CALIFORNIA HIGH-SPEED TRAIN

Program Environmental Impact Report/Environmental Impact Statement

Los Angeles to Bakersfield

NOISE & VIBRATION TECHNICAL EVALUATION

January 2004

Prepared for:

California High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

CALIFORNIA HIGH SPEED RAIL AUTHORITY

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CALIFORNIA HIGH-SPEED TRAIN PROGRAM EIR/EIS

Los Angeles to Bakersfield Noise & Vibration Technical Evaluation

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ACRONYMS

AUTHORITY	CALIFORNIA HIGH-SPEED RAIL
CEQA	CALIFORNIA ENVIRONMENTAL QUALITY ACT
COG	COUNCIL OF GOVERNMENTS
EIR	ENVIRONMENTAL IMPACT REPORT
EIS	ENVIRONMENTAL IMPACT STATEMENT
EPA	ENVIRONMENTAL PROTECTION AGENCY
FAA	FEDERAL AVIATION ADMINISTRATION
FHWA	FEDERAL HIGHWAY ADMINISTRATION
FRA	FEDERAL RAILROAD ADMINISTRATION
FTA	FEDERAL TRANSIT ADMINISTRATION
GIS	GEOGRAPHIC INFORMATION SYSTEM
HSR	HIGH SPEED RAIL
HST	HIGH SPEED TRAINS
HUD	DEPARTMENT OF HOUSING & URBAN DEVELOPMENT
IM	IMPACT METRIC
IR	IMPACT RATING
MTA	METROPOLITAN TRANSPORTATION AUTHORITY
MU	MIXED USE (COMMERCIAL AND RESIDENTIAL LAND USE)
NEPA	NATIONAL ENVIRONMENTAL POLICY ACT
RTP	REGIONAL TRANSPORTATION PLAN
TNM	TRAFFIC NOISE MODEL
USACE	U.S. CORPS OF ENGINEERS

1.0 INTRODUCTION

The California High-Speed Rail Authority (Authority) was created by the Legislature in 1996 to develop a plan for the construction, operation, and financing of a statewide, intercity high-speed passenger train system.[1] After completing a number of initial studies over the past six years to assess the feasibility of a high-speed train system in California and to evaluate the potential ridership for a variety of alternative corridors and station areas, the Authority recommended the evaluation of a proposed high-speed train system as the logical next step in the development of California's transportation infrastructure. The Authority does not have responsibility for other intercity transportation systems or facilities, such as expanded highways, or improvements to airports or passenger rail or transit used for intercity trips.

The Authority adopted a *Final Business Plan* in June 2000, which reviewed the economic feasibility of a 1,127-kilometer-long (700-mile-long) high-speed train system. This system would be capable of speeds in excess of 321.8 kilometers per hour (200 miles per hour [mph]) on a dedicated, fully grade-separated track with state-of-the-art safety, signaling, and automated train control systems. The system described would connect and serve the major metropolitan areas of California, extending from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and San Diego. The high-speed train system is projected to carry a minimum of 42 million passengers annually (32 million intercity trips and 10 million commuter trips) by the year 2020.

Following the adoption of the Business Plan, the appropriate next step for the Authority to take in the pursuit of a high-speed train system is to satisfy the environmental review process required by federal and state laws which will in turn enable public agencies to select and approve a high speed rail system, define mitigation strategies, obtain necessary approvals, and obtain financial assistance necessary to implement a high speed rail system. For example, the Federal Railroad Administration (FRA) may be requested by the Authority to issue a *Rule of Particular Applicability*, which establishes safety standards for the high-speed train system for speeds over 200 mph, and for the potential shared use of rail corridors.

The Authority is both the project sponsor and the lead agency for purposes of the California Environmental Quality Act (CEQA) requirements. The Authority has determined that a Program Environmental Impact Report (EIR) is the appropriate CEQA document for the project at this conceptual stage of planning and decision-making, which would include selecting a preferred corridor and station locations for future right-of-way preservation and identifying potential phasing options. No permits are being sought for this phase of environmental review. Later stages of project development would include project-specific detailed environmental documents to assess the potential impacts of the alternative alignments and stations in those segments of the system that are ready for implementation.

The decisions of federal agencies, particularly the Federal Railroad Administration (FRA) related to high-speed train systems, would constitute major federal actions regarding environmental review under the National Environmental Policy Act (NEPA). NEPA requires federal agencies to prepare an Environmental Impact Statement (EIS) if the proposed action has the potential to cause significant environmental impacts. The proposed action in California warrants the preparation of a Tier 1 Program-level EIS under NEPA, due to the nature and scope of the comprehensive high-speed train system proposed by the Authority, the need to narrow the range of alternatives, and the need to protect/preserve right-of-way in the future. FRA is the federal lead agency for the preparation of the Program EIS, and the Federal Highway Administration (FHWA), the U.S. Environmental Protection Agency (EPA), the U.S. Corps of Engineers (USACE), the Federal Aviation Administration (FAA), the U.S. Fish and Wildlife Service (USFWS), and the Federal Transit Administration (FTA) are cooperating federal agencies for the EIS.

[1] Chapter 796 of the Statutes of 1996; SB 1420, Kopp and Costa

A combined Program EIR/EIS is to be prepared under the supervision and direction of the FRA and the Authority in conjunction with the federal cooperating agencies. It is intended that other federal, state, regional, and local agencies will use the Program EIR/EIS in reviewing the proposed program and developing feasible and practicable programmatic mitigation strategies and analysis expectations for the Tier 2 detailed environmental review process which would be expected to follow any approval of a high speed train system.

The statewide high-speed train system has been divided into five regions for study: Bay Area-Merced, Sacramento-Bakersfield, Bakersfield-Los Angeles, Los Angeles-San Diego via the Inland Empire, and Los Angeles-Orange County-San Diego. This Noise and Vibration Technical Evaluation for the Los Angeles to Bakersfield corridor is one of five such reports being prepared for each of the regions on the topic, and it is one of fifteen technical reports for this region. This report will be summarized in the Program EIR/EIS and it will be part of the administrative record supporting the environmental review of alternatives.

1.1 ALTERNATIVES (NO-PROJECT, MODAL, HST)

1.1.1. No-Project Alternative

The No-Project Alternative serves as the baseline for comparison of the Modal and High-Speed Train Alternatives. The No-Project Alternative represents the state's transportation system (highway, air, and conventional rail) as it existed in 1999-2000, and as it would be after completion of programs or projects currently programmed for implementation and projects with funding expected by 2020 (Figure 1). The No-Project Alternative addresses the geographic area serving the same intercity travel market as the proposed high-speed train (generally from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and San Diego). The No-Project Alternative satisfies the statutory requirements under CEQA and NEPA for an alternative that does not include any new action or project beyond what is already committed.

The No-Project Alternative defines the existing and future statewide intercity transportation system based on programmed and funded (already in funded programs/financially constrained plans) improvements to the intercity transportation system through 2020, according to the following sources of information:

- State Transportation Improvement Program (STIP)
- Regional Transportation Plans (RTPs) for all modes of travel
- Airport plans
- Intercity passenger rail plans (California Rail Plan 2001-2010, Amtrak Five- and Twenty-year Plans)

As with all of the alternatives, the No-Project Alternative will be assessed against the purpose and need topics/objectives for congestion, safety, air pollution, reliability, and travel times.

Figure 1
No-Project Alternative – California Transportation System (Present to 2020)

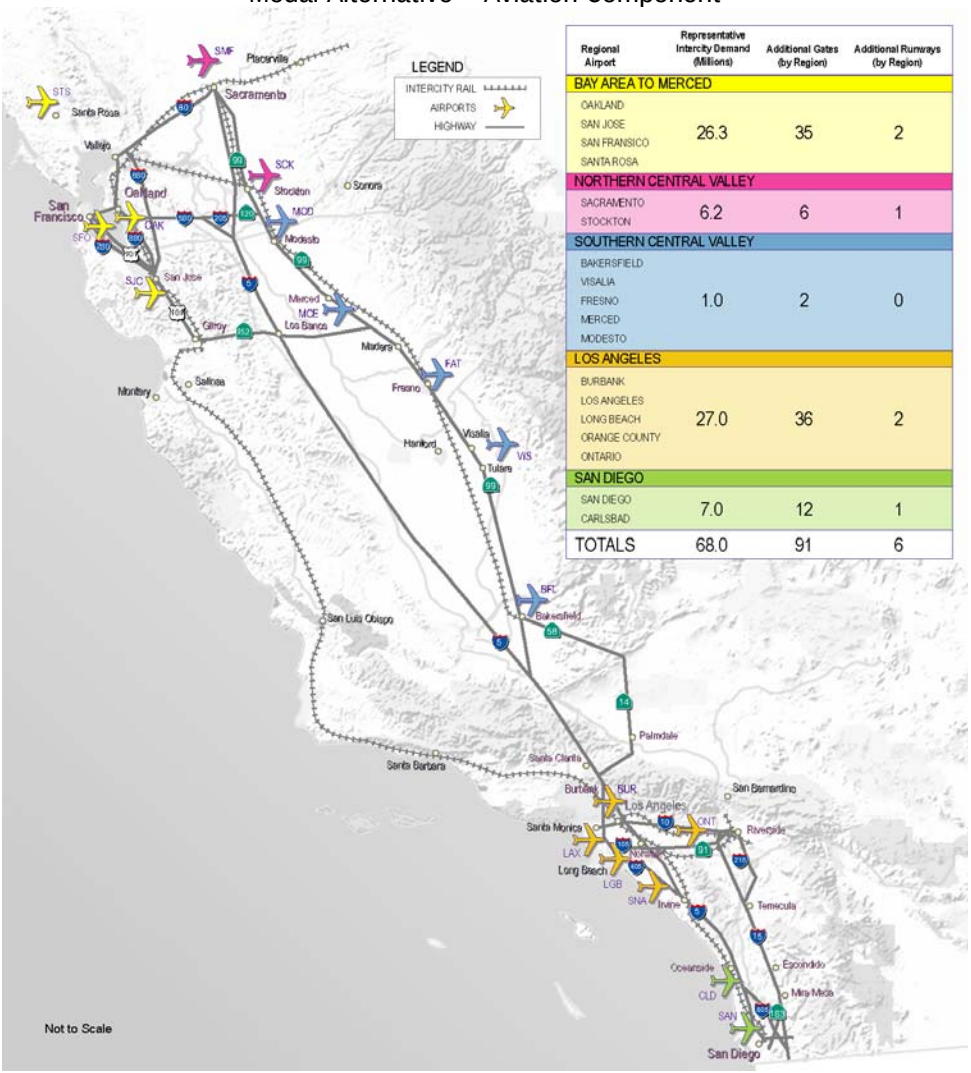
1.1.2 Modal Alternative

There are currently only three main options for intercity travel between the major urban areas of San Diego, Los Angeles, the Central Valley, San Jose, Oakland/San Francisco, and Sacramento: vehicles on the interstate highway system and state highways, commercial airlines serving airports between San Diego and Sacramento and the Bay Area, and conventional passenger trains (Amtrak, etc.) on freight and/or commuter rail tracks. The Modal Alternative consists of expansion of highways (Figure 2), airports (Figure 3), and intercity and commuter rail systems serving the markets identified for the High-Speed

Train Alternative. The Modal Alternative uses the same inter-city travel demand (not capacity) assumed under the high-end sensitivity analysis completed for the high-speed train ridership in 2020. This same travel demand is assigned to the highways and airports and passenger rail described under the No-Project Alternative, and the additional improvements or expansion of facilities is assumed to meet the demand, regardless of funding potential and without high-speed train service as part of the system.

Figure 2
Modal Alternative – Highway Component

Figure 3
Modal Alternative – Aviation Component



Regional Airport	Representative Intercity Demand (Millions)	Additional Gates (by Region)	Additional Runways (by Region)
BAY AREA TO MERCED			
OAKLAND SAN JOSE SAN FRANSICO SANTA ROSA	26.3	35	2
NORTHERN CENTRAL VALLEY			
SACRAMENTO STOCKTON	6.2	6	1
SOUTHERN CENTRAL VALLEY			
BAKERSFIELD VISALIA FRESNO MERCED MODESTO	1.0	2	0
LOS ANGELES			
BURBANK LOS ANGELES LONG BEACH ORANGE COUNTY ONTARIO	27.0	36	2
SAN DIEGO			
SAN DIEGO CARLSBAD	7.0	12	1
TOTALS	68.0	91	6

1.1.3 High-Speed Train Alternative

The Authority has defined a statewide high-speed train system capable of speeds in excess of 200 miles per hour (mph) (320 kilometers per hour [km/h]) on dedicated, fully grade-separated tracks, with state-of-the-art safety, signaling, and automated train control systems. State of the art high-speed steel-wheel-on-steel-rail technology is being considered for the system that would serve the major metropolitan centers of California, extending from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and San Diego (Figure 4).

The High-Speed Train Alternative includes several corridor and station options. A steel-wheel on steel-rail, electrified train, primarily on exclusive right-of-way with small portions of the route on shared track with other rail is planned. Conventional "non-electric" improvements are also being considered along the existing LOSSAN rail corridor from Los Angeles to San Diego. The train track would be either at-grade, in an open trench or tunnel, or on an elevated guideway, depending on terrain and physical constraints.

For purposes of comparative analysis the HST corridors will be described from station-to-station within each region, except where a by-pass option is considered when the point of departure from the corridor will define the end of the corridor segment. Segment and subsegment labels and civil station numbers taken from the project plans and data are also used to identify corridor locations.

Figure 4
High-Speed Train Alternative – Overview and Areas Served

2.0 BASELINE/AFFECTED ENVIRONMENT

2.1 STUDY AREA

The Study Area for noise and vibration assessment is defined by the screening distances established by FRA and FTA for rail and highway corridors. In all cases, the areas are confined to within 1000 feet from the center of the proposed corridor. For airport noise, the area is confined to within the Ldn 65 noise contour established for the particular airport. This is the extent of area where a change in noise would be most noticeable to receivers, and new projects could begin to dominate the noise environment.

2.2 GENERAL DESCRIPTION OF REGIONAL NOISE & VIBRATION ENVIRONMENTS

Regional noise and vibration environments are generally dominated by transportation-related sources, including vehicle traffic on freeways, highways, and other major roads, existing passenger and freight rail operations, and aviation sources, including civilian and military.

Noise contours for major road and rail corridors are required by the State of California to be part of community (city and county) General Plan documents. Contours for road and rail corridors can also be estimated using Table 5-7 of the FTA *Transit Noise and Vibration Impact Assessment* Manual. In this study, existing noise contours for the No-Project Alternative and Representative Cases (typologies) were estimated according to the FTA procedures because of the high number of communities involved. The FTA procedures also allow noise contour estimation based on the local population density, and this method was also used in this study, particularly for Representative Cases at portions of the HST Alternative that would be new corridors.

Near airports, regional noise environments will be dominated by aircraft operations. Major civil and military airports are required to produce noise contour maps to assist local agencies with land development and zoning. Operational growth at a particular airport may also be studied from a noise basis using noise contour maps. The 65 Ldn contour is typically considered to be the transition between aviation and vehicle traffic dominated noise environments, although aircraft flyovers can remain a measurable part of the local noise environment outside of the 65 Ldn airport noise contour.

