3 AFFECTED ENVIRONMENT, ENVIRONMENTAL CONSEQUENCES, AND MITIGATION STRATEGIES

3.0 INTRODUCTION

This chapter addresses potential impacts to environmental resources, treating each of these resources in a separate subsection. CEQA encourages state agencies to prepare joint CEQA-NEPA documents and also encourages agencies to rely on EISs prepared for compliance with NEPA to satisfy CEQA requirements where possible and appropriate. The Co-lead agencies have used their best judgment in preparing this combined Program EIR/EIS to satisfy both CEQA and NEPA requirements, and as a result, it contains more information than that which is mandated by either the federal or State statutory and regulatory requirements. Including this information is appropriate due to the complex and unusual nature of, and the technical issues involved in, the project, the proposed HST system. While some sections in this chapter may appear to focus more on NEPA terminology than CEQA, the information and environmental analyses provided fully satisfy the requirements of both NEPA and CEQA. In addition Chapter 7 includes summary information on certain CEQA requirements discussed in this Chapter.

Each environmental area (sections of this chapter) includes potential mitigation strategies that would be applied in general for the HST system. Each subsequent section of this chapter also outlines specific design features that will be applied to the implementation of the HST system to avoid, minimize, and mitigate potential impacts.

The Authority has focused on avoiding and minimizing potential impacts through rigorous planning and thoughtful design. The Authority has minimized overall impact potential by defining alignments to stay within existing public and railroad rights-of-way to the extent feasible while still accommodating the appropriate features and design standards for the alternatives. While the Program level of environmental analysis has provided a means to avoid and minimize impacts in the selection of corridor options for further consideration, it does not identify specific impacts or mitigation. Most of the potential impacts associated with the implementation of the proposed HST system are highly site-specific in nature. These site-specific issues would be addressed during subsequent project level environmental review, based on more precise information regarding location and design of the facilities proposed (e.g., physical configuration {elevated, at-grade}, specific location, right of way footprint, catenary design features, fencing type and station access configuration, etc.). The level of engineering detail associated with the project level environmental analysis would enable the Authority to further investigate ways to avoid, minimize and mitigate potential impacts. Only after the alignment is refined and the facilities are fully defined through project level analysis, and site-specific avoidance and minimization efforts have been exhausted, would specific impacts and mitigation measures be addressed.

3.0.1 Purpose and Content of this Chapter

This purpose of this chapter is to describe existing environmental conditions in the areas that would be affected by the proposed high-speed train (HST) system and alternatives; evaluate potential environmental impacts associated with constructing and operating the HST alternative or the Modal Alternative; and present potential program-level mitigation strategies to avoid or reduce those impacts. The analysis presented in this chapter addresses the general effects of a program of actions that would make up the proposed statewide HST project. This chapter describes the general differences in potential environmental consequences between the No Project/No Action (No Project) Alternative, the Modal Alternative, and the HST Alternative. The analysis also identifies key differences between the potential impacts associated with the various HST station and alignment options, to support the selection of preferred alignment and station options for the system.

The analysis encompasses all alignment options considered for the HST alternative as described in Chapter 2. A preferred system of HST alignment options is defined in Chapter 6A, including a broad corridor for subsequent study in the northern mountain crossing.

Many sources were used in the preparation of this document. References to these sources are provided in Chapter 12. In some cases to clarify a particular source, specific references are called out in the text.

3.0.2 How this Chapter is Organized

This chapter is organized into sections by resource topic. The resource topics are grouped as follows.

- Transportation and related topics (air quality; noise and vibration; energy; and electromagnetic interference).
- Human environment (land use and community impacts; parklands; farmlands and agriculture; aesthetics and visual resources; socioeconomics; utilities and public services; and hazardous materials/wastes).
- Cultural resources (archaeological resources, historic properties) and paleontological resources.
- Natural environment (geology and seismic hazards; hydrology and water resources; and biological resources, including wetlands).
- Section 4(f) and 6(f) resources (certain types of publicly owned parklands, recreation areas, wildlife/waterfowl refuges, and historic sites).

Each resource topic section contains the following information.

- Methods of evaluation.
- Regulatory requirements.
- Affected environment.
- Environmental consequences.
- Mitigation strategies.
- Subsequent analysis.

The methods of evaluation and regulatory requirements discussions for each resource topic describe the assumptions, approach for evaluation, and rating scheme used to identify potential impacts as *significant* (potentially requiring mitigation), and identify the relevant statutes and CEQA, NEPA, or regulatory agency guidelines relevant to future project approvals or decisions for that resource area. The methods of impact evaluation were developed with input from state and federal resource agencies. The agencies acknowledged that this is a planning-level EIR/EIS aimed at making broad decisions about whether to pursue a high-speed train as a means of intercity travel in California, and if pursued, to help determine the corridors and alignments to carry forward for project-level environmental evaluation. Key differences in potential impacts for each of the alternatives are described.

As described in Chapter 2, *Alternatives*, ridership for this system was estimated to vary between 42 million passengers on the low end and 68 million passengers on the high end (10 million riders would be long-distance commuters) for 2020. For this Program EIR/EIS, the higher ridership forecast of 58 million intercity trips, together with 10 million commute trips, provides a reasonable representation of total capacity and serves as a representative worst-case scenario for analyzing the potential environmental impacts from the physical and operational aspects of the system alternatives in 2020. This higher forecast is generally used as a basis for defining the system alternatives and is referred to hereafter as the *representative demand*. In some specific analyses (e.g., energy, air quality, and transportation), the high-end forecasts would result in potential benefits. In those cases additional analysis is included in this Program EIS/EIR to address the impacts associated with the lower ridership forecasts.

The affected environment discussions summarize the information that provides the basis for analysis of potential environmental impacts on each environmental resource. Information in the affected environment discussions is presented by study region. From north to south the five study regions are: Bay Area to Merced; Sacramento to Bakersfield; Bakersfield to Los Angeles; Los Angeles to San Diego via Inland Empire; and Los Angeles to San Diego via Orange County (LOSSAN). Because the proposed HST system would not be operational until the year 2020, the affected environment discussions describe both the existing conditions as of 2003 and, where appropriate and not overly speculative, the anticipated 2020 conditions that would pertain when the project becomes operational. For disciplines where projections of future changes in existing conditions would be overly speculative, the existing 2003 conditions were used as a proxy for the 2020 conditions. For some disciplines—such as transportation, energy, air quality, and land use—future conditions are routinely projected in adopted regional or local planning documents or are forecast by public agencies. In these cases, the existing conditions and the projected 2020 conditions were used as the basis for impact analysis. The technical studies prepared for each region and addressing each resource area provided key information for the preparation of the affected environment discussions.

The environmental consequences discussions describe the potential environmental impacts (both adverse and beneficial) of the Modal and HST Alternatives in comparison to the No Project Alternative and compared to each other. Each discussion begins by comparing existing conditions with 2020 No Project conditions to describe the consequences of No Project and how environmental conditions are expected to change during the timeframe required to bring the proposed HST system online. As described above, existing (2003) conditions were used as a proxy for 2020 No Project conditions where 2020 baseline information was unavailable, could not be projected, or would be overly speculative. Using 2020 No Project conditions as a basis for comparison, the analysis of impacts then addresses direct and indirect impacts for the proposed HST and Modal Alternatives, as well as potential cumulative impacts. Measures that already have been included as part of the proposed HST Alternative to reduce or avoid potential environmental impacts were incorporated into this analysis; examples include locating the alignment within an existing transportation corridor, and tunneling to avoid surface disruption in sensitive areas such as parklands and wildlife habitat areas. The impact analysis first compares alternatives on a system-wide basis and then compares alternatives regionally. In addition, the alignment and station options within segments of the HST Alternative are compared with one another.

The Final Program EIR/EIS analysis shows differences in both adverse and beneficial potential environmental impacts from the No Project, Modal, and HST Alternatives at the system-wide level. For many of the environmental areas, broad study areas were defined in order to provide a wide context of the existing resources in proximity to proposed improvements. For example, the area of floodplains includes all floodplains within 100 feet (ft) (30.5 meters [m]) of either side of the centerline of the alignment considered. However, the right-of-way necessary for the improvements considered is much smaller (e.g., only 25 ft [7.6 m] on either side of centerline for HST). This broader study area represents the potentially affected area. Potential impacts are reported only for a corridor width or "footprint" that represents the potential impacts of the system planned, which is assumed at 25 ft. (7.6 m) on either side of centerline (50 ft. (25 m) total width) for HST alignment options and approximately 20-40 ft. (6-12 m) on each side of existing highway facilities.

Potential impacts to public services such as traffic and circulation and utilities are addressed in the sections that follow. However, greater specificity in alignment location and profile, station designs, system access, and control systems is needed in order to be able to address the potential impacts on specific public services, such as provision of emergency personnel. These issues will be addressed during subsequent project level environmental review, when more precise information will be available regarding location and design of the facilities proposed (e.g., elevated, at-grade, access locations, station design features, fencing type and location, etc.). The detail of engineering associated with the project level environmental analysis will allow the Authority to identify system requirements and further investigate ways to avoid, minimize and mitigate potential affects on the provision of such services.

A. DESIGN FEATURES/PRACTICES AND MITIGATION STRATEGIES

As currently planned, the preferred HST system would avoid and minimize potential negative environmental consequences of the proposed system. Conceptual designs of the preferred HST system meet the project objectives (Chapter 1: Purpose and Need and Objectives), and design criteria (Engineering Criteria Report, January 2004), which set specific goals to avoid and minimize negative environmental consequences. In addition, design and construction practices have been identified that would be employed as the project is developed further in the project specific environmental clearance, final design and construction stages. While many of these practices are explicitly included in the project description and included in the capital cost estimates for the project, their application to avoidance and minimization of potential impacts may not be readily apparent. Thus, for each environmental resource area (section of Chapter 3), applicable design and construction practices and resulting features related to the potential impacts identified in that section are discussed.

The mitigation strategies discussions describe potential mitigation approaches that can be identified at a program level for use to avoid, minimize, or reduce any potentially significant environmental impacts.

Finally, each resource topic section includes a subsequent analysis discussion summarizing directions for more detailed study during project-level environmental review and documentation should an action alternative be selected through the program environmental process.

3.1 TRAFFIC AND CIRCULATION

This section describes the existing traffic and circulation conditions in the transportation study area and identifies the potential traffic, transit, circulation, and parking impacts of each alternative and high-speed train (HST) alignment and station option.

3.1.1 Regulatory Requirements and Methods of Evaluation

A. REGULATORY REQUIREMENTS

The National Environmental Policy Act (NEPA) and California Environmental Quality (CEQA) both require that potential impacts of a proposed project on the traffic, transit, and circulation of the affected area must be examined as part of the EIR/EIS process. Under CEQA, a proposed project should be analyzed for the potential effects listed below (California Department of Transportation 2003).

- An increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in the number of vehicle trips, the volume-to-capacity [V/C][1] ratio on roads, or congestion at intersections).
- Either individually or cumulatively exceeding a level of service (LOS)[2] standard established by the county congestion management agency for designated roads or highways.
- A substantial increase in hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment).
- Inadequate parking capacity.
- Inadequate emergency access.
- Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks).
- Rail, waterborne, or air traffic impacts.

V/C ratios and LOS are defined quantitatively in Table 3.1-1.

[1] The *volume-to-capacity (V/C) ratio* is the number of vehicles that travel on a transportation facility divided by the full vehicular capacity of that facility (the number of vehicles the facility was designed to convey).

[2] *Level of service* is a qualitative measure used to describe the condition of traffic flow, ranging from excellent conditions at level of service (LOS) A to overloaded conditions at LOS F. LOS D is typically recognized as an acceptable service level in urban areas. The definition for each level of service for signalized intersections is based on the V/C ratio.

Table 3.1-1
Level of Service and Volume-to-Capacity Ratio Definition

Level of Service	Volume-to-Capacity Ratio	Definition
A	0.000–0.600	EXCELLENT. No vehicle waits longer than one red light and no approach phase is fully used.
B	0.601–0.700	VERY GOOD. An occasional approach phase is fully used; many drivers begin to feel somewhat restricted within groups of vehicles.
C	0.701–0.800	GOOD. Occasionally drivers may have to wait through more than one red light; backups may develop behind turning vehicles.
D	0.801–0.900	FAIR. Delays may be substantial during portions of rush hours, but enough lower volume periods occur to permit clearing of developing lines, preventing excessive backups.
E	0.901–1.000	POOR. Represents the maximum vehicles that intersection approaches can accommodate; may be long lines of waiting vehicles through several signal cycles.
F	>1.000	FAILURE. Backups from nearby locations or on cross streets may restrict or prevent movement of vehicles out of the intersection approaches. Tremendous delays with continuously increasing queue lengths.
Source: Transportation Research Board 1980.		

Given the scale of the proposed high-speed rail system, virtually all of the criteria mentioned above would be potentially affected by the No Project, Modal, and HST Alternatives. For this analysis, this program-level document focused on the criteria below.

- Traffic and LOS analysis of the following elements.
    - Intercity highway segments.
    - Primary highways/roadways accessing proposed HST stations.
    - Primary highways/roadways accessing airports.
- Potential impacts on transit, goods movement, and parking for each of the regional corridors and proposed stations and airports.

B. METHOD OF EVALUATION OF IMPACTS

The traffic, transit, circulation, and parking analyses for this Program EIR/EIS focused on a broad comparison of potential impacts on traffic, transit, circulation, and parking along stations and around corridors for the Modal and HST Alternatives. The potential impacts for each of these alternatives were compared to the No Project Alternative.

Highway, roadways, passenger transportation services (e.g., bus, rail, air, intermodal, and transit facilities), goods movements, and parking issues were evaluated in this analysis. Transportation facilities, highways, and roadways included in the analysis serve as the primary means of existing (or planned future) access to proposed rail stations and airports. In addition, these facilities are within 1 mile (mi) (1.6 kilometers [km]) of the proposed suburban rail stations, 0.25 mi (0.40 km) of proposed downtown stations, or 1 mi (1.6 km) of airports, or are key capacity constraint points on major routes along intercity corridors.

Initial analysis included identifying primary routes to be considered, with highways designated in the No Project and Modal Alternatives, and all modes of access to the stations and airport areas in the Modal and HST Alternatives, respectively. The primary routes and modes of access for the stations and airports considered assumptions for distribution of trips by direction.

Once primary routes were identified, screenlines or cordons combining segments of the primary routes that reasonably represent locations for evaluating the aggregate baseline traffic and public passenger transportation conditions (using data for 2002, 2020, or other similar years as available) in the a.m. peak hour were selected. The use of screenlines or cordons is necessitated by the scale of this analysis with its requirement to evaluate roadway conditions throughout the state. A more detailed analytical framework must necessarily be reserved for future analyses of individual projects.

