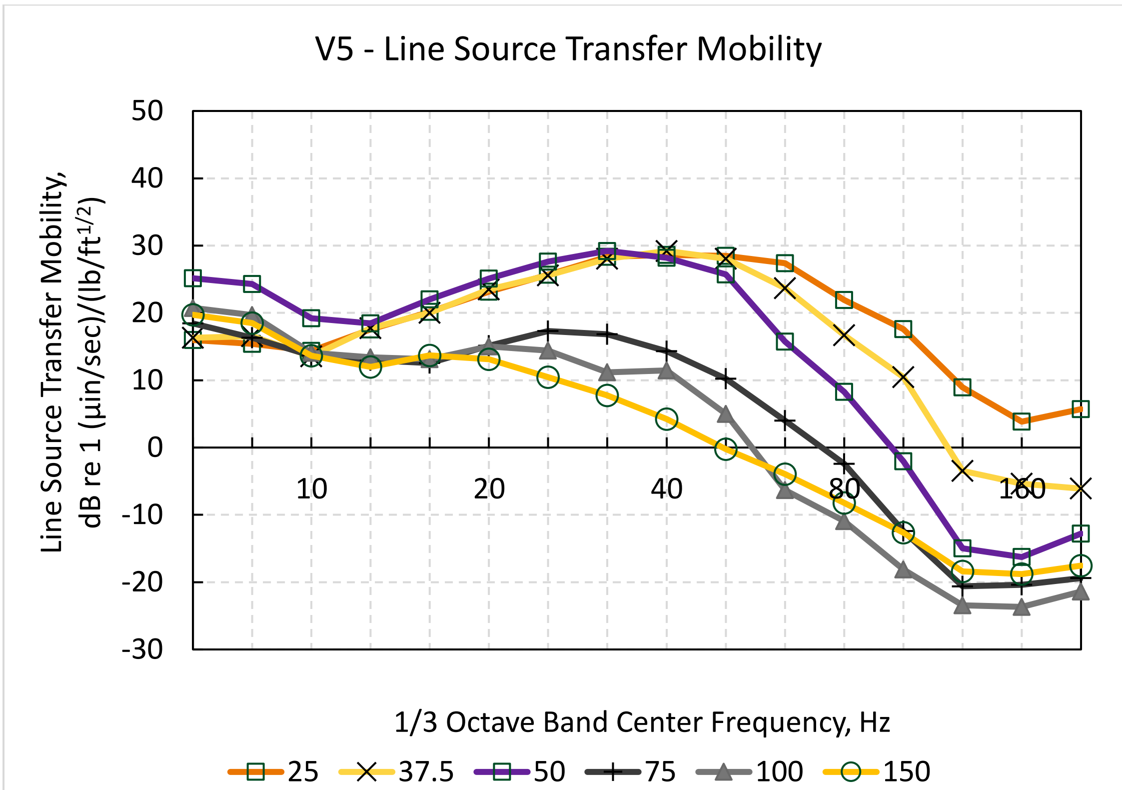

Figure D-5: Line Source Transfer Mobility Measurement Site V-5 Fox Trail and Santa Fe Trail

Table D-6: Site V-6 16338 Avalon Avenue (Avalon Park) 1/3-Octave Band Transfer Mobility Coefficients

Coeff.	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	25.2	30.7	36.8	43.6	46.7	58.3	79.9	110.8	123.4	105.5	71.9	57.0	28.5	29.9	44.0	87.3
B	-4.3	-8.5	-12.0	-14.4	-14.2	-18.2	-27.5	-40.3	-46.1	-40.3	-27.9	-25.6	-13.9	-17.1	-27.1	-60.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$LSTM = A + B * \log(dist) + C * \log(dist)^2$$

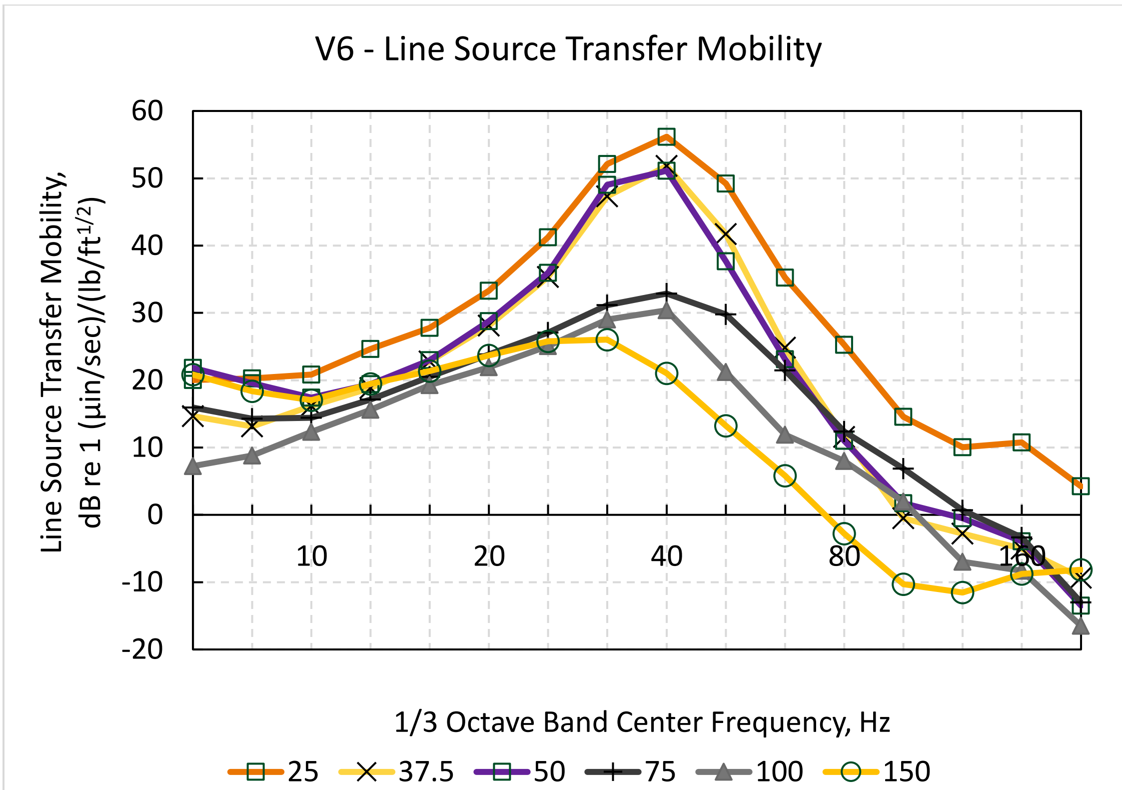

Figure D-6: Line Source Transfer Mobility Measurement Site V-6 16338 Avalon Avenue (Avalon Park)