2.3 SENSITIVE NOISE & VIBRATION LAND USE LOCATIONS

The screening study includes residential, institutional, and park areas as noise and vibration sensitive land uses. All residential zones within the screening distances defined for highways and HST corridors were included in the study. Institutional locations for the study included schools, hospitals, and historic structures within the screening distances. All sensitive land use locations were determined from GIS data and project plans for the region.

2.4 REPRESENTATIVE NOISE & VIBRATION TYPOLOGIES IN REGION

Representative land use typologies for the region were selected from residential, institutional, and park uses within the study screening areas for the HST Alternative. For the Bakersfield to Los Angeles region, the land use typologies selected for individual study are as follows:

Table 2.4.1 Representative Typology by Cases for Region

Bakersfield to Los Angeles

Alignment/Segment	Location/Description	City/County	Land Use Type	Distance (ft)*
Wheeler	Near Poinsettia & Virginia	Bakersfield	Residential	50
Union	Union & 8th	Bakersfield	Residential	130
SR-58	SR-14 & Backus	Kern County	Residential	700
Antelope Valley	W Rosemond Avenue	Rosemond	Residential	100
Antelope Valley	Along Sierra Highway	Lancaster	Residential.	450
Soledad Canyon	Aliso Canyon Rd.	Kern County	Residential	400
Soledad Canyon	Soledad Canyon Rd.	Santa Clarita	Residential	900
Metrolink UPRR Sylmar Station Siding	Along rail near Hubbard Ave	Los Angeles	Residential.	250
Metrolink/ UPRR Glendale	Brand Blvd	Glendale	Residential	50
SR-58	Kern County Preventorium	Kern County	Hospital	150
Burbank Airport siding	Pacific Hospital near Burbank Airport siding	Los Angeles	Hospital	550
Union	Union Ave School along Union Ave. @ Casa Loma	Bakersfield	School	100
Burbank Airport siding	Washington Elementary School along I-5 near Burbank Airport	Burbank	School	700
Burbank Airport siding	Sun Valley Park	Los Angeles	Park	350
I-5 Tehachapi	Pyramid Lake State Rec. Area along I-5	Los Angeles County	Park	50

* Distance from the alignment centerline

The geographic locations for the representative cases indicated in Table 2.4.1 are shown in Figure 5.

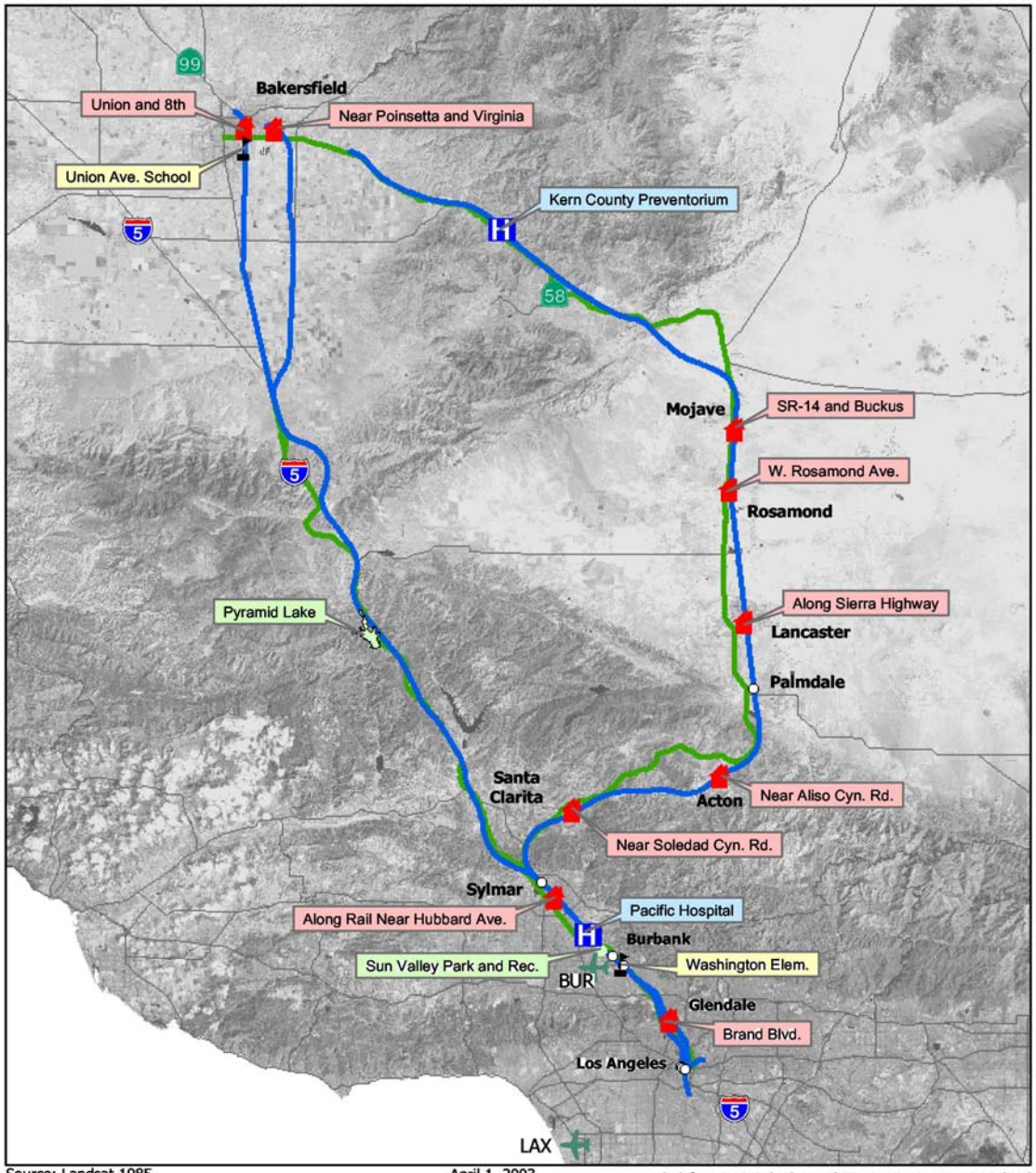
The Bakersfield to Los Angeles region corridor starts in the moderately populated area around Bakersfield. The I-5 option south of Bakersfield to Sylmar is sparsely populated as it travels through the Tehachapi Mountains. The other alterative option from Bakersfield to Sylmar is through the Antelope Valley. The land along this option is sparsely populated outside of the moderately populated regions of Bakersfield, Lancaster, and Rosemond. The alignment does not impact on the residential areas of Tehachapi.

All options from Sylmar to LA Union Station are located in densely populated areas. These options share either existing rail or highway corridors.

Typical residential land use typologies have been selected from each of these areas using the GIS data from which were chosen representative cases within the noise screening distances. Representative cases of hospitals, schools and parkland that might be impacted by the HST alternative of the project have also been selected, using GIS data within the screening distances.

Ambient noise in the Bakersfield to Los Angeles region has been estimated using data in the Noise Element from the General Plan for cities and counties in the region and general methods provided by the FRA and the FTA for estimating noise. The ambient noise from Bakersfield to Sylmar along I-5 is dominated by motor vehicle traffic along I-5. From Bakersfield to Sylmar through Lancaster, the ambient noise is dominated by both motor vehicle traffic and freight trains. From Sylmar to LA Union Station the ambient noise is dominated by motor vehicle traffic along highways and local roads and by freight and passenger trains.

The ambient noise levels, in the densely populated urban areas and areas near existing highways or rail corridors, range from L_{dn} 58 to 67. In the more rural areas of the region, the ambient noise levels range from Ldn 50 to 53.


Bakersfield
Union and 8th
Near Poinsetta and Virginia
Union Ave. School
Kern County Preventorium
Mojave
SR-14 and Buckus
W. Rosamond Ave.
Rosamond
Pyramid Lake
Along Sierra Highway
Lancaster
Palmdale
Santa Clarita
Acton
Near Aliso Cyn. Rd.
Near Soledad Cyn. Rd.
Sylmar
Along Rail Near Hubbard Ave.
Pacific Hospital
Burbank
Sun Valley Park and Rec.
BUR
Washington Elem.
Glendale
Brand Blvd.
Los Angeles
LAX
Source: Landsat 1985
April 1, 2003
California High Speed Train Program EIR/EIS
10 5 0 10 Miles
10 5 0 10 Kilometers
CALIFORNIA HIGH SPEED RAIL AUTHORITY
Legend
Representative Land Use Typologies
Residential
Hospital
School
Park
High Speed Rail Alternative and Stations
Modal Alternative Highways
Modal Alternative Airports
Noise and Vibration
Land Use Typologies
Bakersfield to
Los Angeles Region
Figure 5

3.0 EVALUATION METHODOLOGY FOR NOISE & VIBRATION

3.1 CHARACTERISTICS OF HST NOISE & VIBRATION

High-speed trains have similar noise and vibration characteristics to conventional trains with some unique features resulting from the higher speed of travel. The HST is expected to be a steel-wheel, steel-rail electrically-powered train operating on its own tracks in an exclusive right-of-way. Because there will be no highway grade crossings, the annoying sounds of the train horn and warning bells will be eliminated. The use of electrical power cars eliminates the rumble associated with diesel-powered locomotives. All of the above factors allow HST to generate lower noise levels than conventional trains at speeds with which most people are familiar. At higher speeds, however, HST shows a noise increase over conventional trains due to aerodynamic effects. A mitigating factor is that the high speeds enable HST noise to occur for a relatively short duration (a few seconds at the highest speeds).

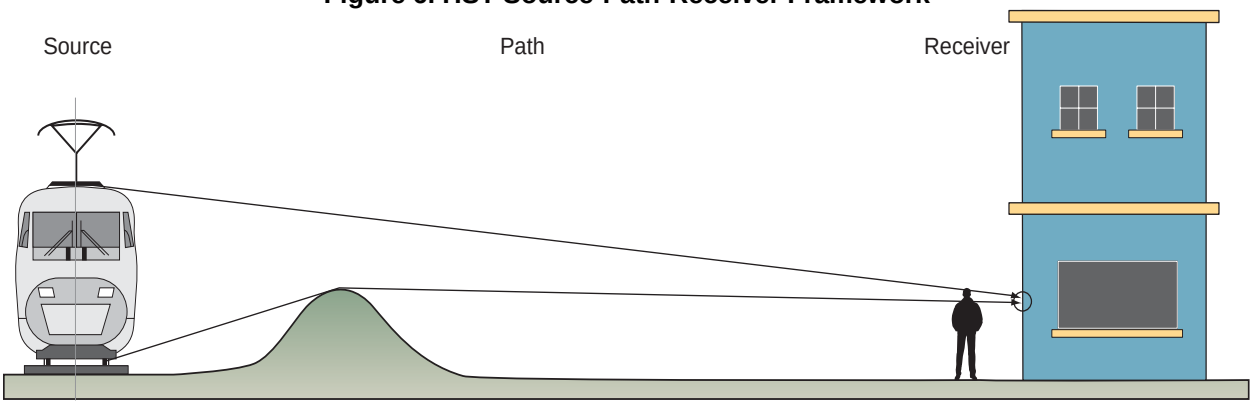
Vibration of the ground caused by the pass-by of the HST is similar to that caused by conventional steel wheel/steel rail trains. The same speed-dependent vibration generation mechanisms are present in each type of train. Holding down the vibration levels associated with the HST are the new track construction and smooth track and wheel surfaces resulting from high maintenance standards required for high speed operation.

This section provides a description of the noise and vibration effects associated with HST.

3.1.1 Elements of Noise Environment Associated with HST

Noise from HST is expressed in terms of a Source-Path-Receiver framework as illustrated in Figure 6. The source of noise is the train moving on its tracks. The path describes the intervening course between the source and the receiver wherein the noise levels are reduced by distance, topographical and man-made obstacles, atmospheric effects and other factors. Finally, at each receiver, the noise from all sources combines and is the noise environment at that location.

Figure 6. HST Source-Path-Receiver Framework



3.1.2 Noise Sources on HST and Conventional Trains.

The total noise generated by a train consists of several individual noise-generating mechanisms, each with its own characteristics, including location, intensity, frequency content, directivity and speed dependence. The distribution of noise sources on a typical HST is shown in Figure 7. These noise sources can be grouped into three categories according to the speed of the train.

Noise Sources at Low Speeds. For low speeds, below about 40 mph, noise emissions are dominated by the propulsion units, cooling fans, and undercar and top-of-car auxiliary equipment such as compressors and air conditioning units. HST will be electrically powered whereas conventional trains are usually diesel powered, a major difference in noise emission levels at low speed. Cooling fan noise is similar on all trains, but missing from the HST will be the low-frequency noise generated by the diesel exhaust that people associate with freight and commuter trains. Sources of HST noise occur both low and high on the body of the train. For example cooling fans and auxiliary systems can be located both on top and underneath the coaches and power cars. Traction motors on the power cars are low down near the wheels. Below 40 mph, noise levels increase only slightly with speed increases, typically following a relationship of 10 times the logarithm of the train speed.

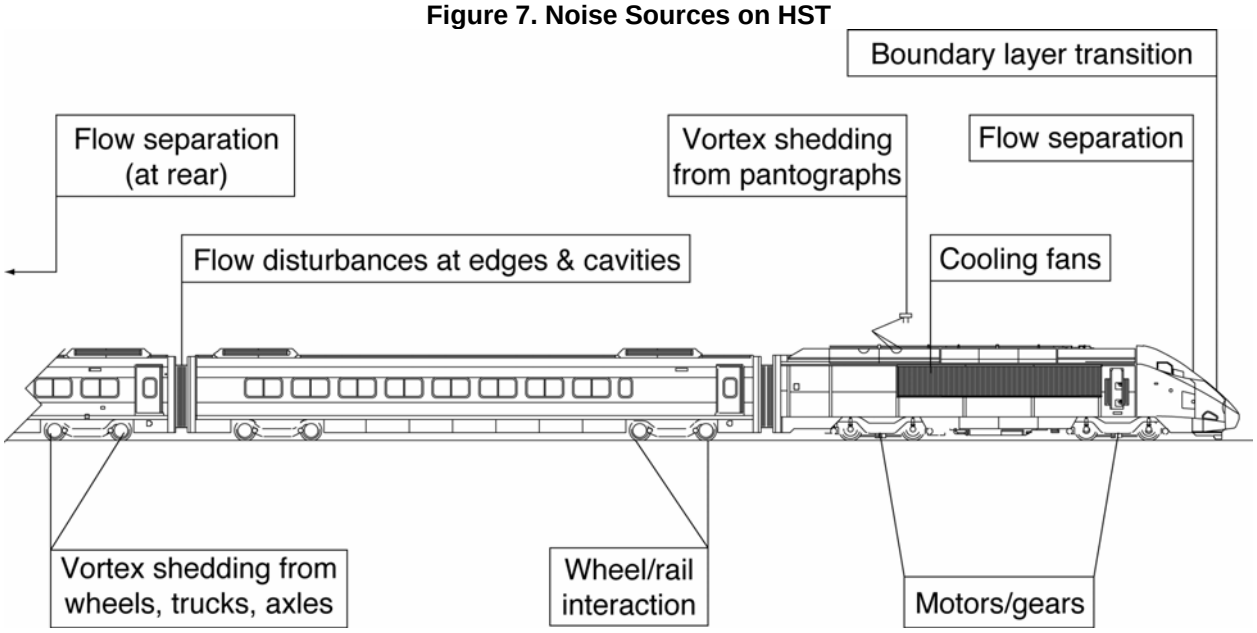
Noise Sources at Medium Speeds. In the speed range from 60 mph to about 150 mph, mechanical noise resulting from wheel/rail interactions and structural vibrations dominate the noise emission from trains. Conventional trains seldom exceed 125 mph, so this speed range which represents a medium range for HST actually represents the top end of noise characteristics for trains with which most people are familiar. Wheel/rail interaction is the source of the rolling noise radiated by steel wheels and rails on both HST and conventional trains. Rolling noise is caused by roughness and unevenness in the running surfaces and emanates from just above the track level. Consequently, this source is low to the ground and easy to shield with noise barriers for at-grade operations. When a train runs on a bridge or an elevated structure, the noise becomes a combination of wheel/rail noise and structure-borne noise. Structure-borne noise comes from many elements of the structure, but is generally concentrated on the area near the point of wheel/rail contact. Speed has a strong influence on noise in the medium speed range, usually about 30 times the logarithm of train speed.