Screenlines, especially on intercity highway links, have been selected to represent typical morning peak-hour conditions. The data used in the evaluation of traffic volumes and capacities at the screenlines therefore are typical values based on averages over time and represented in traffic forecasting tools used by the regional transportation planning agencies. As such, the conditions indicated in the evaluation may not always reflect the experiences of travelers at any particular place at any specific time. For example, localized capacity restrictions (e.g., bottlenecks at a given interchange) are not well represented in those regional traffic models. In addition, incidents on the road such as accidents and vehicle breakdowns (non-recurring congestion) are not represented in regional traffic models. This unpredictable type of incident is responsible for the majority of congestion in urban highway networks. The result of these limitations of the methodology and data used in this analysis is that many times the level of service or average speed shown in the evaluation may be more optimistic than what would actually be experienced on the roadway under the forecasted conditions. Thus, it is important to consider the differences between the alternatives compared rather than focus on the absolute value of the indicators (i.e., V/C or LOS).

Baseline conditions were defined using the methodology below.

- Intercity Screenlines—Baseline conditions (2002, 2020) were established for intercity highway segments based on available counts of existing weekday morning peak-hour traffic volumes and projected annual growth rates. This process involved a comparison of existing V/C to determine LOS at link level.
- Station and Airport Cordons—Baseline (2002 and 2020 data, as available) ratios of demand to capacity across each cordon for roadways (not intersections) were established for the weekday morning peak hour using *2000 HCM* standards for capacity. (Transportation Research Board 2000.)
- Transit Access—Baseline conditions were established through an inventory of available public transportation services at and adjacent to the stations and airports.
- Goods Movement—Baseline conditions (2002, 2020) for goods movement (truck freight) weekday morning peak hour for locations in the area were identified as critical by regional goods movement studies.
- Parking near Stations and Airports—Descriptions of parking conditions are based on 2002 parking reserves, local plans for major parking expansion, and adequacy of local parking codes for meeting No Project growth in demand.

Trip generation was calculated based on the forecasted 2020 demand for high-speed rail and airports and highways improved under the Modal Alternative, the local trips in 2020 generated by project-related development (as data are available), and the additional trips due to induced growth. The generated trips were added to the appropriate baseline volumes and distributed to the identified screenlines or cordons (roadway and public transportation). Next, the generated trips were distributed on selected segments/links on primary regional routes and modes of access to stations and similar facilities at a screenline level. Specific aspects of the methodology for this process are detailed below.

- For each screenline or cordon, new ratios of demand-to-capacity were calculated. *Demand* is the baseline volumes plus additional trip generation by the Modal or HST Alternatives.
- Future No Project link capacity conditions were established through available plans from local and regional agencies, and based on the fiscally constrained element of the relevant regional transportation plan (RTP).
- For the Modal Alternative, assumed 2020 capacity is the baseline capacity plus any improvements included in the fiscally unconstrained element of the RTP needed to mitigate potential V/C impacts. In some instances, further roadway widenings (i.e., beyond even the fiscally unconstrained RTP projects) were needed to provide capacity sufficient to meet projected traffic.
- Link-level analysis of impacts was performed to roadways for weekday morning peak-hour conditions. Capacity levels were based on the *2000 HCM* methodologies.
- Future roadway V/C on selected segments compared future volumes with/without alternatives with future capacity determined. Future V/C with/without the alternatives was analyzed. This assessment was performed at a cordon level, aggregating the V/C on all major facilities accessing the stations or airports.
- Cordon-level analysis was also performed for public transportation services serving the stations or airports, based on weekday morning peak-hour service headway and capacity conditions.
- Impacts were determined by comparing future load factors or service headway requirements with existing levels, No Project levels (as specified in relevant RTPs), and levels demanded by the Modal and HST Alternatives.
- Goods movement impacts were determined through an assessment of the net impact of project alternatives on the corridor.

Summary tables for the regions were then completed that identified impacts on highways/roadways (at screenline), public transportation services, goods movement, and parking facilities. The impacts are described and ranked as high, medium, or low in the summary tables in the appendix for this section, according to the potential extent of change to traffic, transit, circulation, and parking and described in terms of LOS A to LOS F for traffic impacts.

The final step included the identification of mitigation strategies for avoidance of potential impacts related to traffic, circulation, and parking. Most mitigation measures involve subsequent analysis of traffic, circulation, or parking in the next phase of work.

3.1.2 Affected Environment

A. STUDY AREA DEFINED

The transportation study area is defined as the primary highways and roadways that: 1) serve as the primary means of access to proposed rail stations and airport facilities, as well as the highway/roadway improvements and new facilities proposed under the Modal Alternative; and 2) are within 1.0 mi (1.6 km) of proposed rail stations and, for the Modal Alternative, airports and major routes along alignments or highway corridors.

B. GENERAL DISCUSSION OF TRAFFIC AND CIRCULATION

This analysis only considers the primary highways and roadways that serve the transportation study area. Although this level of analysis is appropriate for a program-level environmental document, variations in traffic conditions on smaller transportation facilities such as arterials and roadways are not included in the study area. Many of these smaller facilities are currently congested, and their operation is projected to worsen under the No Project Alternative. Operation on these facilities could indirectly benefit from implementation of the Modal or HST Alternative. The capacity improvements of the Modal Alternative could keep long-distance trips off local roads, while the HST Alternative could reduce demand such that long-distance trips would not be forced onto local streets. The potential impact of the proposed Modal and HST system on these smaller facilities would be examined as part of any subsequent and more detailed project-level environmental analyses.

Currently, the study area highway and roadway corridors considered in this analysis represent some of the worst traffic conditions in the nation. Highways are heavily congested during both the morning and evening peak hours in and around urban centers such as San Francisco, Sacramento, Los Angeles, and San Diego. Although the peak periods have a shorter duration, congestion affects many traditional rural and suburban communities in the Central Valley. This congestion is caused mostly by regional and urban commute traffic. Commute trips (to and from work) make up the majority of highway trips during the peak periods; the intercity trips considered in this analysis represent only a small proportion of highway traffic. The Southern California Association of Governments (SCAG) has estimated that, during morning peak-hour traffic in some of the most congested corridors in southern California, the average speed is less than 20 miles per hour (mph) (32 kilometers per hour [kph]) in the congested direction. In 2002, traffic congestion cost motorists in California $20.4 billion annually in lost time and fuel. Los Angeles and the San Francisco-Oakland area were rated as the nation's two most congested regions, and 6 out of the 25 most congested urban regions were in California (Texas Transportation Institute 2003).

Traffic conditions throughout northern and southern California are expected to worsen, and only limited improvements to transportation facilities are funded and programmed for implementation by 2020. Steadily increasing regional and urban traffic affects intercity commutes by delaying travelers where capacity is constrained. For example, according to the *Bay Area Regional Transportation Plan* (Metropolitan Transportation Commission 1999), regional travel (i.e., travel between different regions) within the Bay Area is expected to grow by 46%, and intraregional travel (i.e., travel within a region) is projected to grow by 115% by 2020. Intercity travel that competes with regional and intraregional travel for use of the same facilities is directly affected by these conditions. For instance, an intercity trip between Los Angeles and San Francisco is likely to be affected by congestion in the heavily traveled regional and intraregional travel corridors in southern and northern California, and in certain segments of the Central Valley.

C. TRAFFIC AND CIRCULATION RESOURCES BY REGION

The following section briefly describes the transportation facilities, highways, and roadways in each of the five regions analyzed.

Bay Area to Merced

This region includes central California from the San Francisco Bay Area (San Francisco and Oakland) south to the Santa Clara Valley and east across the Diablo Range to the Central Valley. The primary airports in the Bay Area are San Francisco International (SFO), Oakland Metropolitan International (OAK), and Norman Y. Mineta San Jose International (SJC). As defined in Chapter 2, *Alternatives*, only OAK and SJC were considered for airport-related improvements under the Modal Alternative. The primary north-south highways in the Bay Area are US-101 and I-280 on the Peninsula, and I-880 and I-680 in the East Bay. I-80 links San Francisco and Oakland via the Bay Bridge and continues to Sacramento. I-580, I-205, and SR-152 provide access to I-5 in the

Central Valley. I-380 and SR-87 provide east-west access on the San Francisco peninsula to SFO and SJC, respectively. In the Bay Area to Merced Region, US-101, I-880, I-80, I-580, and SR-152 would undergo improvements under the Modal Alternative.

Sacramento to Bakersfield

This region of central California includes a large portion of the Central Valley (San Joaquin Valley) from Sacramento south to Bakersfield. Six airports were considered in the analysis of the Modal Alternative: Sacramento International Airport (SMF), Modesto City-County Harry Sham Field (MOD), Merced Municipal/Macready Field (MCE), Fresno Yosemite International Airport (FAT), Visalia Municipal Airport (VIS), and Bakersfield Meadows Field Airport (BFL). The Stockton Airport was not considered because of constraints that make airport expansion infeasible. Only SMF was considered for airport-related improvements. Key intercity highways in the Sacramento to Bakersfield region include I-5, SR-99, and I-80 west of Sacramento. In the Sacramento to Bakersfield region, I-5 and SR-99 would undergo improvements under the Modal Alternative.

Bakersfield to Los Angeles

This region of southern California encompasses the southern portion of the Central Valley south of Bakersfield, the mountainous areas between the Central Valley and the Los Angeles basin, and the northern portion of the Los Angeles basin from Sylmar to downtown Los Angeles. The Burbank-Glendale-Pasadena Airport (BUR) site was considered in the analysis of the Modal Alternative. I-5 is the primary highway link between southern California and northern California and the San Joaquin Valley. SR-14, on the west side of the San Gabriel Mountains, is the primary link between Antelope Valley, eastern California, and Los Angeles. In the Bakersfield to Los Angeles region I-5, SR-58, and SR-14 would undergo improvements under the Modal Alternative.

Los Angeles to San Diego via Inland Empire

This region of southern California includes the eastern portion of the Los Angeles basin from downtown Los Angeles east to the Riverside and San Bernardino areas and south to San Diego generally along the I-215 and I-15 corridors. The Ontario International Airport (ONT) and San Diego International-Lindbergh Field (SAN) are the only airports potentially affected by the Modal Alternative in this region. The intercity highways in Los Angeles and Riverside Counties that could be affected by the Modal Alternative are I-10 and I-215. In San Diego County, potentially affected highways are I-15 and SR-163. In the Los Angeles to San Diego via Inland Empire region, I-10, I-15, I-215, and SR-163 would undergo improvements under the Modal Alternative.

Los Angeles to San Diego via Orange County

This region includes the western portion of the Los Angeles basin between downtown Los Angeles and Los Angeles International Airport (LAX) and the coastal areas of southern California between Los Angeles and San Diego, generally following the existing Los Angeles to San Diego via Orange County (LOSSAN) rail corridor. In the LOSSAN region, I-5 and I-8 would undergo improvements under the Modal Alternative.

LAX and Long Beach Municipal Daugherty Field (LGB) are the only major commercial airports that were considered in the analysis of the Modal Alternative for the LOSSAN region. John Wayne International-Orange County Airport (SNA) in Orange County was not considered in the analysis because of constraints that make airport expansion infeasible.

A limited number of intercity highways in the region connect the three metropolitan areas of Los Angeles, Orange, and San Diego Counties. I-5 has been identified as the primary route between Los Angeles Union Station (LAUS) and San Diego. I-110 and I-105 were identified as the most direct highway links between LAUS and LAX.

3.1.3 Environmental Consequences

A. EXISTING CONDITIONS COMPARED TO NO PROJECT ALTERNATIVE

The existing condition is the transportation infrastructure that exists in 2003 and its associated levels of service. The No Project Alternative includes the existing infrastructure, plus the implementation of funded and programmed transportation improvements that will be operational by 2020 and the projected level or service of that infrastructure in 2020. Impacts on intercity highways are analyzed in terms of V/C ratio, corresponding LOS, and average highway speed. Impacts on transit, goods movement, and parking are harder to quantify but include potential impacts such as full parking lots at stations, and are assigned a low, medium, or high rating corresponding to the estimated level of potential impact.

In general, traffic conditions throughout the study area are poor in terms of congestion levels (e.g., travel delays), particularly during the peak periods. According to nationwide studies conducted by the Texas Transportation Institute, urban areas of San Francisco and Los Angeles experience some of the highest congestion levels in the country (Texas Transportation Institute 2002). Under the No Project Alternative in all regions, existing traffic conditions are projected to deteriorate on highway segments, around airports, and near the proposed HST stations in the study area. As shown in Figures 3.1-1 and 3.1-2, all of the 68 intercity highway segments analyzed, except I-580, would have a high V/C ratio under the No Project Alternative. Traffic congestion is projected to increase because travel is expected to increase by 2 to 3% per year in many areas. The No Project Alternative does not provide infrastructure improvements sufficient to address the projected growth in highway travel and the exponential increase of commute trips to both the traditional urban areas (i.e., the San Francisco Bay Area and Los Angeles basin) and the emerging urban areas in the Central Valley. In most cases, the potential impact would manifest itself as deteriorating LOS on highway segments and local streets or extended peak-period congestion on highways that already operate at LOS F (i.e., the morning peak period would extend from two hours to four hours). As summarized in Table 3.1-2, V/C ratios are projected to deteriorate by 38.4% on average across all five regions, and each region would have more LOS F segments under the No Project Alternative compared to existing conditions. The average V/C ratio would also deteriorate significantly (38.4%), which would result in more severe congestion and peak periods that last longer under the No Project Alternative compared to existing conditions.

Table 3.1-2
Summary of Existing and No Project Conditions

Intercity Highway Segments Number Operating at V/C greater than 1.0 or LOS F				
Region	Number Analyzed	Existing Condition	No Project Condition	Average Change in V/C from Existing
Bay Area to Merced	14	12	12	5%
Sacramento to Bakersfield	22	2	8	52%
Bakersfield to Los Angeles	10	5	7	73%
Los Angeles to San Diego via Inland Empire	12	7	11	43%
Los Angeles to San Diego via Orange County	10	9	8	19%
Total	68	35	38	
Average				38.4%
Source: Parsons Brinckerhoff 2003.				

Exceptions to these projected worsening conditions are expected to occur in areas where planned highway improvements will be implemented and operational by 2020. There are only a handful of segments projected to improve between existing conditions and the No Project condition, and the projected improvements would not cause a general improvement or stabilization of conditions across the study area. Those segments that do improve are expected to eventually worsen over time as their capacity is filled by new trips attracted to the less-congested facilities.

Summary descriptions of the existing and No Project Alternative traffic, transit, circulation, and parking conditions by region are provided below. Traffic and circulation in proposed HST station areas are analyzed for the No Project Alternative, but the stations would be implemented only under the HST Alternative. For a more detailed discussion of traffic data in the five regions under existing, No Project, and the proposed Modal and HST Alternatives, see Appendix 3.1-A.

<u>Bay Area to Merced</u>

<u>Intercity Highway Segments</u>: After a decade of rapid job growth in the Bay Area, most freeway segments in the study corridors of I-80, US-101, I-880, I-580, and SR-152 are very congested, operating at LOS F in the morning peak hour in the peak direction. V/C ratios are expected to worsen on most segments under the No Project Alternative. Conditions are expected to improve only on I-880 north of San Jose and on US-101 south of San Jose, where planned highway improvements are to be implemented and operational by 2020. Overall, traffic congestion is projected to worsen because travel rates (or the number of trips taken) are increasing by 2 to 3% per year at the gateways to the Bay Area. Commute trips into the Bay Area are expected to increase by 233% between 1990 and 2020.

<u>Proposed High-Speed Train Stations</u>: Roadways in the study area near most of the station areas would have worse LOS under the No Project Alternative than under existing conditions. It is estimated that that LOS in 11 of the 15 station areas would deteriorate. The Millbrae Station area would show the most notable drop in LOS between 2002 and 2020 (dropping from LOS C to LOS E).

<u>Airports</u>: Areas within the screenlines around the San Francisco, Oakland, and San Jose airports are very congested under existing conditions, with LOS F in the peak direction of the morning peak hour. Conditions are projected to deteriorate under the No Project Alternative.

<u>Transit, Goods Movement, and Parking</u>: Generally, public transit and goods movement are operating under congested conditions and are not projected to change under the No Project Alternative. The only exception would be US-101 south of San Jose, where planned highway improvements would improve truck operating conditions by 2020.

Even though there is sufficient parking planned for the HST stations, one of the greatest effects that HST could have on the existing transit system would be the potential use of existing transit parking facilities by HST passengers. At all Caltrain stations other than the Millbrae Station, and at affected San Francisco Bay Area Rapid Transit District (BART) stations such as West Oakland, 12th Street, Coliseum, and Union City in the East Bay, there is sufficient parking under existing conditions. In downtown San Francisco and Oakland, as well as at the three major airports, there currently is no excess parking. Parking conditions at these locations are expected to remain the same or improve under the No Project Alternative because Caltrain and BART capital expansion programs include parking expansions and the programs are likely to continue to adjust to market demands. However, HST riders could potentially use existing transit parking facilities, resulting in parking impacts.

Sacramento to Bakersfield

Intercity Highway Segments: Under existing conditions, 4 of the 22 locations analyzed are operating at LOS E or F, while the remaining 18 locations are operating at LOS D or better. The four locations first mentioned are I-80 at the Yolo Causeway, I-5 between Hodd Franklin Road and Elk Grove Boulevard, SR-99 between Mack Road and Florin Road, and SR-99 between Collier Road and the San Joaquin/Stanislaus County line. These four worst locations are operating near capacity (V/C 0.93 or more) or over capacity (V/C 1.0 or more) along key intercity highway segments. Traffic congestion is projected to worsen on all except one of the key intercity highway segments under the No Project Alternative, even with planned highway widenings. The one exception is on I-80 at the Yolo Causeway, where planned widening of the freeway is expected to slightly improve the V/C ratio, although LOS will remain LOS F. Under the No Project Alternative, the number of locations operating at LOS E or F would increase to nine, compared to four under existing conditions. Although the remaining 13 locations would operate at LOS D or better, LOS at several of these locations would degrade by two or more ranks (e.g., from LOS B to LOS D). These locations are summarized in Table 3.1-3.

Table 3.1-3
Summary of Locations Degrading by Two or More Levels of Service under Existing and No Project Alternative Conditions
Sacramento to Bakersfield Region

	Existing Conditions		No Project Alternative	
Intercity Highway Segments	V/C	LOS	V/C	LOS
I-5 north of J-11 (County Road) to Sacramento/San Joaquin County line	0.74	C	1.30	F
I-5 south of I-580	0.59	A	0.96	E
I-5 between Button Willow Rowlee and Lerdo Highway	0.43	A	0.78	C
SR-99 between Collier Road and Liberty Road	0.65	B	1.01	F
SR-99 between Hammett Road and San Joaquin/Stanislaus County line	0.82	D	1.57	F
SR-99 south of Mitchell Road	0.68	B	0.84	D
SR-99 between Adams Avenue and Clovis Avenue	0.66	B	1.03	F
SR-99 north of 7th Standard Road	0.50	A	0.74	C
SR 99 between SR-119 and Houghton Road	0.35	A	0.73	C
Source: Parsons Brinckerhoff 2003.				

Airports: Under the No Project Alternative, traffic congestion is projected to worsen at the major roadways that provide access to the Sacramento and Bakersfield Airport areas. Parking should be sufficient at the airports.

Transit, Goods Movement, and Parking: No change is projected for public transit and parking conditions under the No Project Alternative. The No Project Alternative could result in some impact on goods movement because demand would increase, but limited infrastructure improvements would be implemented.

Compared to existing conditions, no significant impacts on goods movement or parking are anticipated to occur at any of the analyzed locations under the No Project Alternative.

Bakersfield to Los Angeles

Intercity Highway Segments: The I-5 corridor is a critical transportation facility in this region and serves as the primary highway link between southern and northern California for the movement of private automobiles and trucks carrying goods. According to the California Highway Patrol (CHP), travelers on the Grapevine section of I-5 (between Gorman and Santa Clarita) experience severe weather conditions during the winter. During these severe conditions, CHP closes the Grapevine to all traffic. CHP does not record the number of closures per year, but, in general, the segment can be closed between two and eight times per year, depending on the frequency and severity of snow and ice conditions. Of the ten locations analyzed in this region, five are currently operating with severe traffic congestion (LOS F); all five of these locations are on the I-5 corridor. There are no significant capacity improvements programmed or funded for 2020 on the I-5 corridor. Therefore, under the No Project Alternative, traffic conditions are projected to worsen considerably on all of the key intercity highway segments, with eight of the ten analyzed locations projected to operate at LOS E or F. The remaining two segments (I-5 at Gorman and SR-14 Palmdale) would continue to operate at LOS A. The most notable projected LOS degradations under No Project would occur at locations listed below.

- I-5 north of SR-14 in Santa Clarita, expected to worsen from LOS C to LOS F.
- SR-14 north of Avenue P in Palmdale, expected to worsen from LOS A to LOS E.
- SR-14 north of I-5 in Santa Clarita, expected to worsen from LOS D to LOS F.

Proposed High-Speed Train Stations: Traffic conditions near all proposed HST stations are operating between LOS B and LOS E under existing conditions; however, they would all degrade to LOS F under the No Project Alternative. The most notable degradations would occur at the proposed Palmdale (LOS C to LOS F), Sylmar (LOS B to LOS F), and Burbank Downtown Station sites (LOS C to LOS F).

Airports: Under the No Project Alternative, traffic congestion would increase at the major roadways that provide access to the Burbank Airport area.

Transit, Goods Movement, and Parking: No change is projected for transit and parking conditions under the No Project Alternative. The overall potential impact on goods movement of the No Project Alternative is low.

Los Angeles to San Diego via Inland Empire

Intercity Highway Segments: Under existing conditions, the average speed on some of the region's most congested corridors is estimated to be less than 20 mph (32 kph) in the congested direction. Additionally, congestion delay is projected to increase by 100%, (Southern California Association of Governments 2003) and traffic congestion is projected to worsen on all of the key intercity highway segments, with 11 of the 12 locations analyzed projected to operate at LOS F. The most notable LOS degradations under the No Project Alternative are projected to occur at the locations listed below.

- I-15 between I-10 and I-215, expected to worsen from LOS B to LOS F.
- I-215 between I-10 and Riverside, expected to worsen from LOS A to LOS F.
- I-215 between I-15 and Temecula, expected to worsen from LOS A to LOS C.
- I-15 between Temecula and Escondido, expected to worsen from LOS B to LOS F.

Proposed High-Speed Train Stations: Traffic conditions are expected to worsen at the proposed HST station areas, with the exception of four station areas where funded roadway improvements will occur under the No Project Alternative. These locations include the Escondido Rock Springs Station site (V/C ratio would improve from 0.72 to 0.55, LOS C would improve to LOS A), Mira Mesa Station site (0.73 to 0.71, LOS C under both conditions), Qualcomm Station site (1.17 to 0.68, LOS F to LOS B), and University Towne Centre station site (0.62 to 0.50, LOS B to LOS A).

Airports: Under the No Project Alternative, traffic congestion is projected to increase at the major roadways that provide access to the San Diego International Airport area, and traffic conditions at the Ontario International Airport are projected to improve because of roadway improvements.

Transit, Goods Movement, and Parking: No change is projected for transit and parking conditions under the No Project Alternative. Under No Project, potential impacts on goods movement would vary between low at locations such as March Air Reserve Base (ARB), Temecula, and Mira Mesa, and high at the proposed El Monte and San Bernardino HST station areas, based on observed truck volumes and surrounding land uses at these sites.

Los Angeles to San Diego via Orange County

Intercity Highway Segments: Under existing conditions, nine of the ten locations analyzed are operating at LOS F, and the remaining location (I-5 at SR-55) is operating at LOS E with a V/C ratio of 0.96, approaching LOS F (V/C of 1.0 or more). These conditions are not expected to improve under the No Project Alternative; on average, V/C ratios are projected to increase by 12% at these locations, reflecting more severe congestion and longer congested peak periods. There are two exceptions to this projected condition under the No Project Alternative: significant freeway and transit system expansions are planned along I-5 to Tamarack Avenue and along I-5 to Via De La Valle. These expansions will improve the existing LOS F condition to LOS D and E, respectively.

Proposed High-Speed Train Stations: Traffic conditions are expected to worsen at the proposed HST station sites, with the exception of four stations, where funded roadway improvements will result in improved conditions under the No Project Alternative. The proposed station sites where improvements are expected are Norwalk Station (V/C ratio would improve from 0.71 to 0.70, LOS C under both conditions), Fullerton Transit Center Station (0.84 to 0.77, LOS D to LOS C), Anaheim Transit Center Station (0.55 to 0.50, LOS A under both conditions), and University Towne Centre Station (0.68 to 0.65, LOS B under both conditions).

Airports: Under the No Project Alternative, traffic congestion would increase at the major roadways that provide access to LAX and Long Beach Airport.

Transit, Goods Movement, and Parking: Based on the existing number of transit routes, frequencies, and span of service, no significant impact on public transit services is projected (including service to LAX) if no significant improvements to existing public transit service were provided under No Project.

Most delay impacts on goods movement would occur in Los Angeles County and north Orange County, where heavy freight received at the Ports of Los Angeles and Long Beach exits the region en route to destinations throughout the nation. Potential negative impacts on goods movement in south Orange County are projected to occur because the higher vehicular traffic on I-5, which is forecast under the No Project Alternative, would not be met by a corresponding increase in the capacity of transportation facilities.

With the exception of the proposed Norwalk and Irvine Stations, no parking impacts are projected under the No Project Alternative. The Norwalk (LOSSAN) Station is projected to have medium parking impacts, and the Irvine Station is projected to have high parking impacts, because there is little land around the station areas that can be developed to meet the projected parking demand.

B. NO PROJECT ALTERNATIVE COMPARED TO MODAL AND HIGH-SPEED TRAIN ALTERNATIVES

The No Project Alternative represents the future baseline condition. It is assumed that any improvements associated with the proposed Modal or HST Alternatives would be in addition to the No Project condition. For this comparison, it is assumed that the Modal Alternative accommodates the same intercity demand, for either automobile or airplane trips, as the HST Alternative demand. It is projected that improvements associated with the proposed Modal Alternative would increase the capacity of highways (by adding traffic lanes) and airports (by adding runways and gates) to better accommodate demand compared to the No Project Alternative, and would result in improved levels of service and reduced congestion on those facilities.

As shown in Figures 3.1-3 through 3.1-6, both the proposed Modal and HST Alternatives would improve traffic at the intercity screenlines compared to the No Project Alternative. Long-term potential impacts related to the No Project Alternative would potentially be alleviated by the Modal Alternative through the addition of lane miles and airport capacity, and they would potentially be alleviated by the HST Alternative through the diversion of automobile and airplane trips to the HST. As summarized in Table 3.1-4, for the five regions the average V/C ratio improvement is anticipated to be between 14% and 33% under the Modal Alternative, and between 1% and 9% under the HST Alternative. The differences among the regions are directly related to the volume of demand. For instance, in the Sacramento to Bakersfield region under the Modal Alternative, there would be 0.70 intercity and commute (total) peak-hour trips per lane mile, a peak-hour volume of about 2,790 total highway trips over about 4,070 lane mi (6,550 km) compared to the other regions, where there would be between 2.5 (Bay Area to Merced region) and 8.1 (Bakersfield to Los Angeles region) total peak-hour trips per lane mile. Therefore, segments with less demand would experience greater changes in LOS with the proposed improvements compared to regions with higher demand. This result is illustrated by the Sacramento to Bakersfield region where, under the Modal Alternative, a 33% improvement in V/C ratio is projected, compared to a 14% to 21% change in other regions. The 14% to 33% improvement under the Modal Alternative would result from the significant improvement to highway capacity represented by 2,970 additional lane mi (4,779 km). Under the HST Alternative, 1% to 9% improvement is projected to occur, resulting from the diversion of 34 million highway trips to the HST. (No additional lane miles are included with this alternative.)

Table 3.1-4
Summary of No Project Conditions Compared to Modal and HST Alternatives

Region	Intercity Highway Segment Averages				
	NP	Modal Alternative		HST Alternative	
	V/C	V/C	% Change from NP	V/C	% Change from NP
Bay Area to Merced	1.22	0.96	21%	1.14	7%
Sacramento to Bakersfield	0.92	0.62	33%	0.89	4%
Bakersfield to Los Angeles	1.67	1.38	14%	1.67	1%
Los Angeles to San Diego via Inland Empire	1.40	1.15	19%	1.29	9%
Los Angeles to San Diego via Orange County	1.35	1.11	16%	1.31	3%
Average	1.31	1.04	21%	1.26	5%

NP = No Project Alternative.
Source: Parsons Brinckerhoff 2003.

In addition to adding capacity in discrete amounts to roadways and airports throughout the state, the Modal Alternative would provide capacity in excess of what is needed for projected intercity automobile or airplane trips, because in most cases the capacity added as part of the Modal Alternative is more than the marginal representative demand. Since highway lanes are not scaleable (i.e., it is not possible to build 25% or 50% of a highway lane to meet a 25% or 50% increase in traffic demand), most lanes added as part of the Modal Alternative have excess capacity. The traveling public is likely to respond to this new excess capacity by using the improved facilities for all trips, not just intercity trips. For example, on roadways where capacity is added, traffic congestion may well be eased, making a particular roadway a more attractive route for travel. New traffic would not necessarily be intercity traffic only, but could include shorter trips within a region. An analogous situation at airports would be one in which transcontinental or international flights make use of capacity that was added to meet intercity demand. In the case of both roadways and airports, as the forecast intercity demand is met, intercity travelers may compete for capacity with non-intercity travelers in the air and on the road. This phenomenon cannot be evaluated quantitatively at this programmatic level of analysis. Therefore, the current assessment of the Modal Alternative is possibly portraying the consequences of adding capacity to roadways and airports in terms of congestion, speeds, and level of service more optimistically and thus more favorably then actually may occur if the improvements included in the Modal Alternative were actually implemented.