Noise Sources at High Speeds. Above approximately 170 mph, aerodynamic noise sources tend to dominate the radiated noise from HST. Conventional trains are not capable of attaining such speeds. Aerodynamic noise is generated from solid elements of the train body moving rapidly through the air. The motion causes air to flow around components and separate from the train in an unsteady way, especially in the areas around the wheels, the gaps between coaches, and the pantograph (the telescopic structure that picks up electrical current from the overhead wires). Unsteady flow causes aerodynamic noise which increases very rapidly with speed, typically 60 to 70 times the logarithm of speed.

HST noise in the transition speeds between each of the three foregoing ranges is a combination of the sources in each range, with no clear dominant source.

Sources at all Speeds: Horns and Bells. Horns are an example of a train noise source that is meant to be the dominant noise source at any speed. Audible warnings at grade crossings, including train horns and warning bells, are a common feature of conventional trains. These noise sources often prove to be a source of annoyance to people living in the vicinity of railroad tracks. In the case of HST, however, these sources are absent except in the case of emergencies because grade crossings are eliminated for reasons of safety. Elimination of horns and bells at grade crossings is a clear noise benefit associated with the implementation of HST.

Figure 7. Noise Sources on HST



3.1.3 Noise Propagation from Trains

Sound from a train reduces in level in its path to nearby receivers due to a number of natural and environmental factors, including:

Divergence – Sound reduces by spreading in all directions.

Absorption – Sound gets absorbed by the air and the ground.

Refraction – Wind and temperature gradients change the direction of sound waves.

Natural Shielding – Topographical features (hills) interfere with sound waves.

Man-made Shielding -- Noise barriers and buildings interfere with sound waves.

Most of these effects occur in nature and provide a gradual and predictable reduction of noise with distance in open areas. A typical natural reduction would be 5 to 6 dB per doubling of distance starting from about 100 feet from the tracks. In contrast, for built-up areas and locations where mitigation is applied, the man-made shielding by buildings and noise barriers provides significant reductions of noise in a short distance. A typical reduction by man-made shielding is 5 to 10 dB in the shadow of the structure. Specially designed noise barriers for HST can achieve somewhat greater noise reductions.

3.1.4 Noise Perception at the Receiver

When train noise reaches the receiver, whether it be a person outdoors in the garden or someone indoors sleeping, it combines with other sounds in the environment and may or may not stand out in comparison. The distant sources may include traffic, aircraft, industrial activities, animal sounds or wind in the trees. These distant sources create a background noise in which no particular source is identifiable, but is fairly constant from moment to moment and varies slowly from hour to hour. Superimposed on this slowly-varying background noise is a succession of identifiable noisy events of relatively brief

duration. Examples include the passby of a train, the overflight of an airplane, or the screeching of brakes. These single events may be loud enough to dominate the noise environment at a location for a short time, and when added to everything else, can be responsible for annoyance.

The highest noise level reached during a single event is called the "maximum level" (Lmax). Lmax is used to provide information on how loud is the noise from a train passby, for example. Some typical Lmax's are shown in Figure 8.

Despite the usefulness of the Lmax in describing a single event, there are better measures for assessing the noise environment containing many such events of varying duration in a fluctuating noise environment. The primary descriptor used for HST environmental assessment is Day-Night Sound Level (Ldn), which describes a receiver's cumulative noise exposure from all noise events that occur in a 24-hour period, with events between 10 pm and 7 am increased by 10 decibels to account for greater nighttime sensitivity to noise. The Ldn is used to describe the general noise environment in a location – the so-called "noise climate." The descriptor is a computed number, not one to be read moment to moment on a meter. Its magnitude is related to the general noisiness of an area. The U.S. Environmental Protection Agency (EPA) developed the Ldn descriptor and now most Federal agencies, including the FRA and Federal Transit Administration (FTA), use it to evaluate noise impacts.

Along highway and rail corridors where the noise sources run for 24-hours a day and 7 days a week, the Ldn is considered the best descriptor of the noise environment. Freeway noise tends to be continuous, with sources extending out in the distance in both directions. This type of source is characterized as a "line source," a term that defines the way the sound propagates away from the highway. HST and railroad noise is a bit different in character. Rather than a continuous line source like highway traffic, rail traffic is described as a "truncated line source," where trains pass by only periodically. The sound propagation from a rail line differs from that of the highway.

A comparison of Ldn associated with surface transportation sources at various distances is shown in Figure 9. The example is based on rural areas adjacent to a typical 4-lane freeway[2], a moderately busy freight railroad[3], and the HST at 180 mph in a segment between Merced and Sacramento[4]. In general, the HST noise falls off more rapidly with respect to distance than that from a busy freeway.

The way people react to noise in their environment has been studied extensively by researchers throughout the world. As a result of these studies, noise impact criteria have been adopted by FRA and other federal agencies based on the contribution of the noise from a source like HST to the existing environment. FRA bases noise impact criteria on the increase in Ldn (for buildings with nighttime occupancy) or increase in Leq (for institutional) buildings caused by the project. Criteria are discussed in Section 3.2.

[2] Freeway, 4 lanes, 1885 vehicles/hour/lane, 65 mph, 2% medium trucks, 3% heavy trucks.

[3] Freight trains with 2 locomotives, 40 cars, 60 mph, 10 daytime, 3 nighttime.

[4] HST, 180 mph, 67 daytime, 5 nighttime.

Figure 8. Typical Lmax Values

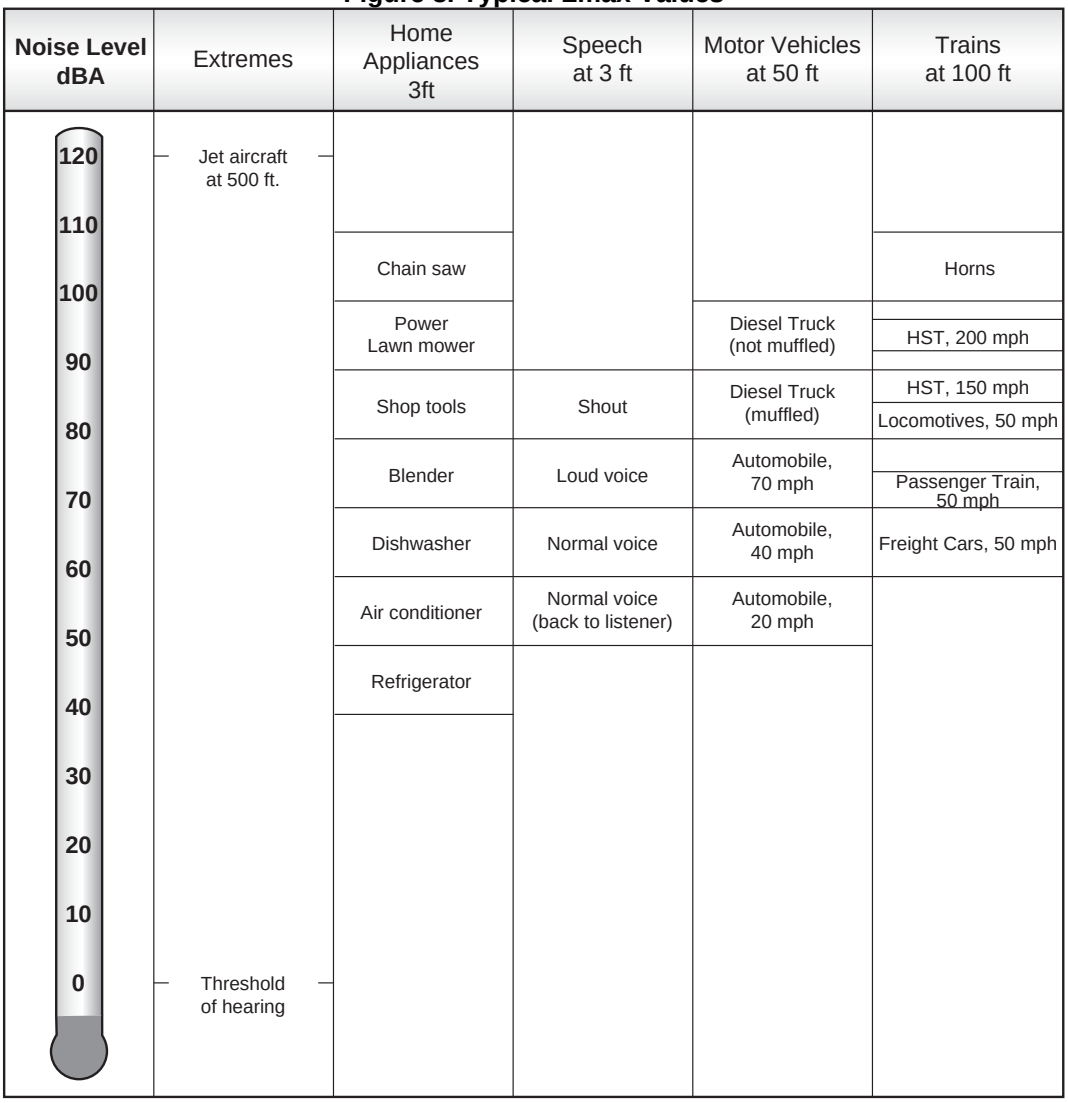
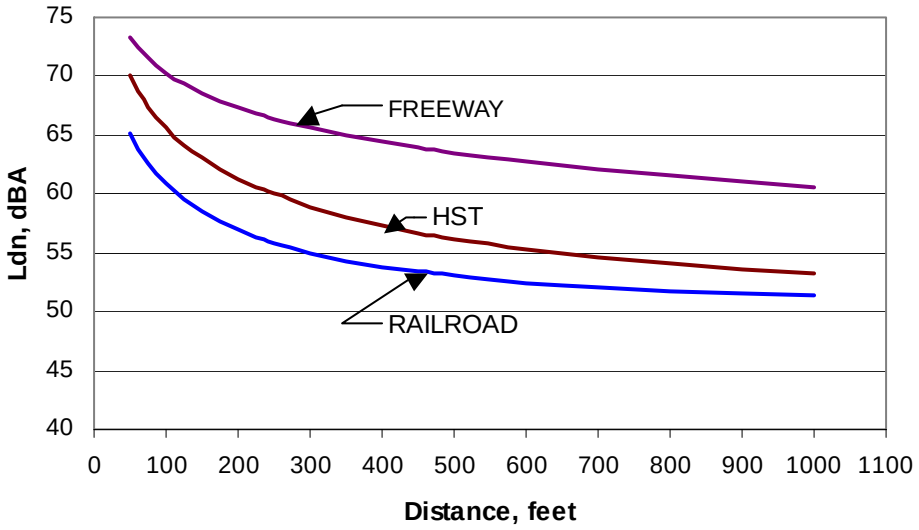


Figure 9 Example of Noise Exposure vs. Distance for Transportation Modes



3.1.5 Vibration from HST

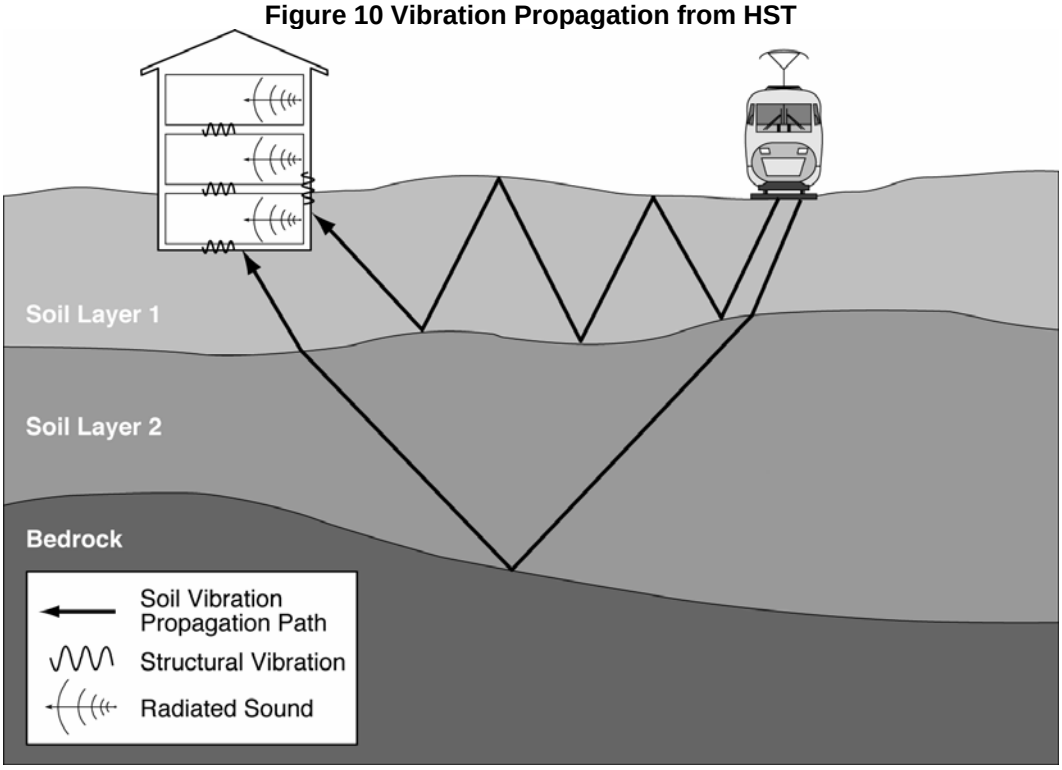
Ground-borne vibration from trains refers to the fluctuating motion experienced by people on the ground and in buildings near railroad tracks. In general, people are not exposed to vibration levels from outside sources that they can feel in their everyday lives. They slam their doors and a wall may shake, or drop something heavy and feel the floor shake, but when an outside source like a train causes their homes to shake, they become concerned. The effects of ground-borne vibration in a building close to a source of vibration may include perceptible movement of the floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. None of these effects is great enough to cause damage, but could result in annoyance if repeated many times per day.

As is the case with noise, ground-borne vibration can be considered to follow a Source-Path-Receiver Framework, as shown in Figure 10. The Source of vibration is the train wheels rolling on the rails. They create vibration energy that gets transmitted through the track support system into the trackbed or track structure. The amount of energy that is transmitted into the track structure depends strongly on factors such as how smooth the wheels and rails are and the details of the vehicles and tracks. Vibration levels from conventional trains and from HST have been measured and documented by FRA in the guidance manual. As in the case of noise, speed makes a difference: vibration levels increase according to a 20 times the logarithm of speed relationship.