The HST Alternative would reduce long-term impacts on freeways and airports by diverting intercity automobile and airplane trips to the HST system. Like the Modal Alternative, it is possible that the HST system could attract additional (induced) trips to the roadway and airports not accounted for in the Modal Alternative's highway and airport demand.

In addition to improving highway capacity by reducing traffic and reducing demand for trips to the airport, the HST Alternative would eliminate traffic delays at existing at-grade crossings along the Caltrain corridor in the Bay Area and at other select crossings throughout the state. This reduction in delay was measured by estimating the daily vehicle delay savings (i.e., the reduction in the number of hours spent sitting waiting at grade crossings) that would be achieved through grade separation at six sample crossings along the Caltrain shared-use corridor. The four- and six-lane arterial streets were projected to have average daily traffic (ADT) ranging from about 15,000 to 40,000 vehicles in 2020. Grade separations proposed for the HST Alternative resulted in a delay savings from about 10 vehicle hours per day at the lowest volumes to almost 200 vehicle hours per day at the highest volumes. The grade separations would also improve the reliability of both the vehicle trips crossing the HST corridors and the existing commuter conventional intercity rail and freight trips within the corridors. There will also be potential for closures (both permanent and temporary) of minor streets, where grade separation is not deemed necessary due to low traffic volumes and access requirements.

Overall, as summarized in Table 3.1-4, although highway conditions would improve under the Modal and HST Alternatives, the general conditions would remain at poor LOS with V/C ratios of more than 1.0 on average for each of the five regions. As discussed above, the conditions shown in the evaluation may not always reflect the experiences of travelers at any particular place at any specific time. For example, localized capacity restrictions (e.g., bottlenecks at a given interchange) are not well represented in regional traffic models. In addition, incidents on the road, such as accidents and vehicle breakdowns, are not represented in the regional traffic models. These non-recurring incidents are unpredictable and are responsible for the majority of congestion on urban highway networks.

Goods movement and transit have some minor regional or local impacts; however, on a statewide basis, the potential effects of the Modal and HST Alternatives would be negligible. Planning provisions were made for parking at airports and station areas under the Modal and HST Alternatives respectively; consequently, there should be little effect on the existing parking supplies.

3.1.4 Comparison of Alternatives by Region

This section summarizes key findings comparing the Modal and HST Alternatives to the No Project Alternative, and to each other by region, based on traffic, circulation, and parking. For detailed summary tables associated with this analysis, see Appendix 3.1-A.

A. BAY AREA TO MERCED

Modal Alternative

Intercity Highway Segments: The number of segments operating at LOS F would decrease from 12 under the No Project Alternative to 7 under the Modal Alternative, and the V/C ratios along these segments would improve by 15% on average (Table 3.1-5). The most substantial improvement compared to the No Project Alternative would occur along SR-152 between I-5 and SR-99, where the LOS would improve from LOS F to LOS A, and the V/C ratio would decrease by 50%, from 1.21 to 0.60.

Table 3.1-5
Segments Operating at LOS F (V/C Higher than 1.0)
Bay Area to Merced

Alternative	Number of Segments	V/C % Change
No Project[a]	12	6%
Modal[b]	7	-15%
HST[b]	11	-4.7%

[a] Compared to existing conditions.
[b] Compared to No Project Alternative.
Source: Parsons Brinckerhoff 2003.

Proposed High-Speed Train Stations: The LOS and V/C ratios in the vicinity of the 15 proposed HST station areas are not projected to change under the Modal Alternative compared to the No Project Alternative. As noted in the *Existing Conditions Compared to No Project Alternative* section above, traffic and circulation in proposed HST station areas are analyzed for the Modal Alternative, but the stations would be implemented only under the HST Alternative.

Airports: It was assumed that capacity improvements would be made at OAK and SJC under the Modal Alternative. Freeway links and access roads accessing SJC are estimated to improve from LOS F to LOS E compared to the No Project Alternative because of the proposed capacity improvements in the area.

Transit, Goods Movement, and Parking: The Modal Alternative is not projected to have any potential impact on public transit conditions compared to the No Project Alternative because there are no planned increases in transit services under the Modal Alternative. The Modal Alternative is projected to improve goods movement compared to the No Project and HST Alternatives because the proposed highway capacity improvements would reduce congestion and improve truck travel times.

In general, the Modal Alternative would not affect parking near proposed station and airport areas, and it is assumed there would be no change compared to the No Project Alternative.

High-Speed Train Alternative

Intercity Highway Segments: The number of segments operating at LOS F would decrease from 12 under the No Project Alternative to 11 under the HST Alternative, and the V/C ratios along the segments would improve by approximately 5% on average (Table 3.1-5). The most substantial improvement under the HST Alternative compared to the No Project Alternative would occur along US-101 between San Francisco and SFO, where the LOS would improve from LOS F to LOS C, and the V/C ratio would decrease by 33%, from 1.06 to 0.71. This significant improvement would result from the additional lane capacity from diversion of automobile trips to HST and the reduction in trips to SFO during the peak period because of the diversion of air travelers to the HST system.

Proposed High-Speed Train Stations: The only significant projected degradation under the HST Alternative compared to the No Project Alternative would occur at the proposed Transbay Terminal, where the LOS would degrade from LOS D to LOS F, and the V/C ratio would increase from 0.89 to 1.01 because substantially more trips would be attracted to the facility.

Airports: LOS on freeway links accessing SFO would improve from LOS F to LOS E under the HST Alternative compared to the No Project Alternative because air travelers would be diverted to the HST system.

Transit, Goods Movement, and Parking: The HST Alternative is not projected to have any potential impact on public transit conditions compared to the No Project Alternative. The HST Alternative is not projected to have any impact on goods movement. Assuming that the HST Alternative would provide parking at all station areas except in downtown San Francisco and Oakland, parking conditions under the HST Alternative would be similar to those under the No Project and Modal Alternatives.

High-Speed Train Alignment Option Comparison

The two Pacheco Pass alignment options listed below would affect US-101 traffic south of San Jose.

- Morgan Hill/Caltrain/Pacheco Pass alignment.
- Caltrain/Gilroy/Pacheco Pass alignment.

The single option below would affect I-880 traffic north of Fremont/Newark.

- Hayward alignment/I-880.

If the Gilroy bypass option were implemented instead of the Gilroy option, a station is proposed in Morgan Hill instead of Gilroy, with the result that some Gilroy traffic would have to travel north on US-101 to reach the Morgan Hill Station. This outcome would increase traffic on US-101 in Gilroy by about 4%, lowering speeds by less than 1 mph (1.6 kph). The LOS on US-101 would remain LOS B in the morning peak direction, and LOS A in the morning off-peak direction.

If one of the Diablo Range Direct alignment options were implemented, there would be no stations at Los Banos, Gilroy, or Morgan Hill. Traffic in Gilroy would be the same as under the Gilroy bypass option. Traffic on US-101 south of SR-85 would increase by approximately 1% with no change in LOS.

If the Hayward/Niles/Mulford Line option were implemented and the Auto Mall Station were chosen instead of the Union City Station, traffic would increase by approximately 2% on I-880 north of SR-4 with no change in LOS.

Traffic impacts would be more severe in the potential Transbay Terminal area than in the 4th and King Street Station area. This difference would be partly caused by the congestion levels anticipated for all streets near the Transbay Terminal. In contrast, the major effects at 4th and King Streets would be concentrated on King Street. The impact at the Transbay Terminal may potentially be counteracted by high usage of transit in the downtown San Francisco area.

B. SACRAMENTO TO BAKERSFIELD

Modal Alternative

Intercity Highway Segments: The number of segments operating at LOS F would decrease from seven under the No Project Alternative to two under the Modal Alternative, and the V/C ratios along these segments would improve by 34% on average, as shown in Table 3.1-6. This region would experience the largest change in LOS because it has the lowest volume of demand per lane mile compared to the other regions. The most substantial improvement compared to the No Project Alternative would occur along SR-99 between Collier Road and Liberty Road, where the LOS would improve from LOS F to LOS A, and the V/C ratio would decrease by 42%, from 1.01 to 0.58.

Table 3.1-6
Segments Operating at LOS F (V/C Higher than 1.0)
Sacramento to Bakersfield

Alternative	Number of Segments	V/C % Change
No Project[a]	7	51%
Modal[b]	2	-34%
HST[b]	7	-1.5%

[a] Compared to existing conditions.
[b] Compared to No Project Alternative.
Source: Parsons Brinckerhoff 2003.

Proposed High-Speed Train Stations: The LOS and V/C ratios at the 14 proposed HST station areas in the region are not projected to change under the Modal Alternative compared to the No Project Alternative.

Airports: It was assumed that capacity improvements would be made at Sacramento, Fresno, and Bakersfield airports under the Modal Alternative. There would be no significant change in the LOS or V/C ratios within the airport areas compared to the No Project Alternative.

Transit, Goods Movement, and Parking: The Modal Alternative is not expected to have any substantial potential impact on transit services compared to the No Project Alternative. The Modal Alternative could have a positive effect on goods movement due to the improvements in LOS. The Modal Alternative would not generally affect parking near proposed station and airport areas, and it is assumed there would be no change compared to the No Project Alternative.

High-Speed Train Alternative

Intercity Highway Segments: Under the HST Alternative, there would be no change in the number and location of segments operating at LOS F compared to the No Project Alternative. However, there would be an approximate 2% improvement in V/C ratios on average (Table 3.1-6). The most substantial V/C ratio improvement (13%) would occur on I-5 between SR-165 and the Merced/Fresno County line. The LOS along this segment would remain LOS A.

Proposed High-Speed Train Stations: The LOS and V/C ratios at the 14 proposed HST station areas are not projected to change under the HST Alternative compared to the No Project Alternative.

Airports: Compared to the No Project Alternative, the HST Alternative would improve traffic conditions at SMF from LOS D to LOS B and would reduce the V/C ratio by 28%, from 0.88 to 0.63. Although the HST Alternative would improve conditions near the Bakersfield airport from a V/C ratio of 1.09 to 1.05, this improvement would not be substantial enough to improve service to LOS E or better.

Transit, Goods Movement, and Parking: The HST Alternative is not expected to have any substantial impact on transit services compared to the No Project Alternative.

Considering all alignment options where HST tracks are proposed to be at grade and adjacent to existing freight and passenger tracks, as many as 258 locations would be grade-separated from roadway traffic under the HST Alternative. Each of these grade separations would reduce conflicts between rail and highway traffic, thereby improving the efficiency and safety of both modes. The exact number of locations at which crossing roadways would be grade-separated from rail tracks would depend on the final specific HST alignments chosen for the region.

The HST Alternative would be planned to provide an adequate supply of parking at HST stations; therefore, compared to the No Project Alternative, no parking impacts are expected under the HST Alternative.

High-Speed Train Alignment Option Comparison

The major alignment and station options in this region are alternative station locations.

- In Sacramento, a station in downtown Sacramento or on Power Inn Road.
- In Modesto, a station in downtown Modesto or on Briggsmore.
- In Merced, a station at the municipal airport, in downtown Merced, or at Castle Air Force Base (AFB).
- In Bakersfield, a station at the airport, on Golden State, or on Truxtun.

Because of relatively low volumes of demand, the choice of stations would cause no significant differences in aggregate roadway LOS between the HST Alternative and the No Project Alternative. There would be no change in the LOS in all instances, although the V/C ratio may be slightly higher under the HST Alternative.

With respect to transit, the Power Inn Road and Bakersfield Airport Station options would require the addition of transit services. Direct connection to Amtrak service would be available only at the downtown Sacramento, Briggsmore, downtown Merced, and Truxtun Stations.

As noted above with respect to goods movement, the proposed HST system would not affect future goods movement and consequently it is not possible at this level of analysis to distinguish between the design options. With respect to parking, the only significant difference among station options would occur in Sacramento, where the Power Inn Road option would require 1,200 (or 69%) more new parking spaces than the downtown Sacramento option.

C. BAKERSFIELD TO LOS ANGELES

Modal Alternative

Intercity Highway Segments: Under the Modal Alternative, there would be no change in the number and location of segments operating at LOS F compared to the No Project Alternative. However, V/C ratios along these LOS F segments would improve an average of approximately 17%, as shown in Table 3.1-7. The most substantial improvement in V/C ratio compared to the

No Project Alternative (27%) would occur on I-5 near Burbank; however, the LOS along this segment would remain LOS F.

Table 3.1-7
Segments Operating at LOS F (V/C Higher than 1.0)
Bakersfield to Los Angeles

Alternative	Number of Segments	V/C % Change
No Project[a]	7	73%
Modal[b]	7	-17%
HST[b]	7	0.7%

[a] Compared to existing conditions.
[b] Compared to No Project Alternative.
Source: Parsons Brinckerhoff 2003.

Proposed High-Speed Train Stations: All five of the proposed HST station areas would remain LOS F under the Modal Alternative, and there would be no significant change in V/C ratios compared to the No Project Alternative.

Airports: It was assumed that additional runway and gate capacity improvements would be made at BUR under the Modal Alternative. Although the demand of the Modal Alternative would result in increased traffic in and around BUR, the V/C ratio would decrease by 14% because of planned highway improvements that will be implemented under the No Project Alternative.

Transit, Goods Movement, and Parking: The Modal Alternative is not expected to have significant impacts on public transit, goods movement, or parking compared to the No Project Alternative.

High-Speed Train Alternative
Intercity Highway Segments: Under the HST Alternative, there would be no change in the number and location of segments operating at LOS F compared to the No Project Alternative, and there would be no significant change in V/C ratios.

Proposed High-Speed Train Stations: Within each of the five proposed station areas, there would be an increase in traffic. V/C ratios would increase compared to the No Project Alternative by an average of about 4%, and level of service would remain LOS F. The most substantial impact would occur at the Burbank Downtown Station, where the V/C ratio would increase by 7%.

Airports: The HST Alternative would cause no significant change in the levels of service or V/C ratios in the Burbank airport area, compared to No Project.

Transit, Goods Movement, and Parking: The HST Alternative is expected to improve goods movement by grade separating many Metrolink and freight crossings that would be at grade under the No Project Alternative. This outcome would positively affect both train operations that use the grade separation and bus operations that are currently delayed at grade crossings.

Under the HST Alternative, the impact on parking at the Palmdale Station is assumed to be low because land is available for creating parking facilities in the immediate vicinity of the proposed station. The impacts on parking at Sylmar and Burbank Downtown Stations are rated medium because these locations are currently stations on the existing Metrolink commuter rail system, and there is some potential for parking to spill over from the HST into the existing parking lots. It is assumed that parking sufficient to meet the forecast HST ridership demand would be provided in new or expanded parking structures at both locations. The impact on parking is rated low at LAUS because major multilevel parking structures would be constructed in downtown Los Angeles to accommodate the HST parking demand in conjunction with station development.