The Path of vibration involves the ground between the source and a nearby building. The vibration of the track or structure excites the adjacent ground, creating vibration waves that propagate through the various soil and rock strata to the foundations of nearby buildings. Ground-borne vibration propagation characteristics vary considerably among the different ground types found in a region. FRA's guidance manual provides a generic method for estimating propagation effects for Tier 1 and a more detailed method for Tier 2 assessments.

The Receiver of vibration is the building. Vibrations propagate from the foundation throughout the building structure, causing floors, walls and other building elements to vibrate. Vibration impact criteria have been adopted by FRA based on people's annoyance from repeated exposure to ground-borne vibrations from trains. These criteria are discussed in Section 3.2.

Figure 10 Vibration Propagation from HST



3.2 CRITERIA FOR NOISE & VIBRATION IMPACT

Criteria for HST noise and vibration impact assessment have been established by the FRA based on activity interference and annoyance ratings developed by the US Environmental Protection Agency. These criteria provide the basis for the screening procedures used in the programmatic assessment.[5]

HST Noise. FRA's noise criteria are ambient-based such that a project's noise is compared with existing conditions to provide an assessment of the effect of the potential change in noise environment on various land uses in the transportation corridor. They incorporate elements of both "relative" and "absolute" limits in assessment of project noise levels. Relative criteria are based on expected annoyance due to the change in the noise environment caused by the HST. Absolute criteria are based on activity interference caused by the HST alone.

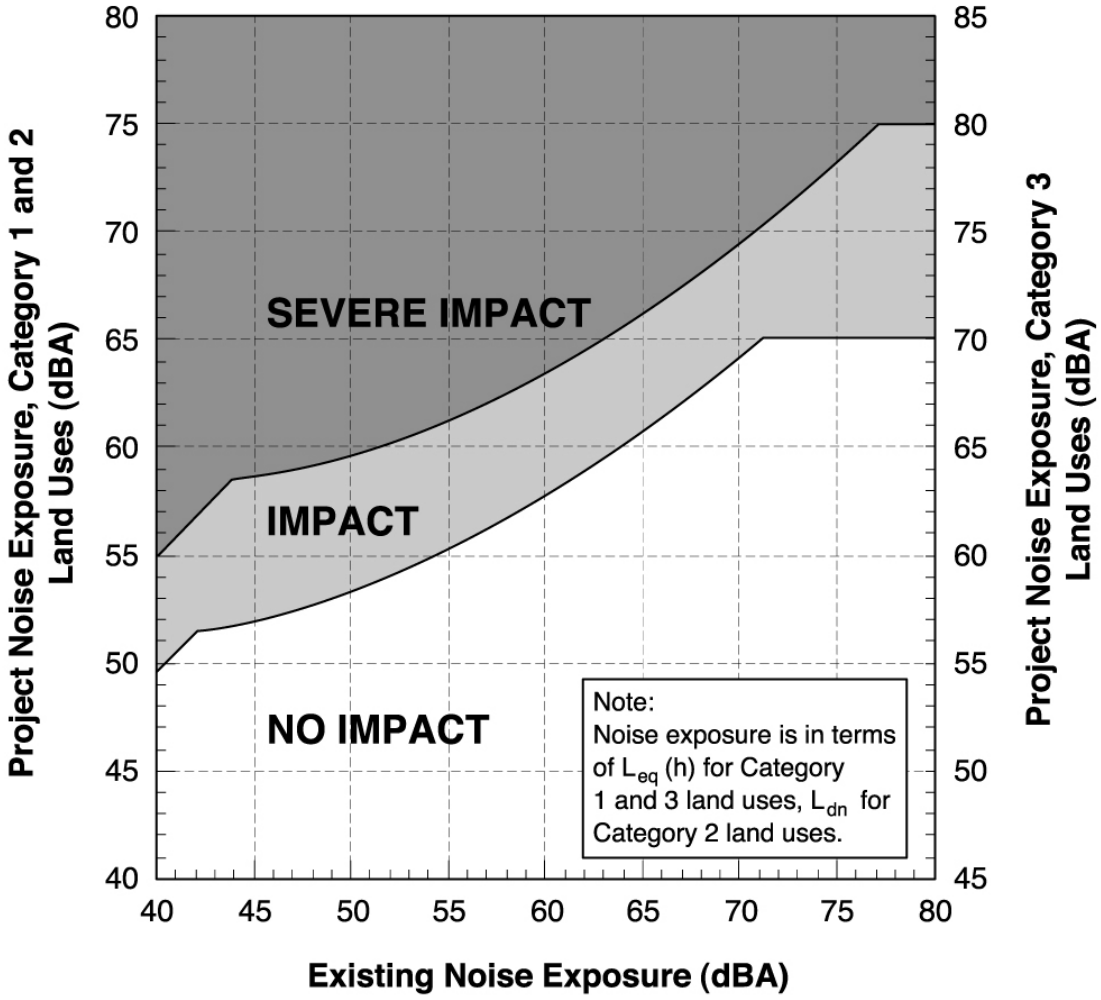
The metric used for noise impact assessment is the day-night sound level (Ldn) in dBA for residential land uses, Land Use Category 1, including buildings where people sleep (hospitals, hotels, motels). The hourly equivalent sound level (Leq) in dBA is applied during hours of active use in parks (Land Use Category 2) and institutional uses (Land Use Category 3 -- churches, libraries, schools).

Changes in noise over existing conditions are categorized into three levels of effect by FRA: No Impact, Impact and Severe Impact, as shown in Figure 11. The project noise level is compared to the existing ambient noise level prior to the introduction of the project. The intersection of the two levels on the graph is an indicator of the degree of impact. Below the threshold of Impact the project is considered to have no noise impact since, on the average, the introduction of the project will result in an insignificant

[5] U.S. Department of Transportation, Federal Railroad Administration. "High Speed Ground Transportation Noise and Vibration Impact Assessment," (see FRA website).

increase in the number of people highly annoyed by the new noise source. For Severe Impact, a significant percentage of the people exposed to the noise would be highly annoyed by the new noise source. Impact is assessed when the HST's noise level would be noticeable but would not be sufficient to cause strong, adverse reactions from the community. Upper limits are imposed in the FRA criteria to account for high noise levels judged to interfere with human activities.

Figure 11 Noise Impact Criteria for High Speed Rail Projects



HST Vibration. FRA's vibration criteria are based on research documenting people's reactions to various levels of building vibrations induced by rail systems. The research, combined with national and international standards related to human exposure to vibration provides the foundation for predicting annoyance from ground-borne vibration in residential areas that would be caused by the HST. The criteria shown in Table 3.2.1 are based on the expected maximum vibration level caused by an average passby of the HST at site-specific locations.

The metric used for vibration impact assessment is the one-second average root-mean-square velocity level (Lv) in VdB. For frequent events, e.g., more than 70 HST passbys per day, the criterion for residential land use is 72 VdB.

Table 3.2.1 Ground-Borne Vibration Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro inch/sec)	
	Frequent Events[1]	Infrequent Events[2]
Category 1: Buildings where low ambient vibration is essential for interior operations.	65[3]	65[3]
Category 2: Residences and buildings where people normally sleep	72	80
Category 3: Institutional land uses with primarily daytime use.	75	83

Notes:
1. "Frequent Events" are defined as more then 70 vibration events per day. Most rapid transit projects fall into this category.
2. "Infrequent Events" is defined as fewer than 70 vibration events per day. This category includes most commuter rail systems
3. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration sensitive manufacturing or research will require detailed evaluation to define acceptable vibrations levels. Ensuring lower vibration levels in a building often requires special design of the HVAC (heating/air conditioning) systems and stiffened floors.

Modal and No-Project Alternative Noise and Vibration Criteria. The alternatives to HST include railroad, highway, and aviation components, each of which has criteria established by the corresponding transportation departments concerned with those modes.. Railroad noise and vibration criteria have been established by FTA for commuter trains and can be applied to the speeds attained by usual intercity operations; highway noise criteria have been established by FHWA; and aviation noise criteria have been established by FAA. It is to be noted that neither of the latter agencies have vibration criteria. Although each agency has a different approach, it is possible to link the noise impact assessments obtained from the various methods by a commonality of annoyance relationships quantified by the US EPA and noise standards adopted by the US HUD.

Railroad noise and vibration criteria developed by FTA are actually the original criteria adopted by FRA. Since they are identical to those used for HST, these criteria will be used for all rail operations in the Modal and No-Project Alternatives.

Aviation noise can be assessed using the Ldn metric, and noise impact occurs where Ldn exceeds 65 dBA, according to FAA. Noise contours around airports are routinely developed to identify the area exposed to noise levels in excess of the impact threshold. Some airports have noise contours for future planned airport operations. However, noise contours are not available for the Modal Alternative and consequently could not be used to assess the potential impacts of the aviation mode in the Modal Alternative. It was not possible to obtain noise contours for the No-Project Alternative. Consequently the potential noise impacts associated with the aviation component of these two alternatives is not included. Vibration is assumed not to be an issue with aviation.

Highway noise metrics used by FHWA are slightly different from the other modes. Highway noise impact is based on the traffic equivalent noise level (Leq) during one hour of the day -- the hour with the worst impact on a regular basis. For adding to the impacts of other modes and subsequent comparison with

HST, the hourly Leq can be used to develop an estimate of Ldn in communities along the highway corridors.

3.3 SCREENING PROCEDURE FOR PROGRAMMATIC ASSESSMENT

Noise Screening for HST Alternative. FRA has developed a screening method for application early in the HST development, before many details of the system have been defined. Distances from the center of the corridor are provided to encompass all potentially impacted locations. The purpose is to provide an indication whether any noise-sensitive receivers are close enough to the proposed alignments for noise impact to be possible, and it identifies locations where the HST has little possibility of noise impact. The method is used for making a general comparison of potential impacts for different corridors. It is also a key element in the identification of locations for subsequent analysis in Tier 2 where the greater refinement in the detailed analysis is used to focus in on the actual impacts. Correspondingly, screening identifies locations where no additional noise studies need be conducted.

The FRA screening procedure takes account of the noise impact criteria, the type of corridor, and the ambient noise conditions in typical communities. Distances are developed from detailed noise models based on noise emissions of typical steel-wheel/steel-rail high-speed trains, expected maximum operation levels and speeds, along with the noise-sensitivity of residential land use. The FRA screening procedure is considered to be appropriate for HST speeds from 125 mph to 210 mph. FRA's screening method is not intended for use at speeds less than 125 mph, or for areas near stations. However, FTA has developed a screening method that is consistent with the FRA method, and will be used for these conditions.

The screening distances differentiate among areas according to their estimated existing ambient noise. "Urban" and "Noisy Suburban" areas are grouped together. These areas are assumed to have ambient noise levels greater than 60 Ldn. Similarly, "Quiet Suburban" and "Rural" areas are grouped as areas where ambient noise levels are less than 55 Ldn. For developed land with Ldn between 55 and 60, the classification is dependant on other factors such as proximity of major transportation facilities and density of population.

Table 3.3.1 Noise Screening Distances for HST Alternative

Speed (mph)	Type of Corridor	Land Use - Ambient	Distance† (ft)
≥ 125	Existing Rail	Urban/Noisy Suburban	450
		Quiet Suburban/Rural	900
	Existing Highway	Urban/Noisy Suburban	450
		Quiet Suburban/Rural	700
	New Rail	Urban/Noisy Suburban	450
		Quiet Suburban/Rural	900
< 125	Any	Urban/Noisy Suburban	375
		Quiet Suburban/Rural	750
Station§	Any	Urban/Noisy Suburban	225
		Quiet Suburban/Rural	450

† Measured from centerline of track
§ For a distance of 1/4 mile in either direction from center of station

Vibration Screening for HST Alternative. FRA also provides a screening method for HST vibration levels. The method is similar to that for noise, except it assumes typical ground propagation conditions. Vibration propagation is site-specific depending on the soil conditions. Although it is not possible to account for this in a Tier 1 analysis, this has been addressed in the typology analyses. The FRA screening distances are shown below:

Table 3.3.2 Vibration Screening Distances for HST Alternative

Speed (mph)	Receptor Type	Distance† (ft)
≥ 125	Special Facilities (e.g. concert halls, research)	750
	Residential	220
	Institutional (e.g., schools, public buildings)	160
< 125	Category 1 (e.g., concert halls, research)	600
	Category 2 (e.g., residences, theaters, auditoria)	200
	Category 3 (e.g., schools, public buildings)	120

† Measured from centerline of track

Modal and No-Project Alternatives. The railroad noise component of the alternatives is screened according to the FRA/FTA methods described above. Areas considered for impact by aviation noise are based on the published noise contour maps for each airport showing the location of the 65 Ldn noise contour. Screening distances for highways are calculated for various roadway types according to the number of lanes, using the authorized FHWA traffic noise model to determine the distance to where the 65 Leq noise contour is reached. Highway noise screening distances are shown below:

Table 3.3.3 Noise Screening Distances for Highways

Number of Lanes	Distance† (ft)
2	242
4	335
6	390
8	455
10	510
12	580
14	640
16	715

† Measured from centerline of highway

3.4 SUBSEQUENT ANALYSIS IN TIER 2

Locations identified as potentially impacted by noise and vibration in the screening procedure will be revisited with a more detailed assessment in Tier 2 analysis. FRA provides procedures for a general assessment to refine the noise impact areas, followed by a detailed analysis to develop mitigation for impacted areas.

3.5 PARAMETERS FOR COMPARING ALTERNATIVES

The screening procedures described above are designed to provide distances from the center of a corridor, or area enclosed by contours. However, noise and vibration impacts relate to the number of people who are likely to be annoyed by activity interference. The areas defined by the screening distances along the alignments, together with available population density information in GIS format, provide a measure of the number of people potentially impacted by HST and the other alternatives. Consequently, people impacted will be the base parameter for comparing the alternatives.

Rating the severity of impacts by "High," "Medium," or "Low" requires an assessment of how many people are exposed to impact-level noise and vibration. Consequently, a metric describing the relative magnitude of impact has been developed. For this screening study, an Impact Metric (IM) and Impact Rating (IR) have been defined as follows:

Impact Metric (IM) = (#Res. Population Impacts/Mile) + 0.3 x (#MU population Impacts/Mile) + (l00 x # Hospitals)/Mile + (250 x # Schools)/Mile

Noise Rating Scheme (IR): High (H) = IM > 200; Medium (M) = 80 < IM <200; Low (L) = IM < 80

Vibration Rating Scheme (IR): High (H) = IM >100; Medium (M) = 40 < IM < 100; Low (L) = IM < 40

Implications of the Rating Scheme for noise as defined in this manner are that a moderate impact of only Low (L) with IM less than 80 corresponds to a residential impact of 4 people per house and 20 houses per mile (520 feet between houses for development on both sides of the alignment), and no institutional impacts (hospitals, schools). Institutional impacts, because of their higher occupancy add substantially to the severity of impact.

4.0 NOISE IMPACTS

4.1 NO-PROJECT ALTERNATIVE

The No-Project Alternative, potential noise impacts associated with existing highways only were obtained from the screening analysis. Because of limited or nonexistent information, impacts for expected future (2020) rail and aviation conditions were not included in the impact tabulations. Therefore the comparison between the No-Project Alternative and the HST Alternative is somewhat conservative in that the No-Project Alternative impacts are underestimated.

4.2 MODAL ALTERNATIVE

Potential noise impacts for the Modal Alternative associated with highway expansions and airport improvements were obtained from screening analyses. These impacts can be used to compare with the overall results of the No-Project Alternative potential highway impacts and potential HST impacts. Complete aviation data for the Modal Alternative is not available for this study, but where data were available an assessment of impact was made. The aviation component will increase the number people impacted and the degree of impact for the Modal Alternative. From the data available, it would appear that the number of people potentially impacted by the aviation component is small in comparison with the highway component. However, where available the potential airport impacts were combined with the highway component for comparison between the Modal Alternative and the HST Alternative.

4.3 HIGH-SPEED TRAIN ALTERNATIVE

HST noise typologies were analyzed using the General Assessment method provided by the FRA. Representative Cases were chosen to show, in more detail than is possible with the screening analysis, a range of impact levels that are likely to be encountered in the Tier 2 impact evaluation. Potential impacts for the entire HST Alternative were obtained from the screening analysis. The results of the screening analysis can be used to compare potential impacts between regional alignment options and between the potential highway impacts of the Modal Alternative and No-Project Alternative. Residential, park, and institutional noise impact summaries are based upon the GIS land use and location data made available for the screening study and the corresponding screening distances used for each alignment segment.

4.4 NOISE TYPOLOGIES FOR HST

The results of the HST Representative Case noise typology studies are shown in Table 4.4.1 and 4.4.2 below. Table 4.4.1 includes residences and hospitals where there is occupancy both night and day and people generally sleep. Table 4.4.2 includes schools and parks with primarily daytime usage. The Representative Cases illustrate the typologies that exist throughout the Bakersfield to Los Angeles portion of this Rail Alternative. The FRA criteria, as described in Section 3.2, define three levels of noise impact: “no impact” (NI), “impact” (I), and “severe impact” (SI). Severe impact is normally associated with a Significant Impact as defined by CEQA, whereas an “impact” is usually not considered a significant impact, but worthy of consideration for mitigation based on a detailed cost/benefit analysis.

Reviewing Table 4.4.1, it can be seen that, within the City of Bakersfield (in the I-5 corridor between Bakersfield and Sylmar), the potential HST noise impacts to the residences analyzed are SI before applying noise reduction for standard mitigation as provided in the FRA manual. Standard noise reduction for these two receptor areas appear to be insufficient to reduce the impact to a level I. More

detailed noise analysis for these two receptor areas indicate a noise wall may need to be from 14 to 16 feet high to mitigate to an impact level of I. For the Union Avenue School in Bakersfield, the impact level, as indicated in Table 4.4.2, is SI before mitigation, which can be reduced to a level I with a standard noise wall.

The Pyramid Lake State Park along the I-5 corridor is seen to have an impact level of SI, as indicated in Table 4.4.2, which is reduced to a level of I with typical noise reduction provided by standard noise mitigation.

Along the HST corridor through Tehachapi to the Antelope Valley, and through Lancaster, the residences analyzed are impacted at a level of SI before mitigation. Typical noise mitigation can reduce the impact to a level I for the residences in Lancaster on Sierra Highway and the ones near Mojave on Backus Street, but the residences in Rosemond are indicated as requiring more substantial mitigation. The noise impact level for the Kern County Preventorium along SR58 is indicated to be SI before mitigation. Typical noise mitigation appears to be insufficient to reduce this to an impact level of I for this receptor. More detailed analysis indicates that a noise wall, between 14 and 16 feet high, would reduce the impact level for both the residences in Rosemond and the Kern County Preventorium. However additional mitigation measures are indicated as being necessary. When the speed is reduced to less than 200mph (i.e., approximately 190mph) at both locations, the analysis indicates a reduction with the higher noise wall to be an impact level of I.

In the Soledad Canyon area, the residences analyzed for noise are indicated to have an impact level of SI before mitigation. For the residences in Santa Clarita (which would be 900 feet from the alignment), standard noise mitigation reduces the level of impact to I. The residences in Aliso Canyon are indicated, by a detailed analysis to require more substantial mitigation. For these receptors, a noise wall 14 to 16 feet high may be needed to mitigate to an impact level of I.

In the rail corridor south of Sylmar through Burbank, the potential HST noise impacts to residences are indicated to be SI before mitigation. After applying standard mitigation, the impacts are reduced to a level I for the residences in Glendale. The impact to the residences on Brand Street in Glendale is SI before mitigation, but can be reduced to I with typical noise mitigation. In the area of Burbank Airport, the Washington Elementary School and the Sun Valley Park are not impacted by noise as indicated in Table 4.4.2.

In Los Angeles, the Pacific Hospital, which would be in the area of the Burbank Airport siding, is indicated as having no impact for noise. This receptor would be located 550 feet from the siding which would have a lower speed than the mainline (90mph compared with 214mph). For the residences on Hubbard Avenue in Los Angeles, more substantial mitigation appears to be needed. A detailed analysis indicates that a 14 to 16 foot high noise wall and a slight speed reduction to 205mph reduces impact to these residential receptors to a level I.

Table 4.4.1 Typology Analysis Table – Potential Residential and Hospital Noise Impacts
Bakersfield to Los Angeles

ALIGNMENT/ SEGMENT	DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)*	SPEED (mph)	EXISTING Ldn	PROJECT Ldn	IMPACT LEVEL**	IMPACT LEVEL AFTER MIT.
Wheeler Ave	Residences Near Poinsettia & Virginia	Bakersfield	New	50	181	58	77	SI	I†
Union Ave.	Residences Near Union & 8th	Bakersfield	New	130	185	60	71	SI	I†
SR-58	Residences at SR-14 & Backus	Near Mojave	New	700	194	50	61	SI	I
Antelope Valley	Residences on W Rosemond Avenue	Rosemond	Exist. Rail	100	206	58	75	SI	I††
Antelope Valley	Residences along Sierra Highway	Lancaster	Exist. Rail	450	214	62	66	SI	I
Soledad Canyon	Residences on Aliso Canyon Road	Kern County	New	400	205	50	68	SI	I†
Soledad Canyon	Residences on Soledad Canyon Road	Santa Clarita	New	900	217	50	62	SI	I
Metrolink UPRR Sylmar Station Siding	Residences along rail near Hubbard Avenue	Los Angeles	Exist. Rail	250	214	62	72	SI	I††
Metrolink/ UPRR Glendale	Residences on Brand Blvd	Glendale	Exist. Rail	50	105	67	72	SI	I
SR-58	Kern County Preventorium	Kern County	Exist. Rail	150	214	53	73	SI	I††
Burbank Airport siding	Pacific Hospital	Los Angeles	Exist. Rail	550	90 / 214	60	55	NI	--

* Measured from centerline of alignment.
** NI = No Impact, I = Impact, SI = Severe Impact
† Detailed noise analysis indicates a 14 to 16 ft high noise wall may be needed.
†† Detailed noise analysis indicates a 14 to 16 ft high noise wall may be needed and a possible speed reduction to less than 200 mph.

Table 4.4.2 Typology Analysis Table – Potential School and Park Noise Impacts
Bakersfield to Los Angeles

ALIGNMENT/ SEGMENT	DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)*	SPEED (mph)	EXISTING Leq	PROJECT Leq	IMPACT TYPE**	IMPACT TYPE AFTER MITIG.
Union	Union Ave School along Union Ave. @ Casa Loma	Bakersfield	New	100	203	60	73	SI	I
Burbank Airport siding	Washington Elementary School along I-5 near Burbank Airport	Burbank	Highway	700	118	65	54	NI	--
Burbank Airport siding	Sun Valley Park	Los Angeles	Exist. Rail	350	200	60	55	NI	--
I-5 Tehachapi	Pyramid Lake State Rec. Area along I-5	LA County	Highway	50	155	50	78	SI	I

* Measured from centerline of alignment.
** NI = No Impact, I = Impact, SI = Severe Impact

4.5 NOISE SCREENING ANALYSIS

The screening analyses were performed for the No-Project, the Modal and the HST Alternatives. The analyses were accomplished using available GIS data for land use and alignment geometry. The land use along rail and highway alignments were "buffered" using the screening distances presented in Section 3.3. For airports, the screening distance is the distance to the existing CNEL 65 noise contour. The screening analyses for airports determined the number of people currently impacted. The number of people impacted by the Modal Alternative was determined using an "area equivalent" method approved by the FAA. The area equivalent method estimates that for every 1 dBA increase, the population impacted increases by 17%. The increase in noise level was estimated by the growth in demand forecast for each airport. The number of people potentially impacted within the noise buffers was determined using GIS census data.

There are two types of residential land use in the GIS database: strictly residential and mixed use (MU). The former is referred to as Anderson Land Use category 11, and the latter as Anderson Land Use category 16. Anderson Land Use category 16 applies to mixed use land (e.g., commercial and high density residential) where the residential component is typically 30% of the total. This latter fact was used in determining the impact metric (IM) described in Section 3.3.

The impact rating (IR) for each segment is indicated as being L, M or H. The IR designates the degree of impact based on the number of people impacted per mile of alignment based on the metric thresholds presented in Section 3.3. Figure 12 indicates the results of the screening analysis for the No-Project and Modal Alternatives with the highway alignments color coded to show whether the rating is H, M, or L. Similar results of the HST screening analysis are indicated in Figure 13. The highest impact ratings for all three Alternatives are seen to coincide with the more densely populated areas such as found in the San Fernando Valley.

Table 4.5.1 presents the detailed results of the screening analyses for the three project alternatives. In addition to potential residential land use impact, impacts to schools, hospitals and parks are also included. For hospitals and schools, the number of potentially impacted locations is indicated. Where parks are potentially impacted, the amount of acreage within the screening distances is indicated.

Under the No-Project Alternative (see Figure 12), the IR for the various highway segments ranges from L to H. The area of H impact is the I-5 corridor from Sylmar to downtown Los Angeles. These same trends are also seen for the Modal Alternative. This result is not unexpected considering the close proximity of residential land along this alignment segment. What is different between the two alternatives is that the number of people impacted increases with the Modal Alternative and consequently the IM, although not enough to change the IR.

The HST Alternative (see Figure 13) is indicated to have potential impacts which are L along both the I-5 corridor and the Antelope Valley alignment as would be expected considering the sparseness of residential land use and open space along most of these two routes. There are segments along the Antelope Valley alignment that pass through populated areas, but these are isolated cases compared with the entire length of this segment.

Within Bakersfield, the two alignment options do pass through areas with residential population. Overall the HST Alternative has IRs which range from L to H depending primarily on the proximity and density of residential population, but also on the speed of the train. The noise Typology study results are seen to reflect the same general trend as the screening analysis results. Where population is dense and close to the alignment, impacts are higher and more substantial and conversely where the alignment passes

through less densely populated areas such as in the southern and eastern portion of the region, the impacts are less and not as substantial.

Figure 14 indicates the two combinations of HST segments which produce the least and the greatest potential impacts based on the results of the screening analysis. The primary factor used to select the segments for each combination was the number of people potentially impacted. In most cases the HST segment with the greatest potential impact would be the longest segment with the highest IR and conversely the segment with the least potential impact would be the shortest segment with the lowest IR. In most cases this is true, but because the IR represents a range of values of the IM, cases arise where, because of the density of population, a shorter segment can have a greater potential impact than a longer segment. This is the case with the I-5 corridor, which must pass through southern Bakersfield first before it enters less populated areas.

The HST alignment with the least potential noise impacts consists of the Antelope Valley Option, with the Metrolink/UPRR option through downtown Burbank, in conjunction with the LAUS siding to South Connection. The HST alignment with the greatest potential for noise impact consists of the I-5 Option and the I-5 through downtown Burbank to Silverlake with the LAUS South Siding to East Connection.