High-Speed Train Alignment Option Comparison

The Bakersfield to Sylmar HST alignment options that roughly follow I-5 and SR-58 are the two principal alignment options in this region. If the SR-58/Soledad Canyon option were chosen, there would be a station in Palmdale. In Palmdale, the SR-58/Soledad Canyon HST option would only slightly increase the aggregate V/C ratio (from 1.20 to 1.22) in the study area, primarily on roads that provide direct access to the station. If the I-5 option were chosen, there would not be a station in Palmdale. Traffic analyses that incorporate the I-5 and SR-58 alignments show no significant difference between the two options.

Other design options are listed below.

- In Burbank, a station at Burbank airport or a station in downtown Burbank.
- Near LAUS, a station south of LAUS above the Los Angeles River or a station on the east bank of the Los Angeles River.

In Burbank, most of the roadways providing access to the alternative station areas are forecast to operate above capacity (i.e., LOS F) with or without the HST Alternative. For the airport option, the HST Alternative would increase the aggregate roadway V/C ratio by 2%; for the downtown option, the projected increase would be 7%. An airport station would provide better access to air service; a downtown Burbank station would be located closer to the midpoint between Sylmar and LAUS and would provide better access to Metrolink commuter trains.

At LAUS, either design option would include new parking on both sides of the Los Angeles River and would require a people-mover link to LAUS. The southern option would increase traffic on already congested (LOS F) Alameda Street, whereas the east bank option would add traffic to Mission Road, which is not a primary access street for the station currently and would need widening and upgrading.

D. LOS ANGELES TO SAN DIEGO VIA INLAND EMPIRE

Modal Alternative

Intercity Highway Segments: Under the Modal Alternative, only the I-15 segment between Temecula and Escondido would show an improvement in LOS, from LOS F to LOS E, compared to the No Project Alternative. As shown in Table 3.1-8, the average V/C improvement would be approximately 17%. The potentially most substantial improvement compared to the No Project Alternative would occur along I-215 between I-15 and Temecula, where the V/C ratio would decrease by 33% and the LOS would improve from LOS C to LOS A.

Table 3.1-8
Segments Operating at LOS F (V/C Higher than 1.0)
Los Angeles to San Diego via Inland Empire

Alternative	Number of Segments	V/C % Change
No Project[a]	11	43%
Modal[b]	10	-17.4%
HST[b]	10	-7.2%

[a] Compared to existing conditions.
[b] Compared to No Project Alternative.
Source: Parsons Brinckerhoff 2003.

Proposed High-Speed Train Stations: No changes in traffic conditions around HST stations are expected to occur under the Modal Alternative compared to the No Project Alternative.

Airports: Under the Modal Alternative, capacity improvements are planned at the San Diego airport and Ontario. Compared to the No Project Alternative, the level of service at San Diego airport street screenlines is expected to deteriorate as follows: Pacific Highway (LOS A to LOS F), Laurel Street (LOS E to LOS F), Hawthorn Street (LOS D to LOS F), and North Harbor Drive (LOS A to LOS B). There are no significant impacts expected in the area of the Ontario airport.

Transit, Goods Movement, and Parking: There is little differentiation in potential transit and goods movement impacts between the No Project, Modal, and HST Alternatives. The Modal Alternative would have slightly more impacts on parking at the Ontario and San Diego airports than the HST or No Project Alternatives.

High-Speed Train Alternative

Intercity Highway Segments: Overall, the HST Alternative would improve V/C ratios by an average of approximately 7% compared to the No Project Alternative. As under the Modal Alternative, only the I-15 segment between Temecula and Escondido would show an improvement in LOS (from LOS F to LOS E) compared to the No Project Alternative. This segment would also potentially show the most substantial change in V/C ratio: a 19% improvement, from 1.16 to 0.94.

Proposed High-Speed Train Stations: Compared to the No Project Alternative, traffic conditions around the 17 proposed HST stations would potentially deteriorate as follows: South El Monte (LOS B to LOS C), Qualcomm (LOS B to LOS C), Escondido Transit Center (LOS D to LOS E) and San Diego International Airport (LOS C to LOS E).

Airports: Compared to the No Project Alternative, the HST Alternative would cause no significant change in levels of service or V/C ratios in the airport areas.

Transit, Goods Movement, and Parking: There is little differentiation in potential impacts between transit, goods movement, and parking between the No-Project, Modal, and HST Alternatives.

In the proposed HST station areas, the potential for conflict between feeder buses and private vehicles was considered. Where there are more bus routes, there is increased potential for conflicts between personal vehicles and buses. However, multiple bus routes serving a station benefit train riders by providing multiple opportunities for local circulation and distribution without private vehicles. The number of bus routes would be high at the Mira Mesa (28 routes) and Downtown San Diego (33 routes) Stations; the Temecula, Escondido Rock Springs, and Qualcomm Stations would have a low number of bus routes—6 or fewer. The other 12 stations would have a medium (between 6 and 28) number of bus routes. However, the HST Alternative overall would not have transit impacts beyond those of the Modal and No Project Alternatives.

High-Speed Alignment Options Comparison

These are the major alignment and station options compared in this section.

- San Bernardino loop compared to San Bernardino downtown bypasses.
- Carroll Canyon option compared to Miramar Road option.
- Qualcomm terminus compared to downtown terminus.

The San Bernardino loop would provide service to a major intermodal transfer location at the Santa Fe Depot as well as better regional coverage for northern Riverside and San Bernardino Counties. This benefit would need to be evaluated, taking into account the 4-to 8-minute delay incurred by routing trains to a station in San Bernardino. The Carroll Canyon alignment in San Diego County would represent a new transportation corridor, in contrast to the Miramar Road alignment, which has heavy congestion and space limitations. In San Diego, the Qualcomm terminus would potentially provide easier access, parking, and station location opportunities than the downtown terminus, but would not serve the central business district core without requiring an additional transfer to light rail and necessitating additional travel time.

E. LOS ANGELES TO SAN DIEGO VIA ORANGE COUNTY

Modal Alternative

Intercity Highway Segments: The number of segments operating at LOS F would decrease from eight under the No Project Alternative to five under the Modal Alternative. As shown in Table 3.1-9, the average V/C ratio would improve by approximately 14%. The potentially most substantial improvement compared to the No Project Alternative would occur along I-105 at Inglewood Avenue, where the LOS would remain LOS F, but the V/C ratio would decrease by 21%, from 1.98 to 1.57.

Table 3.1-9
Segments Operating at LOS F (V/C Higher than 1.0)
Los Angeles to San Diego via Orange County (LOSSAN)

Alternative	Number of Segments at LOS F	V/C % Change
No Project[a]	8	19%
Modal[b]	5	-14.4%
HST[b]	6	-3.0%

[a] Compared to existing conditions.
[b] Compared to No Project Alternative.
Source: Parsons Brinckerhoff 2003.

Proposed High-Speed Train Stations: Compared to the No Project Alternative, the Modal Alternative would not change traffic conditions around the proposed HST stations, except at the LAX Terminal Station. Under the Modal Alternative, the V/C ratio at the LAX Terminal Station would increase by 6%, and the LOS would degrade from LOS E to LOS F compared to the No Project Alternative.

Airports: Planned capacity improvements would occur at John Wayne International-Orange County Airport and Long Beach Municipal Daugherty Field under the Modal Alternative. Near LAX, the aggregate LOS on roadway links to the terminal would worsen from LOS E to LOS F, and the V/C ratio would worsen from 0.97 to 1.03 compared to the No Project Alternative. Near LGB, the aggregate LOS on roadway links to the terminal would worsen from LOS A to LOS B, and the V/C ratio would worsen from 0.59 to 0.64 compared to the No Project Alternative. These airport roadway links are projected to worsen under the Modal Alternative because peak-period traffic accessing the airports would increase.

Transit, Goods Movement, and Parking: The Modal Alternative would have no significant impacts on transit compared to the No Project Alternative. Planned increases in bus and commuter rail service are expected to meet demand for transit. Also, the Modal Alternative is not expected to have any significant impact on goods movement compared to the No Project Alternative.

Except at the proposed Norwalk (which is a new station and does not have any parking associated with the location yet) and San Juan Capistrano (which is constrained by many historic properties surrounding the station site) Stations, parking capacity at each station is projected to meet the demand of travelers under the Modal Alternative; there would be no significant change compared to the No Project Alternative.

High-Speed Train Alternative

Intercity Highway Segments: Under the HST Alternative, traffic congestion is projected to improve slightly on the intercity highway segments compared to the No Project Alternative. The most significant changes would occur on I-5 at Balboa Avenue and on I-5 at Tamarack Avenue, where the LOS would improve from LOS F to LOS E and from LOS D to LOS C, respectively. The average regional V/C ratio would improve by 3%.

Proposed High-Speed Train Stations: The HST Alternative would cause no significant changes in LOS or V/C ratios within the station areas compared to the No Project Alternative.

Airports: The HST Alternative would cause no significant changes in LOS or V/C ratios in the LAX and Long Beach Municipal Daugherty Field areas compared to the No Project Alternative.

Transit, Goods Movement, and Parking: The HST Alternative would cause no significant impacts on public transportation or goods movement compared to the No Project Alternative.

Except at the proposed Norwalk Station, parking capacity at each station is projected to meet the demand of travelers under the HST Alternative; there would be no significant change compared to the No Project Alternative. Under the HST Alternative, potential parking impacts could occur at the Norwalk Station because available land around the HST station areas is lacking.

High-Speed Train Alignment Option Comparison

Only the LOSSAN segment has an alternative alignment that presents significant differences in transportation impacts. One alignment option involves using the existing LOSSAN passenger rail corridor; the other option involves using the Union Pacific Railroad's (UPRR's) Santa Ana subdivision right-of-way.

The existing LOSSAN corridor option would allow for the use of an existing right-of-way from Los Angeles to Irvine in Orange County. This option would have fewer impacts on existing freight rail services in Orange County because the service could continue operations on the corridor while the HST was being constructed. This option also would allow use of an existing higher-speed rail infrastructure, further minimizing the traffic and circulation impacts in the cities traversed by the alignment. Between Los Angeles and Fullerton, this corridor represents the Burlington Northern Santa Fe Railroad's (BNSF's) primary freight line out of the Los Angeles Metropolitan Area. This option would involve using four tracks: two dedicated to passenger service and two to freight.

The UPRR Santa Ana Branch Line option would also allow for a dedicated HST alignment that uses an existing railroad right-of-way for most of the distance between Los Angeles and Anaheim in Orange County. However, this option would present a high impact on the existing local freight service on the Santa Ana Branch Line, which is estimated to be between two and four hauler trains per day. Although this service does not represent heavy traffic, these trains typically operate at about 10 mph (16 kph) and spend long periods on the track. It is assumed that this service would have to be removed from the line because of the limited existing right-of-way. Potential benefits associated with the HST Alternative include the full grade separation of major arterial and highway crossings (see Appendix 3.1-B). There are 26 at-grade crossings between Los Angeles and Irvine. Of the 26 grade separations, seventeen would occur between Anaheim and Los Angeles; of those, 11 would be on the LOSSAN corridor option and 6 would be on the UPRR Santa Ana Branch option.

3.1.5 Design Practices

The HST system would be fully grade separated from all roadways allowing vehicular traffic to flow without additional impediment in the local circulation system. In the urban areas where traffic congestion is typically at the highest levels, the HST system is predominantly in or adjacent to existing rail corridors/services and would include a considerable amount of grade separation of the existing tracks. These features included as part of the HST project implementation would improve No Project traffic levels of service and safety highway circulation system.

To minimize potential traffic and circulation impacts, HST stations in California will be multi-modal transportation hubs. All the potential high-speed rail station locations were selected at sites that would provide linkage with local and regional transit, airports, and highways. In particular, convenient links to other rail and transit services (heavy rail, commuter rail, light rail, conventional intercity rail, and local and regional bus services) would promote efficient circulation around stations by increasing availability and efficiency of transfers to these other transit and rail services.

Through the HST systems primary purpose of serving intercity travel and its capability to provide express or long distance commuter services, the implementation of the proposed system would result in a direct reduction of overall vehicular travel and roadway congestion, particularly in urban areas where congestion is the greatest.

3.1.6 Mitigation Strategies and CEQA Significance Conclusions

Currently, regional planning agencies and the counties and cities in the regions have considerable flexibility to deal with identified traffic, transit, and parking impacts. The California High Speed Rail Authority could participate in developing potential construction and operational mitigation measures in consultation with state, federal, regional, and local governments and affected transit agencies during project-level reviews.

Potential mitigation measures could be developed to improve the flow of intercity travel on the primary routes and access to the proposed stations or airports. These improvements would be based on the forecast capacity deficiencies identified for the No Project, Modal, and HST Alternatives and could possibly employ some of the following approaches.

- Transportation System Management (TSM)/Signal Optimization (including retiming, rephrasing, and signal optimization); other measures may include turn prohibitions, use of one-way streets, and traffic diversion to alternate routes.
- Local spot widening of curves that allows for geometric improvements without significant right-of-way acquisition.
- Major intersection improvements (full lane widening), which require significant right-of-way acquisition to accommodate additional left-turn and/or through lanes.

V/C ratios on the major intercity routes identified in the system screenline analysis show the desirability of more capacity on several freeway segments under all alternatives. When considering measures for traffic mitigation, the increase in automobile congestion and lowered vehicle flows that would be caused by the HST Alternative would be studied at the project-level analysis in the context of providing a new form of transportation (HST) and would consider total passenger flow versus vehicle flow in the study area if the HST alternative is selected. Further, the people-carrying capacity of the HST Alternative would be considerably higher than the capacity of the potentially feasible lane additions described in the Modal Alternative, allowing it to more easily absorb trip growth.

Consultation and coordination with public transit services in order to encourage the provision of adequate bus feeder routes to serve proposed station areas could mitigate potential transit impacts.

In each case where impacts are deemed significant at the project level, mitigation measures would be proposed. The potential for localized increases in automobile congestion and impaired vehicle flows caused by the HST Alternative would be offset by the new transportation service, to the point where the total flow of people in the corridor would increase at many locations. Further, the people-carrying capacity of the rail system is considerably higher than comparable lanes of roadway, enabling the HST alternative to more easily absorb growth in trip making. These effects should be considered when determining appropriate levels of traffic mitigation.

Potential mitigation strategies that might be associated with the HST Alternative are listed below by regional and local applications.

Regional strategies:

- Coordination with Regional Transportation (highway and transit) planning (e.g., Regional Transportation Plans, Congestion Management Plans, Freeway Deficiency Plans, etc.)
- Intelligent Transportation Systems Strategies (ITS)

Local strategies:

- Provide additional parking
- Off-site parking with shuttles
- Shared parking strategies
- Parking permit plans for neighborhoods
- Parking and curbside use restrictions
- Develop and implement a construction phasing and traffic management plan
- Roadway widening
- Installation of new traffic signals
- Improve capacity of local streets with upgrades in geometrics such as providing standard roadway lane widths, traffic controls, bicycle lanes, shoulders and sidewalks
- Modifications at intersections, such as signalization and/or capacity improvements (widening for additional left-turn and/or through lanes)
- Signal coordination and optimization (including retiming and rephrasing)
- Designation of one-way street patterns near some station locations
- Truck route designations
- Turn prohibitions
- Use of one-way streets and traffic diversion to alternate routes
- Increase bus feeder service and/or add routes to serve the proposed station areas
- Increase service from other connecting/complimentary modes of transportation (commuter rail, bus and rail transit)

- Minimize closure of any proximate freight or passenger rail line or highway facility during construction.

Based on the analysis above, and considering the CEQA Appendix G thresholds of significance for traffic, the HST system alternative would have a positive effect when viewed on a system-wide basis, particularly by reducing traffic on highways and around airports to the extent that intercity trips are diverted to the HST system (see Table 3.1-4) and by eliminating delays at existing at-grade crossings where the HST system would provide grade separation. Around station areas an increase in traffic and congestion is expected with the proposed HST. At this programmatic level of analysis it is not possible to know precisely the location, extent, and particular characteristics of such increased traffic and congestion. For now, at the programmatic level of analysis, because of this uncertainty, the impact is significant. Mitigation strategies, as well as design practices discussed in Section 3.1.5, will be applied to reduce this impact.

The above mitigation strategies are expected to substantially lessen or avoid impacts around station areas in most circumstances. Planning multi-modal stations, coordinating with transit services, providing accessible locations and street improvements, and encouraging transit-oriented development in station areas, all will help to ease traffic constraints in station areas. At the second-tier, it is expected that for various projects involving HST stations impacts will be mitigated to a less than significant level, but it is possible that for some stations impacts will not be mitigated to the less than significant level. Sufficient information is not available at this programmatic level to conclude with certainty that the above mitigation strategies will reduce impacts around stations to a less than significant level in all circumstances. This document therefore concludes that traffic impacts around station areas may be significant, even with the application of mitigation strategies. Additional environmental assessment will allow a more precise evaluation in the second-tier, project-level environmental analyses. The co-lead agencies will work closely with local government agencies at the project-level to implement mitigation strategies.

3.1.7 Subsequent Analysis

If the HST Alternative is selected, subsequent multimodal access and circulation studies could be conducted at proposed station areas along proposed alignments as plans for alignments, stations, and operations are refined. Additional environmental analysis would be required in conjunction with these studies to ascertain the exact locations of potential project-generated traffic impacts and potential parking demand impacts and the potential effects on existing bus and rail transit ridership. Station area circulation studies would be expected as part of project-level environmental documentation.

3.2 TRAVEL CONDITIONS

This section addresses the travel conditions related to different transportation modes in the study area. This section describes existing conditions and describes the potential of the No Project, Modal, and High-Speed Train (HST) Alternatives to affect travel conditions. Automobile and air transportation currently carry more than 98% of intercity trips, and are therefore the focus, together with the HST mode, of this section. For this analysis, *travel conditions* are defined as the experience, quality, sustainability, safety, reliability, and cost of intercity travel within the study area. Travel factors were developed based on the purpose and need (Chapter 1) for the proposed HST system and are used to evaluate the general impact of proposed changes to the transportation system for each of the alternatives.

3.2.1 Methods of Evaluation

A. METHOD OF EVALUATION OF IMPACTS

The overall method used to evaluate travel conditions is described below. To evaluate the relative differences in travel conditions that would result from implementation of the alternatives, six travel factors were considered that relate directly to the purpose and need and the goals and objectives defined in Chapter 1. These factors are listed below.

- Travel time.
- Reliability.
- Safety.
- Connectivity (both modal and geographic).
- Sustainable capacity.
- Passenger cost.

Travel Time

Travel time is the total time required to complete a journey. With the exception of the automobile, intercity transportation options require multiple modes to complete a trip. Most people acknowledge that an air trip is not just the time spent in the air (the line-haul portion of the trip), but also includes the time required to travel to the airport, check in, pass through security, board the plane, and travel to the final destination. The total travel time of a mode is also dependent on its reliability. If a mode is unreliable, a traveler must allow more time to complete a trip, effectively lengthening the total travel time.

Reliability

Reliability is the delivery of predictable and consistent travel times and is a key factor in attracting passengers to use a particular mode of travel. Travel time and reliability directly affect productivity, as they determine the ease and speed with which workers and products arrive at their destinations. Greater travel demand on capacity constrained facilities results in further congestion and is one of the primary reasons for longer travel times. Reliability is primarily a function of unexpected delays due to many factors, including traffic congestion, accidents, mechanical breakdowns, roadwork, and inclement weather.

Safety

Projected growth in the movement of people and goods in California by road and air underscores the need for improved travel safety. National and statewide statistics indicate that the rate of fatality or serious injury by private motor vehicle is increasing, primarily because more people are traveling by this mode. Nationally, over the last 10 years, accident and injury rates have remained fairly constant for commercial airline travel, which remains a safe mode compared to the private automobile.

Connectivity (Modal and Geographic)

Modal: Connections between modes of transportation are an element in the development and operation of a successful total transportation system. The ability to transfer easily between modes and the frequency of service are additional key factors that can determine a traveler's modal choice. Statewide, connections between airports and the extensive regional urban and commuter transit systems are currently limited. Under existing conditions and No Project, modal connections at airports are limited, and the connections and services available are fragmented and not provided as an integrated system with coordinated fares, schedules, and amenities. With the exception of the new BART extension to San Francisco International Airport (SFO) and the Metrolink connection to Burbank Airport, other airports do not have direct rail connections to city centers, other transit systems, or the region. At these airports, transit connections can be cumbersome, often requiring multiple transfers and long waiting times, are not well advertised to potential passengers, and lack coordinated fares and schedules.

Geographic: Connecting the northern and southern urban areas of the state (southern California and San Francisco Bay Area) with an additional transportation system could significantly improve statewide mobility. Connecting these urban areas with the cities and communities of the Central Valley could yield potential benefits. Due to poor connectivity, limited services, and weather impacts, travel options to and from Central Valley cities are limited, travel times are long, and the potential for delay is high.

Sustainable Capacity

Sustainable capacity is a measure of the transportation system's capability to meet projected demand without the need to develop additional infrastructure. The current California transportation system is stressed beyond capacity in many places and for considerable periods of the day. Rush "hour" is a thing of the past. As demand increases without sufficient capacity, the severity of the congestion will increase and result in more frequent delays and longer peak travel periods throughout the day. This demand-capacity imbalance will worsen over time as system use increases. As a result, the transportation system will lose the ability to absorb short-term or long-term demand increases and become increasingly inflexible because of the lack of capacity. Indeed, travelers are already witnessing this phenomenon on many of California's major highways and at its major airports. US-101 between SFO and Redwood City is typically congested beyond traditional peak periods, and Los Angeles International Airport (LAX) regularly suffers significant flight delays due to congested conditions for arriving or departing flights.

Cost

Direct, passenger-borne costs are another key factor in passenger travel choice. Most travel demand studies have found that travel costs are highly variable, depending on the type of traveler and the purpose of travel. Business travelers may be willing to pay high fares for urgent needs, but leisure travelers may constrain themselves to the lowest fare possible. In some cases, travelers are also willing to pay a premium for a reliable, comfortable, and safe journey.

The six travel factors are summarized in Table 3.2-1. These travel factors are used to evaluate the relative difference between alternatives both qualitatively and quantitatively. The method by which the travel factors have been applied to the alternatives is summarized in Table 3.2-2. Each of the travel factors is described in greater detail as they are applied in the potential environmental consequences of travel conditions discussion.

In general, the No Project and Modal Alternatives would include the same intercity travel modes that are available under existing conditions, which are the automobile, airplane, intercity bus, and conventional rail. The intent of the environmental analysis performed in this Program EIR/EIS is to broadly assess the highest potential level of impact. Therefore, the high-end forecasts for the HST (68 million trips) are used to describe the operations and required facilities for the proposed alternatives. However, in a few areas where the high-end forecast produced the lowest impacts or highest benefit, analysis of conditions based on the low-end HST forecast (42 million trips) is also included. Both the high- and the low-end include 10 million long-distance commute trips.

Table 3.2-1
Relation of Travel Factors and Purpose and Need/Objectives

	Travel Factors					
	Connectivity	Travel Time	Reliability	Safety	Sustainable Capacity	Passenger Cost
Project Purpose						
To improve intercity travel experience	X	X	X	X	X	
To maximize intermodal transportation opportunities	X	X				
To meet future intercity travel demand	X	X				
To increase efficiency of intercity transportation system	X		X		X	
To maximize use of existing transportation corridors	X		X			
To develop a practical and feasible transportation system by 2020 and in phases	X					X
To provide a sustainable reduction in travel time		X			X	
Project Need						
Limited modal connections	X	X				
Future growth in travel demand					X	
Capacity constraints			X		X	
Unreliability of travel			X	X	X	
Project Goals and Objectives						
Maximize mobility	X				X	X
Minimize travel times		X				
Minimize environmental impacts					X	
Maximize system safety			X	X		
Maximize reliability			X			

X = Directly applies.
Source: Parsons Brinckerhoff 2003.

Table 3.2-2
Transportation Factors

Typology	Description	Measurement
Travel Time	Total door-to-door travel time	Total travel time including access and in-vehicle times
Reliability	Ability and perception to arrive at the destination on-time	Accidents Inclement weather Transportation-related construction Volume variation Special events Traffic control devices and procedures Base capacity Vehicle availability
Safety	Loss of life or injury	Comparison of safety performance characteristics by mode (operator, vehicle, and environment)
Connectivity	Transportation options that connect to other systems and destinations	Modal Number of intermodal connections and options, and frequency of service provided by each alternative Geographic Connectivity between regions by mode
Sustainable capacity	Ability to accommodate additional demand beyond the design demand	Amount of additional infrastructure required to meet a threshold demand above and beyond the design demand
Passenger cost	One-way travel costs	Total costs including fares and other costs for intercity travel by mode
Source: Parsons Brinckerhoff 2003.		

3.2.2 Affected Environment

A. STUDY AREA DEFINED

This program-level analysis of travel conditions and potential impacts does not measure the specific potential impact on individual transportation facilities (e.g., a transit line, highway or airport). Rather, travel conditions have been evaluated for the total project area and regional level. Specific examples of representative travel conditions in a corridor or for a specific highway, airport, or rail facility are identified where possible. The study area for this analysis of travel conditions encompasses all five regions in the project area—Bay Area to Merced, Sacramento to Bakersfield, Bakersfield to Los Angeles, Los Angeles to San Diego via Inland Empire, and Los Angeles to San Diego via Orange County (LOSSAN).

B. GENERAL DISCUSSION OF TRAVEL CONDITIONS

For travel conditions, the affected environment is California's intercity travel network, which consists of three main components: highways, airports, and rail. Of these, automobiles and air transportation currently carry over 98% of intercity trips, and are therefore the focus of this section. Congestion in the affected environment is a serious concern, as shown in Figure 3.2-1. According to the Texas Transportation Institute, the urban areas of San Francisco and Los Angeles experience some of the most severe highway congestion and travel delays in the country (Shrank and Lomax 2002). Recent research by the Institute of Transportation Studies at the University of California, Berkeley, indicates that California airports generally experience the highest average air travel delays in the nation (Hansen et al. 2002). Although the main contributors to this congestion are local and commuter highway trips and transcontinental and international flights (at least at major airports such as SFO and LAX), intercity trips compete for the limited capacity on these overburdened facilities.

The highway system is congested near and around urban centers (e.g., San Francisco, Los Angeles, San Diego) and in rural and suburban communities (e.g., Central Valley) during both the morning and evening peak hours. The Los Angeles area has some of the worst travel delay—the extra time spent traveling because of congestion—in the country, according the Texas Transportation Institute (Shrank and Lomax 2002). According to San Francisco's Metropolitan Transportation Commission (MTC), seven out of ten of the most congested highway corridors in the Bay Area (including segments of I-880, I-580, and US-101) are key intercity routes in the Bay Area to Merced region (see Figure 3.2-2). Similarly, according to the San Joaquin Council of Governments, several major routes that traverse the Central Valley (I-5, I-205, I-580, SR-120, SR-99) are critical intercity links for passengers and goods traveling between northern and southern California. Section 3.1, *Traffic and Circulation,* of this Program EIR/EIS notes that several of these routes are currently operating during the peak periods at or near congested levels of operations. In fact, I-5 and SR-90 (key intercity routes assessed in this analysis) are designated by the California Department of Transportation (Caltrans) as "high emphasis focus routes" of critical importance to the movement of goods in California.

California's aviation system provides for intercity, domestic, and international travel. The aviation system is also a significant economic generator that fuels the state's economy. According to the Federal Highway Administration, in 2002 California's airports contributed to about 9% of the state's employment and total economic output (Federal Highway Administration 2003). According to Caltrans, in 2002 about 159 million passengers in California traveled by air, or about 12% of the national total. Seven California airports are ranked in the top 50 U.S. primary/commercial service airports. As shown in Table 3.2-3, all seven airports are located in one of the five regions considered in this analysis.

Table 3.2-3
California Airport National Rankings (2002)

Airport	U.S. Ranking	Region
Los Angeles (LAX)	3	Bakersfield to Los Angeles and Los Angeles to San Diego (via Inland Empire and Orange County)
San Francisco (SFO)	8	Bay Area to Merced
San Diego (SAN)	30	Los Angeles to San Diego (via Inland Empire and Orange County)
San Jose (SJC)	34	Bay Area to Merced
Oakland (OAK)	37	Bay Area to Merced
Sacramento (SMF)	44	Sacramento to Bakersfield
John Wayne/Orange County (SNA)	45	Los Angeles to San Diego via Orange County
Source: Aviation in California Fact Sheet, California Department of Transportation, Division of Aeronautics, 2002.		

The National Center of Excellence for Aviation Operations and Research predicted that demand at California airports, which dropped by as much as 33% after the September 11, 2001, terrorist attacks, will recover to 2000 levels in 2002 or 2003 or shortly thereafter (National Center of Aviation Operations and Research 2002). As a result, the seven major airports in Table 3.2-3 currently operating at or near capacity are all planning major improvements to accommodate existing and future projected demand. In 2000, almost 25% of all flight arrivals were delayed for 9 minutes or more, a number significantly higher than the national average (Hansen et al. 2002).

Congested airways are one source of passenger delay for intercity trips; congested highways are another. According to the California Transportation Commission, California's major airports suffer from poor ground access and severe congestion, which directly impacts international trade (California Transportation Commission 2000). As shown in Section 3.1, *Traffic and Circulation,* many of the highway segments and primary airport access routes to the study area airports have a level of service (LOS) of E and F. *Level of service* describes the condition of traffic flow, ranging from excellent conditions at LOS A to overloaded conditions at LOS F. LOS D is typically recognized as an acceptable service level in urban areas.