Source: Landsat 1985

10 5 0 10 Miles

10 5 0 10 Kilometers

CALIFORNIA HIGH SPEED RAIL AUTHORITY

April 7, 2003

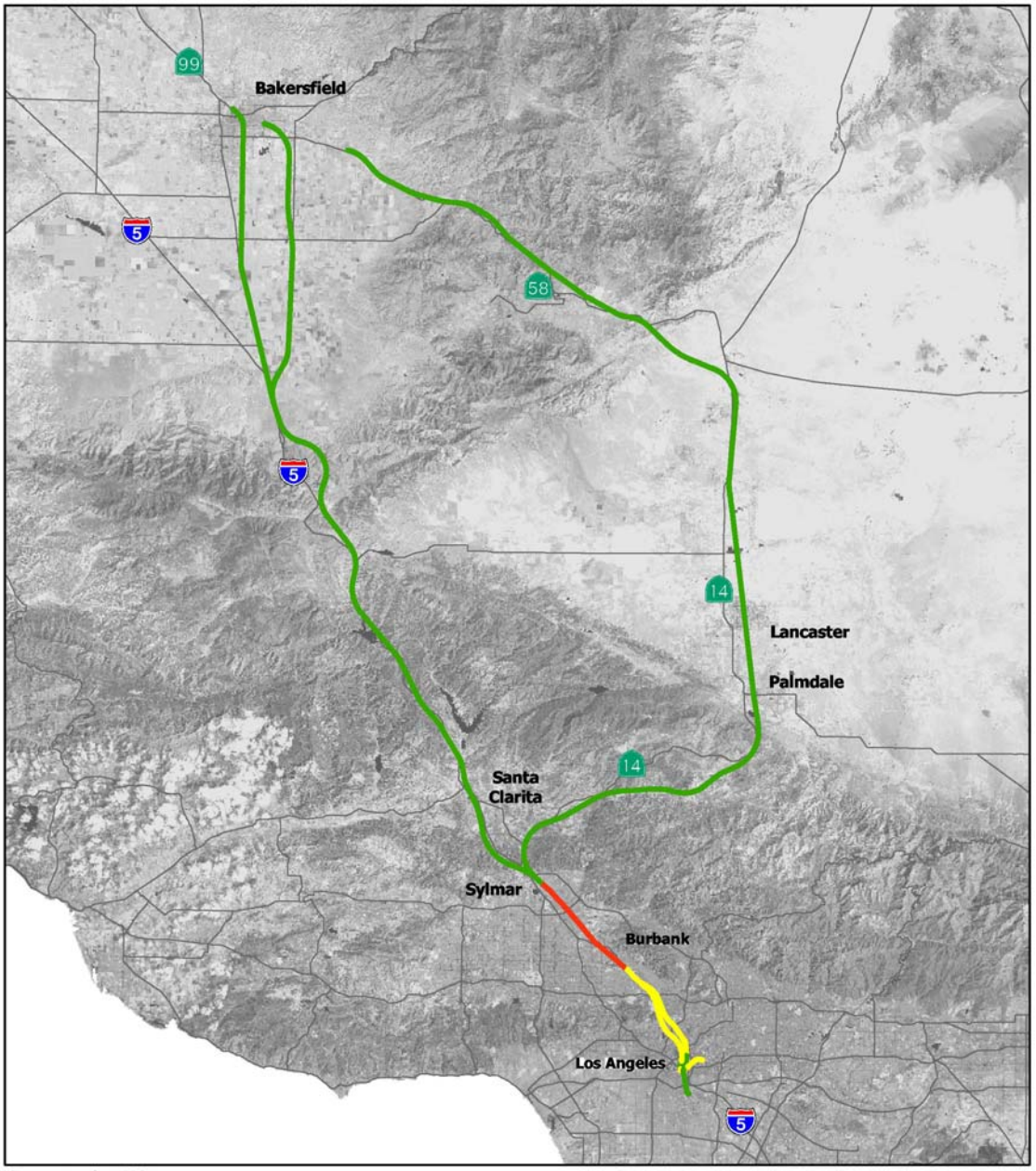
Legend

No-Build and Modal Alternatives
Highways - Noise Impacts
- High
- Medium
- Low

California High Speed Train Program EIR/EIS

Noise Impacts
No-Build and Modal Alternatives
Bakersfield to
Los Angeles Region

Figure 12



Source: Landsat 1985

April 8, 2003

California High Speed Train Program EIR/EIS

10 5 0 10 Miles

10 5 0 10 Kilometers

Legend

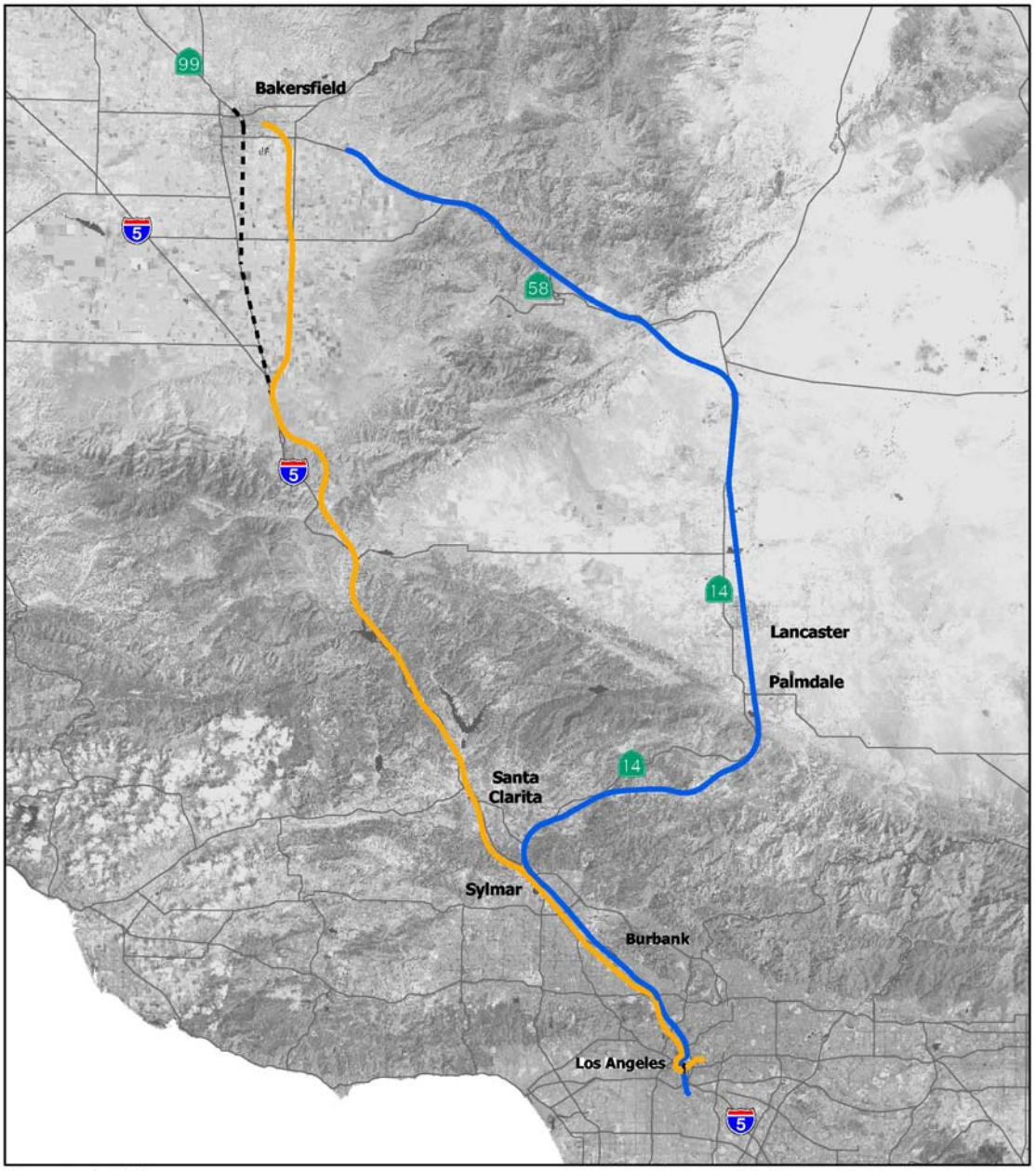
High Speed Rail Alternative
Noise Impacts

- High
- Medium
- Low

Noise Impacts
High Speed Rail Alternative
Bakersfield to
Los Angeles Region

Figure 13

CALIFORNIA HIGH SPEED RAIL AUTHORITY



Source: Landsat 1985

April 8, 2003

California High Speed Train Program EIR/EIS

10 5 0 10 Miles

10 5 0 10 Kilometers

CALIFORNIA HIGH SPEED RAIL AUTHORITY

Legend

High Speed Rail Alternative
Potential Noise Impacts

- Least
- Greatest
- Other Routes

Routes with Least and Greatest Potential Noise Impacts High Speed Rail Alternative Bakersfield to Los Angeles Region

Figure 14

Table 4.5.1 Analysis/Comparison Table – Potential Noise Impacts Bakersfield to Los Angeles

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution		Impact Rating (H,M,L)
				Schools	Hospitals	
No-Project Alternative						
Burbank to LA Union Station	2430	7	225	2		H
I-405 to Burbank	9147	40	60	1		H
Palmdale to I-5	333		40			L
SR-14 to I-405 (S.E.P.)						L
SR-99 to SR-14	204		1145			L
SR-99 to SR-14 (Palmdale)	755		6			L
Modal Alternative						
Burbank to LA Union Station	3,752	10	304	3		H
I-405 to Burbank	13,714	55	81	3		H
Palmdale to I-5	465		48			L
SR-14 to I-405 (S.E.P.)	10					L
SR-99 to SR-14	280		1372			L
SR-99 to SR-14 (Palmdale)	755		6			L
High-Speed Train Alternative						
BAKERSFIELD TO SYLMAR						
Union Ave.+I-5:Tehachapi (Subsegments 2,3)	653		795	2		L
Wheeler Ridge+I-5:Tehachapi (Subsegments 1,3)	1168		772	1		L
SR-58 to Soledad Canyon (Subsegments 4,5,a,7)	377		95		1	L
SYLMAR TO DOWNTOWN BURBANK						
Sylmar Station to Burbank Downtown Station (Subsegments 8,b,10,d,12,c)	2454		9	1		H
DOWNTOWN BURBANK TO LA						
BURBANK DOWNTOWN SIDINGS TO LAUS						
I-5: Burbank Downtown to Silverlake (Subsegments e,15,16)	1520		134			M
Metrolink/UPRR: Burbank Downtown to SR-110 (OVER) (Subsegments f,18,19,20)	821		5	1		M
Metrolink/UPRR: Burbank Downtown to SR-110 (UNDER) (Subsegments f,18,19,21)	959		10	1		M
LAUS TO MAINTENACE YARD						
LAUS Existing Siding to South Connection (Subsegments h,24,29)			0			L
LAUS South Siding to East Connection (Subsegments g,22,28)	146		13	1		M
LAUS Existing Siding to East Connection (Subsegments h,22,28)	146		13	1		M
LAUS South Siding to South Connection (Subsegments g,24,29)	0		0			L
LAUS East Bank North to South Connection (Subsegments 27,I,29)	154		3			L

5.0 VIBRATION IMPACTS

5.1 NO-PROJECT ALTERNATIVE

Vibration impacts are assumed to be non-existent for highway and airport modes.

5.2 MODAL ALTERNATIVE

Vibration impacts are assumed to be non-existent for highway and airport modes.

5.3 HIGH-SPEED TRAIN ALTERNATIVE

HST Alternative entries in the Analysis/Comparison Table above can be used to compare potential impacts between regional alignment options. Residential, park, and institutional impact summaries in the Analysis/Comparison Table are based upon the GIS land use and location data made available for the screening study and the corresponding screening distances used in each alignment portion. Please see the Appendix for a list of the individual screening distances used, and the length of alignment to which each screening distance applies.

5.4 VIBRATION TYPOLOGIES

The results of the Representative Case land use typology vibration studies are shown in the Typology Analysis Table below. The Representative Cases shown illustrate the typologies that exist throughout the Bakersfield to Los Angeles portion of the HST Alternative. Representative Cases were chosen to show a range of the impact levels that are likely to be encountered in Tier 2 analyses.

The results of the typology analyses using the FRA criteria for assessing vibration impacts are indicated in Table 5.4.1. Of the thirteen cases analyzed, seven of them are indicated as being possibly impacted by groundborne vibration. The closer the building is to the alignment, the greater the likelihood of impact. At 50 feet from the alignment, as in the case of the residence in Bakersfield on Virginia, the projected vibration level is 82 dBV or 10 dBV greater than the criterion.

Speed of the train can also be seen to play an important factor in the level of vibration. In the case of the residence in Glendale on Brand Avenue, at 50 feet away the vibration is less because of a lower speed of 105 mph compared with 181 in Bakersfield. Where the speed is much higher, the distance impact can occur extends out to greater distances as in the case of residence in Los Angeles on Hubbard Avenue at 250 feet away, where the train speed is 214mph. In this instance the projected vibration is slightly over the criterion by 2 dBV.

The typology vibration analyses would seem to indicate that beyond about 200 to 250 feet from the alignment vibration would be low enough not to result in impact. This is consistent with the screening distance of 200 feet used for most of the Bakersfield to Los Angeles alignment segments. However, groundborne vibration is very site-specific, and actual vibration levels from HST will be determined and evaluated in more detail in the Tier 2 analysis. These future investigations would measure the local response of the soil strata along the alignment(s) chosen for further impact assessment. Specific HST technology would be evaluated and the characteristics of such systems would be directly taken into account in the analyses.

Mitigation of groundborne vibration can be achieved using special systems that reduce vibration transmitted into the ground below the tracks. Available technology for reducing HST groundborne vibration relies on special track support systems, which are discussed in more detail in Section 6 under

mitigation strategies. Specific mitigation for portions of the HST alignment which are indicated as requiring groundborne vibration mitigation will be developed in the Engineering Phase of the project.

Table 5.4.1 Typology Analysis Table – Potential Vibration Impacts
Bakersfield to Los Angeles

ALIGNMENT/ SEGMENT	LAND USE/DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)*	SPEED (mph)	MAX. ALLOWED (dBV)	PROJECTE (dBV)	IMPACT? (YES/No)
Wheeler	Residences Near Poinsettia & Virginia	Bakersfield	New	50	181	72	82	YES
Union	Residences Union & 8th	Bakersfield	New	130	185	72	77	YES
SR-58	Residences SR-14 & Backus	Near Mojave	New	700	194	72	60	NO
Antelope Valley	Residences W Rosemond Avenue	Rosemond	Exist. Rail	100	206	72	80	YES
Antelope Valley	Residences along Sierra Highway	Lancaster	Exist. Rail	450	214	72	67	NO
Soledad Canyon	Residences Aliso Canyon Road	Kern County	New	400	205	72	68	NO
Soledad Canyon	Residences Soledad Canyon Road	Santa Clarita	New	900	217	72	57	NO
Metrolink UPRR Sylmar Station Siding	Residences along rail near Hubbard Ave.	Los Angeles	Exist. Rail	250	214	72	74	YES
Metrolink/ UPRR Glendale	Residences Brand Blvd	Glendale	Exist. Rail	50	105	72	77	YES
SR-58	Kern County Preventorium	Kern County	Exist. Rail	150	214	72	77	YES
Burbank Airport siding	Pacific Hospital near Burbank Airport siding	Los Angeles	Exist. Rail	550	214	72	65	NO
Union	Union Ave School along Union Ave. @ Casa Loma	Bakersfield	New	100	203	75	80	YES
Burbank Airport siding	Washington Elementary School along I-5 near Burbank Airport	Burbank	Highway	700	118	75	56	NO

*Measured from centerline of alignment

5.5 VIBRATION SCREENING

The vibration screening analysis was performed only for the HST, because the No-Project and Modal Alternatives are assumed to have no associated vibration impacts. Table 5.5.1 presents the detailed results of the vibration screening analysis for the HST Alternative. All alignment options are indicated as having L IRs. Even though there are areas with high population density such as in south Bakersfield, the San Fernando Valley and Los Angeles, most of these populations are outside of the screening distances. Two schools in Bakersfield are within the screening distance. The Kern County Preventorium, is within the screening distance along the SR58 alignment, and is indicated by the Typology impact analysis to be impacted by vibration, as might be expected.

Table 5.5.1 Analysis/Comparison Table – Potential Vibration Impacts – Segment Options Bakersfield to Los Angeles

	Residential (no. of people)	MU (no. of people)	Institution		Impact Rating (H,M,L)
			Schools	Hospitals	
No-Project Alternative*					
Modal Alternative*					
High-Speed Train Alternative					
BAKERSFIELD TO SYLMAR					
Union Ave.+I-5:Tehachapi (Subsegments 2,3)	154		2		L
Wheeler Ridge+I-5: Tehachapi (Subsegments 1,3)	199				L
SR-58 to Soledad Canyon (Subsegments 4,5,a,7)	240				L
SYLMAR TO DOWNTOWN BURBANK					
Sylmar Station to Burbank Downtown Station (Subsegments 8,b,10,d,12,c)	30				L
DOWNTOWN BURBANK TO LA					
BURBANK DOWNTOWN SIDINGS TO LAUS					
I-5: Burbank Downtown to Silverlake (Subsegments e,15,16)	87	22			L
Metrolink/UPRR: Burbank Downtown to SR-110 (OVER) (Subsegments f,18,19,20)	8				L
Metrolink/UPRR: Burbank Downtown to SR-110 (UNDER) (Subsegments f,18,19,21)	10				L
LAUS TO MAINTENACE YARD					
LAUS Existing Siding to South Connection (Subsegments h,24,29)					L
LAUS South Siding to East Connection (Subsegments g,22,28)	1				L
LAUS Existing Siding to East Connection (Subsegments h,22,28)	1				L
LAUS South Siding to South Connection (Subsegments g,24,29)					L
LAUS East Bank North to South Connection (Subsegments 27,I,29)	9				L

6.0 REFERENCES

PUBLICATIONS

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Federal Highway Administration, *FHWA Highway Traffic Noise Model (Version 2.0 Addendum)*, May 2002

Federal Highway Administration, *FHWA Highway Traffic Noise Prediction* Model, FHWA-RD-77-108, December 1978

Federal Railroad Administration, *High-Speed Ground Transportation Noise and Vibration Impact Assessment: Final Draft*, Report No. 293630-1, December 1998.

Federal Transit Administration, *Transit Noise and Vibration Impact* Assessment, Report No. PB96-1721135. April 1995.