3.2.3 Environmental Consequences

A. EXISTING CONDITIONS VS. NO PROJECT ALTERNATIVE

The No Project Alternative includes programmed and funded transportation improvements to the existing transportation system that will be implemented and operational by 2020. The primary differences between existing conditions and the No Project Alternative are the increased level of intercity travel demand and the implementation of new infrastructure. Improvements (programmed and funded) focus on existing modes; therefore, the same modes of intercity transport will continue to be available. The programmed or funded transportation improvements assumed to be in operation by 2020 are not major system-wide capacity improvements (e.g., major new highway construction or widening, or additional runways) and will not result in a general improvement or stabilization of existing highway or air travel conditions across the study area. Connectivity is not expected to improve with the No Project Alternative because few major intermodal terminals are expected to be built over the next 20 years.

As described in Section 3.1, *Traffic and Circulation*, existing facilities are currently operating at congested levels of service at many locations, and traffic conditions are projected to deteriorate further under the No Project Alternative. Of the 68 intercity highway segments analyzed in Section 3.1, more than half are operating during the peak period at LOS F or a volume-to-capacity (V/C) ratio more than 1.0 under existing conditions. These conditions are expected to deteriorate further under the No Project Alternative. On average, across all five regions, V/C ratios could deteriorate by almost 40%, and each region could have more LOS F segments under the No Project Alternative. Capacity in the No Project Alternative is insufficient to accommodate the projected growth in highway travel in every region, including both the traditional urban areas (e.g., the San Francisco Bay Area and Los Angeles basin) and the emerging urban areas in the Central Valley. Consequently, there would be no sustainable improvement to the transportation system's capacity.

Although intercity travel is only a small percentage of all highway trips, it must compete for limited capacity on already congested infrastructure for which insufficient capacity improvement projects are planned to be operational by 2020. For instance, according to MTC, between years 2000 and 2020 in the Bay Area, total vehicles per household will increase by 5%, and average vehicle miles traveled per weekday will increase by about 30%. This projection is representative of conditions throughout the state (Metropolitan Transportation Commission 2003). In the Central Valley, the San Joaquin Council of Governments estimates that the percentage of time vehicles are delayed relative to the total travel time will increase in 2025, and that the percentage of miles traveled at congested levels of service (LOS E or F) will increase from 1.25% in 1999 to more than 6% in 2025—a more than six-fold increase (San Joaquin Council of Governments 2002). In most cases, the potential impact of these conditions could manifest itself in deteriorating levels of service on highway segments and local streets or an extended peak-period congestion on links that are already operating at near or total breakdown conditions. In many instances, the morning peak period could extend from 2 hours to

4 hours. Likewise, as shown in Figure 3.2-3, increasing demand will lead to greater congestion, total travel time delay, and reduced reliability on the primary highway corridors in southern California.

According to the California Aviation System Plan, almost 173 million passengers enplaned and deplaned in California in 1999, a number that is expected to more than double by 2020 (California Department of Transportation 2001). Under the No Project Alternative, no additional runways or other major capacity expansion projects would be implemented by 2020. According to the Southern California Association of Governments, urbanized airports in southern California are already at 73% of total capacity and available capacity is rapidly diminishing (Southern California Association of Governments 2001). A similar trend can be expected across the state. As a result, many of the airports in the study area that are currently at or near capacity could become severely congested under the No Project Alternative. Capacity constraints are likely to result in significant future aircraft delays, particularly at California's three largest airports. SFO has "one of the worst flight delay records of major U.S. airports—only 64% of SFO flights were on time during 1998" (San Francisco International Airport 2003). According to SFO, within 10 years the three Bay Area airports will not have the sufficient capacity to meet regional air traffic demand even on a good weather day. LAX projects a demand of 19.2 million more annual passengers than their 78.7 million total passenger capacity by 2015, while San Diego International Airport expects to be at capacity prior to 2020 (San Diego Airport 2001). The projected delays at heavily used airports and forecasted highway congestion would continue to delay travel, negatively affecting the California economy and quality of life.

Given these travel trends, overall travel safety is also expected to worsen. As VMT continues to rise over the next 20 years under the No Project Alternative, the accident rate will not change appreciably, but the net number of accidents, injuries, and fatalities could increase, particularly for highway-based trips. As evidence of this trend, the National Highway Traffic Safety Administration reported that between 1998 and 2001 fatalities on California's roadways have increased by an average 4% annually (National Highway Traffic Safety Administration 2001).

Travel costs are also expected to rise because of capacity constraints. Regions could be faced with attempting to control demand through congestion pricing for both the auto and air modes. This approach could result in more congestion-priced toll roads like SR-91 in Orange and Riverside Counties, and peak-period landing fees for airports statewide. Both of these costs would be passed along to the consumer either directly in tolls or indirectly in ticketed fares.

As summarized in Table 3.2-4, the No Project Alternative could result in either a deteriorated LOS or no change compared to existing conditions.

Table 3.2-4
Existing Conditions Compared to No Project Alternative

	No Project Alternative (2020)	
Travel Factor	**Change from Existing Conditions**	**Comment**
Travel Time	Deteriorate	Increased congestion could result in further delays.
Reliability	Deteriorate	Increased congestion and no change in modal options or characteristics could result in greater unreliability.
Safety	Deteriorate	No change in modal options would maintain existing fatality and injury rates; however, increased demand could result in greater number of fatalities.
Connectivity	None	No additional intercity intermodal connections or options, or increased frequencies will be available.
Sustainable Capacity	Deteriorate	No significant mainline capacity improvements will be operational.
Passenger Cost	Deteriorate	Airfares are anticipated to increase beyond their current fare structures relative to other modal options.*

* Based on high-end forecasts from final business plan, California High Speed Rail Authority 2000.
Source: Parsons Brinckerhoff 2003.

B. NO PROJECT ALTERNATIVE VS. MODAL AND HIGH-SPEED TRAIN ALTERNATIVES

This section presents expected travel conditions for the Modal and HST Alternatives and compares relative differences between No Project and the Modal and HST Alternatives. This section is organized by the six travel factors identified earlier. Only the HST Alternative would introduce a new mode to the California intercity transportation system. This new mode would result in some major differences in expected travel conditions. Each travel factor begins with a summary of the specific methods used to define and evaluate the Modal and HST Alternatives and the characteristics of each mode followed by an evaluation of impacts for the Modal and HST Alternatives.

Travel Time

Travel time is a key travel factor that determines the attractiveness of a particular mode of travel to passengers. Travel time is also an important economic factor that directly affects productivity (travel time for workers and products to get to their destination). For the purpose of this analysis, improved travel time is a benefit to the traveler because it can improve the intercity travel experience. Travel time for this analysis was measured as the total (door-to-door) travel time for the example city pairs presented in Chapter 1. Travel times representing the duration of the air or HST trips spent in the airplane or train (line-haul times) are included in Appendix 3.2-A.

Automobile Mode Characteristics: Travel time in an automobile largely depends on three factors: distance traveled, roadway design speed (and associated speed limit), and congestion levels. The design of a roadway dictates the time that will be required to travel between two destinations. The time of day and associated congestion also plays a role in how long a trip will take. For this analysis, it is assumed that the top speed of the automobile is 70 miles per hour (mph) (113 kilometers per hour [kph]).

Automobile travel times are based on driving times between the representative city pair origins and destinations, as summarized in Table 3.2-5. The travel time for existing conditions is the same as the times used in the California High Speed Rail Authority's (Authority's) final business plan (Business Plan) and is based on weighted averages of peak and off-peak travel times

(California High Speed Rail Authority 2000). To replicate the unique congested conditions in the San Francisco and Los Angeles areas, a delay penalty of 30 minutes (min) for trips originating in or destined for the San Francisco or Los Angeles regions was added to all year 2020 projections. This assumption was also incorporated in the higher-end HST ridership and revenue forecasts from the Business Plan. The travel time savings analysis developed for the economic growth analysis of this document (Chapter 5) shows that auto travel time for the Modal Alternative is estimated to be 8.5% shorter than for the No Project Alternative because of the reduction in congestion due to the increase in capacity on the highway system. In the same analysis, the auto travel times for the HST Alternative are estimated to be 4.1% shorter than the Modal Alternative because of the diversion of highway trips to the HST system (California High Speed Rail Authority 2000a).

Table 3.2-5
Total Door-to-Door Automobile Travel Times (Hours:Minutes)

		2020 (Alternatives) Automobile Total Door-to-Door Travel Times[b]		
City Pairs	**Existing Conditions (1999)[a]**	**No Project**	**Modal**	**HST**
Los Angeles downtown to San Francisco downtown	6:57	7:57	7:16	7:36
Fresno downtown to Los Angeles downtown	4:00	4:30	4:06	4:18
Los Angeles downtown to San Diego downtown	2:19	2:49	2:35	2:41
Burbank (airport) to San Jose downtown	5:50	6:50	6:15	6:32
Sacramento downtown to San Jose downtown	2:10	2:40	2:26	2:33

[a] California High Speed Rail Authority's final business plan, 2000, and Independent Ridership and Charles River Associates, Passenger Revenue Projections for High Speed Rail Alternatives in California, 2000.

[b] Sum of existing conditions plus representative delay penalty of 30 min for origin and destinations at San Francisco or Los Angeles, which is consistent with the high-end revenue and ridership forecasts for the Business Plan. Under the low-end revenue and ridership analysis the travel time under No Project would be the same as existing conditions.

Source: Parsons Brinckerhoff 2003.

<u>Air Mode Characteristics</u>: Air travel is the fastest line-haul mode at 530 mph (853 kph) maximum cruising speed. However, a significant portion of a passenger's trip is spent accessing the airport, passing through one or more security checkpoints, boarding and alighting the aircraft, and egressing the airport. The components of a door-to-door air trip include the components listed below. (See Appendix 3.2-B for more detailed explanation.)

- Access time: time spent driving to the airport.
- Terminal time: time spent getting through the airport terminal.
- Line-haul time: time spent on the aircraft.
- Arrival time: time spent getting to the final destination.

It is assumed that all air trips would require travel on the regional highway system with the exception of San Francisco, where some passengers could use the newly opened BART to SFO rail link. Also, passengers in the Los Angeles area could use a Metrolink connection to Burbank.

Total air travel times are summarized in Table 3.2-6. As shown, No Project travel times would increase between 15 and 30 minutes compared to existing conditions, depending on city pairs.[1] These changes are due to increases in line-haul travel time resulting from insufficient capacity at airports under No Project. It is estimated that air travel times would change under the Modal and HST Alternatives compared to No Project because the additional infrastructure under the Modal Alternative and the diversion of trips to HST would reduce airside congestion levels, while all other factors (arrival, terminal, and departure times) would remain constant (California High Speed Rail Authority 2003). Although there would be an improvement of intercity highway travel times, this improvement is not meaningful for access trips to and from the airports.

Table 3.2-6
Total Door-to-Door Air Travel Time (Hours:Minutes)

City Pairs	Airports	Existing Conditions (1999)	2020 Alternatives Air Mode Total Door-to-Door Travel Times		
			No Project Alternative[a]	Modal[b]	HST[c]
Los Angeles downtown to San Francisco downtown	LAX, LGB, BUR, SNA, ONT, SFO, OAK, SJC	3:02	3:32	3:27	3:26
Fresno downtown to Los Angeles downtown	FAT, SNA, ONT, LAX, LGB, BUR	2:47	3:02	3:01	3:00
Los Angeles downtown to San Diego downtown	LAX, LGB, BUR, SNA, ONT, SAN	2:30	3:00	2:45	2:46
Burbank (Airport) to San Jose downtown	BUR and SJC	2:44	3:14	3:09	3:08
Sacramento downtown to San Jose downtown	SMF and SJC	No Service	No Service	No Service	No Service

N/A = Not applicable.
[a] 15-min penalty for San Francisco, Los Angeles, and San Diego area airports based on high-end ridership and revenue forecasts from the Business Plan. Under the low-end forecasts, travel time in 2020 would be the same as under existing conditions.
[b] Total travel time reduced based on increase in capacity at airports.
[c] Total travel time reduced because of reduction in demand at airports from trips shifting from air to HST.
Source: Parsons Brinckerhoff 2003.

<u>High-Speed Train Mode Characteristics</u>: With a maximum operating speed of 220 mph (354 kph), the HST is slower in line-haul speed than an airplane but considerably faster than an automobile. However, for most intercity trips within California, the quick arrival, terminal, and departure times make the overall HST travel time competitive with that of air travel. The HST would also connect closer city pairs, those less than 150 mi (241 km) apart, and for those trips would compete strongly with the automobile. For example, HST travel between Los Angeles and Bakersfield or Sacramento and Modesto would likely be faster than automobile travel.

In Europe and the United States, rail travel time improvements have shifted travel demand from air to rail travel. Within a decade of its inauguration, France's Train à Grande Vitesse (TGV) Sud-Est succeeded in capturing more than 90% of the travel market between Paris and Lyon (Meunier 2002). Amtrak's Acela and Metroliner trains have 50% of the total air-rail market, which is split between New York and Washington. In Germany, recent passenger rail improvements between Frankfurt and Cologne were undertaken with the purpose of shifting air

[1] This assumption is consistent with the high-end revenue and ridership assumptions for the Business Plan.

trips from congested airports where capacity was constrained and could not be expanded to high-speed rail that could more quickly serve the same markets. This same principle could apply to the major airports in the study area, including San Francisco and Los Angeles. The air operation time-slots released by substituting HST for local air service at these two airports could provide more opportunities for international and interstate flights.

HST would also provide direct connections to several airports. This connectivity, combined with the line-haul speed of the HST, could result in faster total travel times for air travelers who use air travel and the HST to reach their final destination. For example, passengers arriving at San Francisco could transfer to the HST and travel to Merced, and this connection could be competitive with or possibly faster than connecting to another flight, driving, or taking a bus or shuttle.

The train in this instance may be quicker for two reasons. First, trains may be boarded swiftly, often in less than 2 minutes because of the number of doors and ability to accommodate extra passengers. In contrast, boarding an airplane must be controlled for security and typically takes place through one door (or at most two doors), a process that can take up to half an hour. Second, current airline boarding practice requires passengers to be present at the gate at least 20 minutes before the scheduled departure time.

Another key difference between HST and air travel is the percentage of total travel time spent during the line haul. On a train, this proportion of time is quite high, and can be used for work, pleasure, or relaxation. For example, passengers traveling by HST between any of the below city pairs would be able to use their laptop computers or any number of personal audio, video, or game devices for approximately 70% of the total travel time, while passengers traveling by air would be able to use these devices for just 30% of their trip.[2]

Total travel times are summarized in Table 3.2-7. Since no HST exists or would exist under the No Project or Modal Alternatives, only the travel times for the HST Alternative are shown. While these travel times are from downtown to downtown where HST has a distinct advantage over air travel because of terminal locations, the potential for many online stations could make the HST competitive for many other trips. Like air travel, the HST has the following door-to-door trip components. (See Appendix 3.2-B for more detailed explanation.)

- Access time: time spent driving to the train station.
- Terminal time: time spent getting through the train station.
- Line-haul time: time spent on the train.
- Arrival time: time spent getting to the final destination.