GIS DATA

Land Use, CAHSR Alignment, Highway Alignment – Provided by regional team

Parks, Population Density, Schools, Hospitals – ESRI Data & Maps Media Kits 2002, ESRI, 380 New York Street, Redlands, CA

OTHER MATERIALS

Aerial Photos, Plan & Profile Drawings, and Alignment Sections – Provided by regional team

7.0 PREPARERS

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APPENDIX A1

Analysis/Comparison Table – Potential Noise Impacts
Bakersfield to Los Angeles

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution		Impact Rating (H,M,L)
				Schools	Hospitals	
NO-PROJECT						
Burbank to LA Union Station	2,430	7	225		2	H
I-405 to Burbank	9,147	40	60		1	H
Palmdale to I-5	333		40			L
SR-14 to I-405 (S.E.P.)						L
SR-99 to SR-14	204		1145			L
SR-99 to SR-14 (Palmdale)	755		6			L
MODAL						
Burbank to LA Union Station	3,752	10	304		3	H
I-405 to Burbank	13,714	55	81		3	H
Palmdale to I-5	465		48			L
SR-14 to I-405 (S.E.P.)	10					L
SR-99 to SR-14	280		1372			L
SR-99 to SR-14 (Palmdale)	755		6			L
HST CORRIDOR & STATION OPTIONS						
Alignments:						
Wheeler Ridge Corridor	1,098		46		1	M
Union Avenue Corridor	583		69		2	H
I-5: Tehachapi Corridor	70		726			L
SR-58 Corridor	40			1		M
Antelope Valley Corridor	54					L
Soledad Canyon Corridor	269		95			L
Metrolink/UPPR: Sylmar Station North	94					H
Metrolink/UPPR: Sylmar Station to Metrolink	883					H
Burbank Airport to Downtown	77					H
I-5: Glendale	828		82			H
I-5: Silverlake Aerial / Cut and Cover Option	674		49			H
Metrolink/UPPR: Glendale	557		1			H
Metrolink/UPPR: Over and	44					L

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution		Impact Rating (H,M,L)
				Schools	Hospitals	
Under I-5 and SR-110						
Metrolink/UPPR: Over I-5 and SR-110	88		3		1	M
Metrolink/UPPR: Under I-5 and SR-110	226		8		1	H
LAUS Existing: East						L
LAUS Existing: South						L
LAUS East Bank: North	61		3			M
East Connection	146		13		1	H
South Connection						L
Stations:						
Palmdale Siding	14					L
Metrolink/UPPR: Sylmar Station Siding	730		8			H
Burbank Downtown Siding	95		1		1	H
Burbank Airport Siding	575					H
I-5: Burbank Downtown *Siding*	18		3			L
Metrolink/UPPR: Burbank Downtown Siding	132		1			M
LAUS South Siding	-					L
LAUS Existing Siding	-					L
LAUS East Bank Siding	93					M

Analysis/Comparison Table – Potential Vibration Impacts – Segment Options
Bakersfield to Los Angeles

	Residential (no. of people)	MU (no. of people)	Institutional		Impact Rating (H,M,L)
			Schools	Hospitals	
No-Project*					
Modal*					
HST Corridor & Station Options					
Alignments:					
Wheeler Ridge Corridor	90				L
Union Avenue Corridor	45			2	H
I-5: Tehachapi Corridor	109				L
SR-58 Corridor	118				L
Antelope Valley Corridor	3				L
Soledad Canyon Corridor	117				L
Metrolink/UPPR: Sylmar Station North	3				L
Metrolink/UPPR: Sylmar Station to Metrolink	3				L
Burbank Airport to Downtown					L
I-5: Glendale	31				L
I-5: Silverlake Aerial / Cut and Cover Option	55				L
Metrolink/UPPR: Glendale	5				L
Metrolink/UPPR: Over and Under I-5 and SR-110	0				L
Metrolink/UPPR: Over I-5 and SR-110	3				L
Metrolink/UPPR: Under I-5 and SR-110	5				L
LAUS Existing: East					L
LAUS Existing: South					L
LAUS East Bank: North	3				L
East Connection	1				L
South Connection					L
Palmdale Siding	1				L
Stations:					
Metrolink/UPPR: Sylmar Station Siding	17				L
Burbank Downtown Siding					L
Burbank Airport Siding	7				L
I-5: Burbank Downtown Siding		22			L
Metrolink/UPPR: Burbank Downtown Siding					L
LAUS South Siding					L
LAUS Existing Siding					L
LAUS East Bank Siding	6 6				L

* Vibration impacts are assumed to be non-existent for highway and airport modes

APPENDIX A2

Bakersfield to Sylmar		
Option	**Segment code**	**Segment name**
	2	Union Avenue Corridor
A	3	I-5: Tehachapi Corridor
	1	Wheeler Ridge Corridor
B	3	I-5: Tehachapi Corridor
	4	SR-58 Corridor
	5	Antelope Valley Corridor
	a	Palmdale Siding
C	7	Soledad Canyon Corridor
Sylmar to Downtown Burbank		
Option	Segment code	**Segment name**
	8	Metrolink/UPPR: Sylmar Station North
	b	Metrolink/UPPR: Sylmar Station Siding
	10	Metrolink/UPPR: Sylmar Station to Metrolink
	d	Burbank Airport Siding
	12	Burbank Airport to Downtown
A	c	Burbank Downtown Siding
Downtown Burbank to LA		
Option	Segment code	**Segment name**
	e	I-5: Burbank Downtown Siding
	15	I-5: Glendale
A	16	I-5: Silverlake Aerial / Cut and Cover Option
	f	Metrolink/UPPR: Burbank Downtown Siding
	18	Metrolink/UPPR: Glendale
	19	Metrolink/UPPR: Over and Under I-5 and SR-110
B	20	Metrolink/UPPR: Over I-5 and SR-110
	f	Metrolink/UPPR: Burbank Downtown Siding
	18	Metrolink/UPPR: Glendale
	19	Metrolink/UPPR: Over and Under I-5 and SR-110
C	21	Metrolink/UPPR: Under I-5 and SR-110
	h	LAUS Existing Siding
	24	LAUS Existing: South
D	29	South Connection
	g	LAUS South Siding
	22	LAUS Existing: East
E	28	East Connection
	h	LAUS Existing Siding
	22	LAUS Existing: East
F	28	East Connection
	g	LAUS South Siding
	24	LAUS Existing: South
G	29	South Connection
H	27	LAUS East Bank: North

	I	LAUS East Bank Siding
	29	South Connection

	SEGMENT_ID
1	Wheeler Ridge Corridor
2	Union Avenue Corridor
3	I-5: Tehachapi Corridor
4	SR-58 Corridor
5	Antelope Valley Corridor
7	Soledad Canyon Corridor
8	Metrolink/UPPR: Sylmar Station North
10	Metrolink/UPPR: Sylmar Station to Metrolink
12	Burbank Airport to Downtown
15	I-5: Glendale
16	I-5: Silverlake Aerial / Cut and Cover Option
18	Metrolink/UPPR: Glendale
19	Metrolink/UPPR: Over and Under I-5 and SR-110
20	Metrolink/UPPR: Over I-5 and SR-110
21	Metrolink/UPPR: Under I-5 and SR-110
22	LAUS Existing: East
24	LAUS Existing: South
27	LAUS East Bank: North
28	East Connection
29	South Connection
a	Palmdale Siding
b	Metrolink/UPPR: Sylmar Station Siding
c	Burbank Downtown Siding
d	Burbank Airport Siding
e	I-5: Burbank Downtown Siding
f	Metrolink/UPPR: Burbank Downtown Siding
g	LAUS South Siding
h	LAUS Existing Siding
I	LAUS East Bank Siding

Detailed Analysis/Comparison Table
Potential CAHSR Noise Impacts
Bakersfield to Los Angeles Region

SEGMENT_ID	miles	# of noise Ander 11 people	People/mile	# of noise Ander 16 people	People/mile	Park (Acres)	# of Hospitals	# of schools	Severity Metric II (Institutions Normalized)	Rating	DESCRIPTION	Greatest	Least	Greatest Miles	Least Miles	# People Impacted
BAKERSFIELD TO SYLMAR																
OPTION A (2,3)	84.2	653.0	7.8	0.0	0.0	795.0	0.0	2.0	13.7	L	Union Ave.+I-5:Tehachapi		x			1153.0
OPTION B (1,3)	84.9	1168.0	13.8	0.0	0.0	772.0	0.0	1.0	16.7	L	Wheeler Ridge+I-5:Tehachapi	x		84.9		1418.0
OPTION C (4,5,a,7)	110.0	377.0	3.4	0.0	0.0	95.0	1.0	0.0	4.3	L	SR-58 to Soledad Caonyon				110.0	477.0
SYLMAR TO DOWNTOWN BURBANK																
OPTION A (8,b,10,d,12,c)	13.3	2454.0	184.4	0.0	0.0	9.0	0.0	1.0	203.2	H	Sylmar Station to Burbank Dowtown Station	x	x	13.3	13.3	2704.0
DOWNTOWN BURBANK TO LA																
BURBANK DOWNTOWN SIDINGS TO LAUS																
OPTION A (e,15,16)	9.1	1520.0	166.6	0.0	0.0	134.0	0.0	0.0	166.6	M	I-5: Burbank Dowtown to Silverlake	x		9.1		1520.0
OPTION B (f,18,19,20)	9.7	821.0	84.9	0.0	0.0	5.0	0.0	1.0	110.7	M	Metrolink/UPRR: Burbank Downtown to SR-110 (OVER)		x		9.7	1071.0
OPTION C (f,18,19,21)	9.7	959.0	98.6	0.0	0.0	10.0	0.0	1.0	124.4	M	Metrolink/UPRR: Burbank Downtown to SR-110 (UNDER)					1445.1
LAUS TO MAINTENACE YARD																
OPTION D (h,24,29)	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	L	LAUS Existing Siding to South Connection		x		3.7	0.0
OPTION E (g,22,28)	3.8	146.0	38.4	0.0	0.0	13.0	0.0	1.0	104.3	M	LAUS South Siding to East Connection	x		3.8		396.0
OPTION F (h,22,28)	3.5	146.0	42.1	0.0	0.0	13.0	0.0	1.0	114.2	M	LAUS Existing Siding to East Connection					396.0
OPTION G (g,24,29)	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	L	LAUS South Siding to South Connection					0.0
OPTION H (27,I,29)	3.9	154.0	39.8	0.0	0.0	3.0	0.0	0.0	39.8	L	LAUS East Bank North to South Connection					154.0

Potential CAHSR Vibration Impacts
Bakersfield to Los Angeles Region

SEGMENT_ID	miles	# of noise Ander 11 people	People/mile	# of noise Ander 16 people	People/mile	Park (Acres)	# of Hospitals	# of schools	Severity Metric II (Institutions Normalized)	Rating	DESCRIPTION	Greatest	Least	Greatest Miles	Least Miles	# People Impacted
BAKERSFIELD TO SYLMAR																
OPTION A (2,3)	84.2	154.0	1.8	0.0	0.0		0.0	2	7.8	L	Union Ave.+I-5:Tehachapi		x	84.2		654.0
OPTION B (1,3)	84.9	199.1	2.3	0.0	0.0		0.0	0	2.3	L	Wheeler Ridge+I-5:Tehachapi	x			84.9	199.1
OPTION C (4,5,a,7)	110.0	240.1	2.2	0.0	0.0		0.0	0	2.2	L	SR-58 to Soledad Caonyon					240.1
SYLMAR TO DOWNTOWN BURBANK																
OPTION A (8,b,10,d,12,c)	13.3	30.3	2.3	0.0	0.0		0.0	0.0	2.3	L	Sylmar Station to Burbank Dowtown Station	x	x	13.3	13.3	30.3
DOWNTOWN BURBANK TO LA																
BURBANK DOWNTOWN SIDINGS TO LAUS																
OPTION A (e,15,16)	9.1	86.8	9.5	22.4	17.2		0.0	0.0	10.3	L	I-5: Burbank Dowtown to Silverlake	x		9.1		93.6
OPTION B (f,18,19,20)	9.7	7.8	0.8	0.0	0.0		0.0	0.0	0.8	L	Metrolink/UPRR: Burbank Downtown to SR-110 (OVER)		x		9.7	7.8
OPTION C (f,18,19,21)	9.7	10.1	1.0	0.0	0.0		0.0	0.0	1.0	L	Metrolink/UPRR: Burbank Downtown to SR-110 (UNDER)					10.1
LAUS TO MAINTENACE YARD																
OPTION D (h,24,29)	3.7	0.0	0.0	0.0	0.0		0.0	0.0	0.0	L	LAUS Existing Siding to South Connection		x		3.7	0.0
OPTION E (g,22,28)	3.8	1.3	0.3	0.0	0.0		0.0	0.0	0.3	L	LAUS South Siding to East Connection	x		3.8		1.3
OPTION F (h,22,28)	3.5	1.3	0.4	0.0	0.0		0.0	0.0	0.4	L	LAUS Existing Siding to East Connection					1.3
OPTION G (g,24,29)	4.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	L	LAUS South Siding to South Connection					0.0
OPTION H (27,I,29)	3.9	9.0	2.3	0.0	0.0		0.0	0.0	2.3	L	LAUS East Bank North to South Connection					9.0

Detailed Analysis/Comparison Table
Potential Highway No-Project Impacts
Bakersfield to Los Angeles Region

SEGMENT_ID	length (miles)	number of people No-Project 11	number of people No-Project 16	people/(linear miles) No-Project 11	people/(linear miles) No-Project 16	# of Hospitals	# of schools	Severity Metric	Rating
Burbank to LA Union Station	7.4	2,430	7	327	1	-	2	394	H
I-405 to Burbank	15.3	9,147	40	598	3	-	1	615	H
Palmdale to I-5	34.8	333	-	10	-	-	-	10	L
SR-14 to I-405 (S.E.P.)	2.5	-	-	-	-	-	-	-	L
SR-99 to SR-14	65.0	204	-	3	-	-	-	3	L
SR-99 to SR-14 (Palmdale)	97.1	755	-	8	-	-	-	8	L

Detailed Analysis/Comparison Table
Potential Highway Modal Impacts
Bakersfield to Los Angeles Region

SEGMENT_ID	length (miles)	number of people modal 11	number of people modal 16	people/(linear miles) modal 11	people/(linear miles) modal 16	# of Hospitals	# of schools	Severity Metric	Rating
Burbank to LA Union Station	7.4	3,752	10	504	1	-	3	606	H
I-405 to Burbank	15.3	13,714	55	896	4	-	3	946	H
Palmdale to I-5	34.8	465	-	13	-	-	-	13	L
SR-14 to I-405 (S.E.P.)	2.5	10	-	4	-	-	-	4	L
SR-99 to SR-14	65.0	280	-	4	-	-	-	4	L
SR-99 to SR-14 (Palmdale)	97.1	755	-	8	-	-	-	8	L

California High Speed Rail

Los Angeles to Bakersfield - Typology Analysis

Noise Impact Analysis

Coaches Length (ft)	82
Num Coaches	15
Power unit Length (ft)	82
# powers units	1
Total length PU	820
Train Length (ft)	1312 0

Num.	Landuse	Community	Location and/or Description	Corridor Type	Civil Station	Train Speed (mph)
1	Residential	Bakersfield	Near Poinsetta & Virginia	New	Wheeler 456+500	181
2	Residential	Bakersfield	Union & 8th	New	Union 458 +000	185
3	Residential	Near Mojave	SR-14 & Backus	New	SR-5864 + 000	194
4	Residential	Rosemond	W Rosemond Ave	Exist. Rail	Antelope Valley75 + 500	206
5	Residential.	Lancaster	along Sierra Highway	Exist. Rail	Antelope Valley 95+400	214
6	Residential	Kern Co.	Aliso Canyon Rd.	New	Soledad Canyon14 +000	205
7	Residential	Santa Clarita	Solodad Canyon Rd.	New	Soledad Canyon39 + 500	217
8	Residential.	LA	along rail near Hubbard Ave.	Exist. Rail	Metrolink UPRR Sylmar Station Siding 93+500	214
9	Residential	Glendale	Brand Blvd	Exist. Rail	Metrolink/ UPRR Glendale119 + 800	105
10	Hospital	Kern County	Kern County Preventorium	Exist. Rail	SR-5813+300	214
11	Hospital	LA	Pacific Hospital near Burbank Airport siding	Exist.Rail	Burbank Airport siding 100+800	214
12	School	Bakersfield	Union Ave School along Union Ave. @ Casa Loma	New	Union 461+200	203
13	School	Burbank	Washington Elementary School along I-5 near Burbank Airport	Highway	Burbank Airport siding 108+000	118
14	Park	LA	Sun Valley Park	Exist. Rail	Burbank Airport siding 103+500	200
15	Park	LA Co.	Pyramid Lake State Rec. Area along I-5	Highway	I-5 Tehachpi42 + 200	155

California High Speed Rail

Los Angeles to Bakersfield - Typology Analysis

Noise Impact Analysis (continued)

ag = at grade
sc = shallow cut
dc = deep cut
as = aerial structure
emb = embankment
nb = noise barrier

	TOTAL # TRAINS One/Direction			
	7 to 22		22 to 7	
	NB	SB	NB	SB
Gold LIne	17	17	2	2
Green Line	0	0	0	0
Blue Line	41	43	6	4
total trains both direct.	118		14	
train/hr	7.9		1.6	

Distance to Alignment (ft)	Existing Ambient (Ldn/Leqday)	FRA Landuse Category	Alignment Geometry		Speed Regime	Reference SEL	Speed Coefficient K	Reference Speed	Reference Length	Shielding Correction
50	58	2	ag		3	99.0	47	180	73	0
130	60	2	ag		3	99.0	47	180	73	0
700	50	2	ag		3	99.0	47	180	73	0
100	58	2	ag		3	99.0	47	180	73	0
450	62	2	ag		3	99.0	47	180	73	0
400	50	2	as		3	99.0	47	180	73	2
900	50	2	ag		3	99.0	47	180	73	0
250	62	2	as		3	99.0	47	180	73	2
50	67	2	ag		2	93.0	17	90	634	0
150	53	2	ag		3	99.0	47	180	73	0
550	60	2	dc		3	99.0	47	180	73	-10
100	60	3	ag		3	99.0	47	180	73	0
700	65	3	ag		2	93.0	17	90	634	0
350	60	3	dc		3	99.0	47	180	73	-10
50	50	3	as		2	93.0	17	90	634	4

California High Speed Rail

Los Angeles to Bakersfield - Typology Analysis

Noise Impact Analysis (continued)

SEL @ 50ft	Leqday @ 50ft	Leqnight @ 50ft	Ldn @ 50 ft	Project Ldn/Leq @ Receiver	No Mitigation Impact
102.1	75	68	77	77	SI
102.6	76	69	77	71	SI
103.5	77	70	78	61	SI
104.8	78	71	79	75	SI
105.5	79	72	80	66	SI
104.7	80	73	81	68	SI
105.8	79	72	81	62	SI
105.5	81	74	82	72	SI
97.3	71	64	72	72	SI
105.5	79	72	80	73	SI
105.5	69	62	70	55	NI
104.5	78	71	79	73	SI
98.2	72	64	73	54	NI
104.2	68	60	69	55	NI
100.2	78	70	79	78	SI

California High Speed Rail

Los Angeles to Bakersfield - Typology Analysis

Noise Impact Analysis - MITIGATED

Coaches Length (ft)	82
Num Coaches	15
Power unit Length (ft)	82
# powers units	1
Total length PU	82
Train Length (ft)	1312

Num.	Landuse	Community	Location and/or Description	Corridor Type	Civil Station	Train Speed (mph)
1	Residential	Bakersfield	Near Poinsetta & Virginia	New	Wheeler 456+500	181
2	Residential	Bakersfield	Union & 8th	New	Union 458 +000	185
3	Residential	Near Mojave	SR-14 & Backus	New	SR-5864 + 000	194
4	Residential	Rosemond	W Rosemond Ave	Exist. Rail	Antelope Valley75 + 500	206
5	Residential.	Lancaster	along Sierra Highway	Exist. Rail	Antelope Valley 95+400	214
6	Residential	Kern Co.	Aliso Canyon Rd.	New	Soledad Canyon14 +000	205
7	Residential	Santa Clarita	Solodad Canyon Rd.	New	Soledad Canyon39 + 500	217
8	Residential.	LA	along rail near Hubbard Ave.	Exist. Rail	Metrolink UPRR Sylmar Station Siding 93+500	214
9	Residential	Glendale	Brand Blvd	Exist. Rail	Metrolink/ UPRR Glendale119 + 800	105
10	Hospital	Kern County	Kern County Preventorium	Exist. Rail	SR-5813+300	214
11	Hospital	LA	Pacific Hospital near Burbank Airport siding	Exist.Rail	Burbank Airport siding 100+800	214
12	School	Bakersfield	Union Ave School along Union Ave. @ Casa Loma	New	Union 461+200	203
13	School	Burbank	Washington Elementary School along I-5 near Burbank Airport	Highway	Burbank Airport siding 108+000	118
14	Park	LA	Sun Valley Park	Exist. Rail	Burbank Airport siding 103+500	200
15	Park	LA Co.	Pyramid Lake State Rec. Area along I-5	Highway	I-5 Tehachpi42 + 200	155

California High Speed Rail

Los Angeles to Bakersfield - Typology Analysis

Noise Impact Analysis - MITIGATED (continued)

ag =at grade
sc =shallow cut
dc =deep cut
as =aerial structure
emb =embankment
nb =noise barrier

	TOTAL # TRAINS One/Direction			
	7 to 22		22 to 7	
	NB	SB	NB	SB
Gold LIne	17	17	2	2
Green Line	0	0	0	0
Blue Line	41	43	6	4
total trains both direct.	118		14	
train/hr	7.9		1.6	

Distance to Alignment (ft)	Existing Ambient (Ldn/Leqday)	FRA Landuse Category	Alignment Geometry		Speed Regime	Reference SEL	Speed Coefficient K	Reference Speed	Reference Length	Shielding Correction
50	58	2	nb		3	99.0	47	180	73	-5
130	60	2	nb		3	99.0	47	180	73	-5
700	50	2	nb		3	99.0	47	180	73	-5
100	58	2	nb		3	99.0	47	180	73	-5
450	62	2	nb		3	99.0	47	180	73	-5
400	50	2	nb		3	99.0	47	180	73	-5
900	50	2	nb		3	99.0	47	180	73	-5
250	62	2	nb		3	99.0	47	180	73	-5
50	67	2	nb		2	93.0	17	90	634	-10
150	53	2	nb		3	99.0	47	180	73	-5
550	60	2	nb		3					N/A
100	60	3	nb		3	99.0	47	180	73	-5
700	65	3	nb		2					N/A
350	60	3	nb		3					N/A
50	50	3	nb		2	93.0	17	90	634	-10

California High Speed Rail

Los Angeles to Bakersfield - Typology Analysis

Noise Impact Analysis - MITIGATED (continued)

SEL @ 50ft	Leqday @ 50ft	Leqnight @ 50ft	Ldn @ 50 ft	Project Ldn/Leq @ Receiver	Mitigation Impact
102.1	70	63	72	72	SI
102.6	71	64	72	66	SI
103.5	72	65	73	56	I
104.8	73	66	74	70	SI
105.5	74	67	75	61	I
104.7	73	66	74	61	SI
105.8	74	67	76	57	I
105.5	74	67	75	65	SI
97.3	61	54	62	62	I
105.5	74	67	75	68	SI
					N/A
104.5	73	66	74	68	SI
					N/A
					N/A
100.2	64	56	65	64	I

California High Speed Rail

Los Angeles to Bakersfield

Groundborne Vibration Predictions

Num.	Landuse	Community	Location and/or Description	Corridor Type	Civil Station	Train Speed (mph)	Distance to Alignment (ft)	FRA Landuse Category	Max. Allowed Vib	OA	IMPACT?
1	Residential	Bakersfield	Near Poinsetta & Virginia	New	Wheeler 456+500	181	50	2	72	**82**	**YES**
2	Residential	Bakersfield	Union & 8th	New	Union 458 +000	185	130	2	72	**77**	**YES**
3	Residential	Near Mojave	SR-14 & Backus	New	SR-5864 + 000	194	700	2	72	**60**	**NO**
4	Residential	Rosemond	W Rosemond Ave	Exist. Rail	Antelope Valley75 + 500	206	100	2	72	**80**	**YES**
5	Residential.	Lancaster	along Sierra Highway	Exist. Rail	Antelope Valley 95+400	214	450	2	72	**67**	**NO**
6	Residential	Kern Co.	Aliso Canyon Rd.	New	Soledad Canyon14 +000	205	400	2	72	**68**	**NO**
7	Residential	Santa Clarita	Solodad Canyon Rd.	New	Soledad Canyon39 + 500	217	900	2	72	**57**	**NO**
8	Residential.	LA	along rail near Hubbard Ave.	Exist. Rail	Metrolink UPRR Sylmar Station Siding 93+500	214	250	2	72	**74**	**YES**
9	Residential	Glendale	Brand Blvd	Exist. Rail	Metrolink/ UPRR Glendale119 + 800	105	50	2	72	**77**	**YES**
10	Hospital	Kern County	Kern County Preventorium	Exist. Rail	SR-5813+300	214	150	2	72	**77**	**YES**
11	Hospital	LA	Pacific Hospital near Burbank Airport siding	Exist.Rail	Burbank Airport siding 100+800	214	550	2	72	**65**	**NO**
12	School	Bakersfield	Union Ave School along Union Ave. @ Casa Loma	New	Union 461+200	203	100	3	75	**80**	**YES**
13	School	Burbank	Washington Elementary School along I-5 near Burbank Airport	Highway	Burbank Airport siding 108+000	118	700	3	75	**56**	**NO**
14	Park	LA	Sun Valley Park	Exist. Rail	Burbank Airport siding 103+500	200	350	3	75	**70**	**NO**
15	Park	LA Co.	Pyramid Lake State Rec. Area along I-5	Highway	I-5 Tehachpi42 + 200	155	50	3	75	**80**	**YES**

California High Speed Rail

Los Angeles to Bakersfield

Groundborne Vibration Predictions (continued)

PREDICTED VIBRATION LEVELS*																			
1/3OB	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400
77	34	44	51	56	73	77	68	66	64	68	66	63	62	63	23	5	1	0	(4)
73	32	42	49	54	70	73	63	58	55	58	53	48	47	48	7	(10)	(14)	(14)	(16)
55	26	34	40	42	54	55	42	36	31	35	32	27	26	26	(14)	(30)	(29)	(24)	(21)
75	32	43	50	55	71	75	65	61	58	60	56	52	51	52	11	(6)	(10)	(11)	(13)
61	28	37	44	46	61	61	49	43	38	41	37	33	32	32	(8)	(26)	(26)	(23)	(21)
63	29	38	44	47	61	63	50	44	40	42	39	34	33	34	(7)	(24)	(26)	(22)	(20)
51	23	32	37	38	50	51	37	31	26	29	26	21	19	20	(21)	(35)	(31)	(25)	(21)
68	31	41	47	50	66	68	56	51	47	48	44	40	39	39	(2)	(19)	(22)	(20)	(19)
77	34	44	51	56	73	77	68	66	64	68	66	63	62	63	23	5	1	0	(4)
72	32	42	49	54	69	72	61	57	53	56	51	45	45	45	5	(13)	(16)	(16)	(17)
58	27	36	42	44	58	58	46	40	35	38	35	30	29	30	(11)	(28)	(28)	(24)	(21)
75	32	43	50	55	71	75	65	61	58	60	56	52	51	52	11	(6)	(10)	(11)	(13)
55	26	34	40	42	54	55	42	36	31	35	32	27	26	26	(14)	(30)	(29)	(24)	(21)
64	30	39	45	48	63	64	53	46	42	44	41	36	35	35	(5)	(23)	(24)	(22)	(20)
77	34	44	51	56	73	77	68	66	64	68	66	63	62	63	23	5	1	0	(4)

California High Speed Rail

Los Angeles to Bakersfield

Groundborne Vibration Predictions (continued)

FORCE DENSITY LEVEL																		
6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33

California High Speed Rail

Los Angeles to Bakersfield

Groundborne Vibration Predictions (continued)

LINE SOURCE REPONSE																		
2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400
20	23	26	29	32	34	36	38	39	39	39	39	37	33	10	(8)	(20)	(29)	(37)
18	21	24	27	29	30	31	30	30	29	26	24	22	18	(6)	(23)	(35)	(43)	(49)
12	13	15	15	13	12	10	8	6	6	5	3	1	(4)	(27)	(43)	(50)	(53)	(54)
18	22	25	28	30	32	33	33	33	31	29	28	26	22	(2)	(19)	(31)	(40)	(46)
14	16	19	19	20	18	17	15	13	12	10	9	7	2	(21)	(39)	(47)	(52)	(54)
15	17	19	20	20	20	18	16	15	13	12	10	8	4	(20)	(37)	(47)	(51)	(53)
9	11	12	11	9	8	5	3	1	0	(1)	(3)	(6)	(10)	(34)	(48)	(52)	(54)	(54)
17	20	22	23	25	25	24	23	22	19	17	16	14	9	(15)	(32)	(43)	(49)	(52)
20	23	26	29	32	34	36	38	39	39	39	39	37	33	10	(8)	(20)	(29)	(37)
18	21	24	27	28	29	29	29	28	27	24	21	20	15	(8)	(26)	(37)	(45)	(50)
13	15	17	17	17	15	14	12	10	9	8	6	4	(0)	(24)	(41)	(49)	(53)	(54)
18	22	25	28	30	32	33	33	33	31	29	28	26	22	(2)	(19)	(31)	(40)	(46)
12	13	15	15	13	12	10	8	6	6	5	3	1	(4)	(27)	(43)	(50)	(53)	(54)
16	18	20	21	22	21	21	18	17	15	14	12	10	5	(18)	(36)	(45)	(51)	(53)
20	23	26	29	32	34	36	38	39	39	39	39	37	33	10	(8)	(20)	(29)	(37)

Exec Summary Charts

Region: Bakersfield to Los Angeles - Potential Noise Impacts - Impact Rating

Alternative	Align. Length (mi) L rating	Align. Length (mi) M rating	Align. Length (mi) H rating	Align. Length (mi) Total
No-Project	199.4	0.0	22.7	222.1
Modal	199.4	0.0	22.7	222.1
HST - Least	113.7	9.7	13.3	136.7
HST - Greatest	84.9	12.9	13.3	111.1

Exec Summary Charts

Region: Bakersfield to Los Angeles - Potential Vibration Impacts - Impact Rating

Alternative	Align. Length (mi) L rating	Align. Length (mi) M rating	Align. Length (mi) H rating	Align. Length (mi) Total
No-Project	0.0	0.0	0.0	0.0
Modal	0.0	0.0	0.0	0.0
HST - Least	111.6	0.0	0.0	111.6
HST - Greatest	110.5	0.0	0.0	110.5