[2] Although the line-haul time of the flight is about 33% of the total trip, due to restrictions on use of electronics during take off and landing, the productive time is reduced by another 10%.

Table 3.2-7
Total Door-to-Door High-Speed Train Mode Travel Times (Hours:Minutes)

City Pairs	2020 HST Total Door-to-Door Travel Times
Los Angeles downtown to San Francisco downtown	3:20[3]
Fresno downtown to Los Angeles downtown	2:23
Los Angeles downtown to San Diego downtown	2:16
Burbank (airport) to San Jose downtown	2:52
Sacramento downtown to San Jose downtown	1:53
Source: California High Speed Rail Authority 2000.	

Existing conventional rail services are typically not competitive with other modes. For example, while the HST line-haul time (a component of total trip time) between downtown San Francisco and Los Angeles would be just under 2.5 hrs, the only existing direct rail service between the Bay Area (Oakland) and Los Angeles (Coast Starlight service) currently has a line-haul time of more than 12 hrs and operates one train daily in each direction. The San Joaquin service between Oakland and Los Angeles currently takes about 8 hrs and 40 min but requires transferring to a bus for the Bakersfield to Los Angeles segment of the trip. The HST line-haul time between downtown Los Angeles and downtown San Diego would be about 1 hr and 13 min as compared with current Surfliner line-haul time of 2 hrs and 45 min. Caltrans and Amtrak plan to reduce travel times by up to 30% on key intercity routes such as the Pacific Surfliner and Capitol Corridor services over the next 20 years; however the projects required to reach these goals are not yet funded.

Alternatives Comparison for Travel Time

No Project Alternative: There are no travel-time benefits associated with the No Project Alternative because there are no significant improvements to capacity or modal options. The No Project Alternative would likely result in longer travel times in all cases as compared to existing conditions, and these increases would range between 15 and 60 minutes for the representative city pairs.

Modal Alternative: The Modal Alternative could achieve up to a 16-min reduction in travel time for the representative city pairs compared to the No Project Alternative. The greatest savings would be achieved in the most congested corridors of Sacramento to San Francisco. These benefits would occur primarily due the additional highway capacity in the Bay Area and southern California regions with the Modal Alternative. It is estimated that with the additional capacity proposed for airports there would be some travel time benefits over the No Project Alternative.

High-Speed Train Alternative: The greatest time savings would be achieved using express service between Fresno and Los Angeles and between Los Angeles and San Diego. Because of its faster line-haul speed, HST would compete with the automobile for shorter distance intercity trips. Because of its shorter terminal processing times, HST would also compete with the airplane for longer distance intercity trips. In the Central Valley, HST would provide shorter travel times than both the highway and air modes for travelers headed to locations near HST stations.

[3] Time based on I-5 alignment option. Antelope Valley alignment option would be 3:30, an additional 10 minutes.

Reliability

In its simplest form, *reliability* can be defined as variation in travel time, hour-to-hour and day-to-day for the same trip. Reliability is important for almost any travel need and on any travel mode. Business travelers want to be able to predict how long it will take them to arrive at a meeting, either across town or across the state. Express shippers need to know where packages are at all times and when they will be available for delivery. Vacationers who want to spend as little of their time off as possible traveling to and from their destinations often find themselves making their trips during the most congested days of the year. Reliable travel means fewer late arrivals, improved efficiency, saved time, and reduced frustration.

Travel on most transportation modes is consistent and repetitive, yet at the same time highly variable and unpredictable. This apparent contradiction accrues because travel is consistent and repetitive since peak usage periods occur regularly and can be predicted. The relative size and timing of rush hour is well known in most communities. Simultaneously, travel is variable and unpredictable because on any given day unusual circumstances such as a rainstorm or an auto accident can cause serious delays at any time.

The traveling public's experience with variations in travel reliability affects their decisions of how and when to travel, so that they have a reasonable expectation that they will arrive at their destination at a particular time. For example, if a highway is known to have highly variable traffic conditions, a traveler using that route to catch a flight routinely leaves extra time reach the airport.

Travel time reliability is the direct result of the variable and often unpredictable events that can occur on different travel modes and at any time of day. The traditional way of measuring and reporting travel times experienced by highway users is to consider only average or typical conditions. However, the travel times experienced by users are seldom constant, even for travel on the same facility in the same peak or off-peak time period. Reliability is influenced by several underlying factors that vary over time and that influence the environment within which transportation operates. These factors are listed below.

Incidents: *Incidents* are events that disrupt normal travel flow, such as obstructions in the travel lanes of highways. Events such as vehicular crashes, mechanical breakdowns, and debris in travel lanes are the most common form of incidents for any mode. On highways, events that occur on the shoulder or roadside can also influence traffic flow by distracting drivers, leading to changes in driver behavior and ultimately to the quality of traffic flow.

Inclement Weather: *Inclement weather* and related environmental conditions (rain, fog, snow, ice, sun glare, etc.) can lead to changes in operator behavior, vehicle performance, and operational control requirements that affect traffic flow. Motorists respond to inclement weather by reducing their speeds and increasing their headways. Airport and civil aviation authorities respond by grounding flights or delaying takeoffs and landings. In cases of severe weather, authorities respond by closing roadways and creating vehicle caravans.

Construction: Construction can often reduce the number, width, or availability of travel lanes, rail tracks, and runways. Nearby construction activities can also reduce reliability if operating rules or conditions are changed (e.g., slow orders on rail tracks). Delays caused by work zones have been cited by highway travelers as one of the most frustrating conditions they encounter on trips.

Volume Variation: *Volume variation* is day-to-day variability in demand that leads to some days with higher travel volumes than others. Different demand volumes superimposed on a system with fixed capacity results in variable, less reliable travel times.

Special Events: Special events such as concerts, fairs, and sports events cause localized congestion and disruption in the vicinity of the event that is radically different from typical travel patterns in the area.

Traffic Control Devices and Procedures: These can lead to intermittent disruption of travel flow through means such as air traffic control, railroad signals and switches, railroad grade crossings, drawbridges, and poorly timed signals.

Base Capacity: *Base capacity* refers to the physical capacity of a transportation system, such as the number the highway lanes or runways. The interaction of base capacity with the other influences on reliability has an effect on transportation system performance. This is due to the nonlinear relationship between volume and capacity on any mode. When congested conditions are approached, small changes in volume lead to diminished throughput of the transportation system and consequent large changes in delay. Further, facilities with greater base capacity are less vulnerable to disruptions; for example, an incident that blocks a single lane has a greater impact on a highway with two travel lanes than a highway with three travel lanes.

Vehicle Availability and Routing: These can directly affect a traveler's ability to make an on-time trip, particularly on a common carrier such as airplane and train, or by rental car. End-to-end routing, hubbing,[4] and other strategies to maximize vehicle operation time can affect reliability when a vehicle that is needed in one location first has to complete a trip from a different location. Short layovers or "pads" that are scheduled between trips for a given vehicle also affect vehicle availability.

The extent to which these eight factors affect each of the major intercity travel modes, and by extension the Modal Alternative and HST Alternative, is analyzed and compared on a qualitative basis by describing and ranking the extent to which each travel mode is potentially susceptible to each of the eight factors. It is presented in Table 3.2-8 and further detailed below. Because the alternatives are composed of combinations of modal elements (including different modes for trip segments like station or terminal access), modal rankings have been combined, providing a qualitative understanding of the reliability of each alternative.

Table 3.2-8
Modal Reliability

	Relative Susceptibility to Reliability Factors*		
Factor	**Air**	**Automobile**	**High-Speed Train**
Incidents	**Low** Air travel has very few major incidents, and is generally not influenced by incidents on other modes.	**High** Automobile travel can be influenced by minor and major incidents at any location along the roadway and is frequently affected by incidents outside of the right-of-way.	**Low** HST has very few major incidents and is generally not influenced by incidents on other modes since the number of grade crossings is minimal or non-existent.
Weather	**High** A variety of weather conditions anywhere in the country can affect air travel.	**High** A variety of weather conditions can degrade operator ability, make roadways impassible, or damage roadways.	**Low** Trains can operate under virtually any conditions. Guideway is constructed to minimize weather impact.

[4] Hubbing is a reference to the "hub and spoke" operations practice where airlines coordinate a large number of their flights to arrive at a major terminal at the same time to allow passengers to transfer from one plane to the next to complete their trip to their final destination.

Factor	Relative Susceptibility to Reliability Factors* Air	Automobile	High-Speed Train
Construction	**Low** Most activities scheduled for periods of low airport usage. High-quality construction minimizes routine maintenance needs.	**Moderate** Construction activities (major and minor) are common, but generally occur during warm weather months. Lane closures are often of long-term duration.	**Low** Most activities are scheduled for hours when system is closed. High-quality construction minimizes routine maintenance needs.
Special events	**Low** Special events (e.g., air space closure) are generally rare but can lead to rerouting or airport closure when they do occur.	**Moderate** Special events are common and can create volume fluctuations or short-term lane closures.	**Low** Most special events can be easily accommodated on HST without effect on travel time. Guideway closures are uncommon for this factor.
Traffic control devices or procedures	**Moderate** Reliability strongly influenced by air traffic control rules and capabilities.	**Moderate** Auto travel influenced by traffic signals, railroad crossings, and other devices. Influence depends on level to which devices are optimized.	**Low** HST operates in exclusive, grade-separated right-of-way, minimizing external influences. Double-tracked guideway minimizes switching needs. HST control systems are redundant and highly automated, allowing for a high level of precision in dispatching and control.
Inadequate base capacity	**Moderate** Capacity can be strong influence due to complex procedures for gate usage, taxiing, and takeoffs/ landings. This factor has strong interaction with weather at certain airports.	**High** This is one of the strongest influences on highway reliability, particularly for facilities with three or fewer lanes per direction. Travel time degrades quickly as capacity is approached.	**Low** HST system generally has large capacity reserve. Operations are not allowed to exceed design capacity. Exclusive guideway maintains high level of base capacity at all times.
Volume variation	**Moderate–High** Air travel demand and number of scheduled flights fluctuates broadly from day to day. Aircraft loading and unloading times directly affected by passenger volumes.	**High** Peak-period travel in medium to large urban areas highly influenced by day-to-day or seasonal volume variations. Strong interaction with inadequate base capacity.	**Low** Day-to-day variation in train volumes tends to be low. Passenger volume variation generally does not influence travel times.
Vehicle availability or routing	**High** Airplanes are used multiple times in a given day, and availability can be affected by factors anywhere in the world and with any type of routing system (point-to-point or hub-and-spoke). High capital cost discourages airlines from keeping large reserve fleet.	**Low** Private automobiles are ubiquitous and are widely available for rental in emergency situations. The road and highway network provides alternative routes for most trips.	**Moderate** HST vehicles complete multiple end-to-end trips in a day, potentially affecting availability at specific times and locations; simple routing schemes generally followed.

* High indicates that the factor can exert a strong negative influence on travel time reliability for the mode. Conversely, low indicates that the factor generally does not play a role in influencing travel time reliability for the mode.

Source: Cambridge Systematics, Inc. 2003.

Automobile Mode Characteristics: On a day-by-day basis, automobiles tend to be the least reliable of the three modes. Highway travel is highly or moderately susceptible to seven of the eight factors described above. It is only when considering the influence of vehicle availability and routing that automobiles potentially would have a lower susceptibility than other modes.

Recent research provides further evidence on the unreliability of highway travel (Texas Transportation Institute and Cambridge Systematics, Inc. 2003). This research, which used actual travel time data covering 579 mi (932 km) of freeways in the Los Angeles area, shows that reliability problems exist on highways at all times of the day, all days of the week, and all weeks of the year. This research expressed unreliability in terms of a *buffer index,* the amount of extra time motorists would need to budget to be certain of arriving on time at their destination 95% of the time. Results showed that a motorist in Los Angeles would need to allow an additional 45 min for a typical 1-hr highway trip—fully 75% of normal driving time. Even in midday periods, a traveler would need to budget an additional 30 min for the same 1-hr trip, or 50% of the normal time. It is important to note that a buffer does not represent certainty, and on any given day this buffer may or may not be needed.

Air Mode Characteristics: Despite its high average speed, air travel often suffers from reliability problems due to a number of factors. The data in Table 3.2-8 suggest that air travel is moderately or highly susceptible to weather, vehicle availability, volume variation, inadequate base capacity, and traffic control procedures. Air travel is more susceptible than the other two modes to reliability problems arising from weather and vehicle availability. Bad weather and a shortage of aircraft in other states can impact service in California. Air travel reliability is generally not, however, influenced by incidents, construction, and special events.

Airline on-time statistics compiled by the Federal Aviation Administration show air travel reliability problems are widespread in California. Airline on-time statistics are available through the Bureau of Transportation Statistics Web site (http://www.bts.gov/ntda/oai). These statistics were reviewed to compare actual versus scheduled flight times for flights departing from Sacramento (SMF), SFO, LAX, and San Diego (SAN) in June 2002.[5] The statistics were analyzed to determine the median scheduled flight time and the 95th percentile actual flight time for flights departing from these four airports.[6] These times and the resulting buffer are shown in Table 3.2-9.[7]

The data in Table 3.2-9 indicate that air travel is generally more reliable than highway travel, as suggested by the smaller buffers (10 to 15% for air travel versus 50 to 75% for highway travel). Nonetheless, the data also show that air travelers at these four airports still need to budget an additional 9 to 18 min of in-vehicle travel time to account for unforeseen reliability problems that often arise with air travel.

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[5] Statistics were analyzed for all flights operated by Alaska, America West, American, American Eagle, Delta, Southwest, United, and United Express. These eight airlines account for more than 95% of domestic departures at these four airports. More than 29,000 individual flights were included in the sample.

[6] The 95th percentile was chosen to maintain consistency with the research results reported for the highway mode.

[7] As with the highway mode, the buffer indicates the additional time needed above the average (median) time air travelers would need to budget to arrive on time for their flight with 95% certainty. For air travel, the buffer is expressed as a percentage of the median flight time.

Table 3.2-9
Reliability Statistics for Air Travel in California

Airport	Delay (95th Percentile Travel Time)	Scheduled Flight Time (Median)	Buffer (Delay/Scheduled Flight Time)
Sacramento (SMF)	9 min.	85 min.	10.6%
San Diego (SAN)	12 min.	90 min.	13.3%
San Francisco (SFO)	18 min.	118 min.	15.3%
Los Angeles (LAX)	12 min.	110 min.	10.9%
Source: Bureau of Transportation Statistics, June 2002.			

High-Speed Train Mode Characteristics: HST has been shown to have a low susceptibility to nearly all of the major factors that affect reliability. It is only on the issue of vehicle availability that HST, like all common carrier modes, has a higher level of susceptibility than highways. Also, HST has the same or lower level of susceptibility on all eight factors compared with air travel or even conventional rail.

Statistics from HST operations in Europe and Asia further confirm the high level of reliability that is inherent with HST. In France, more than 98% of TGV train runs have been completed within 1 min of schedule. In Spain during 2002, 99.8% of AVE runs were completed within 5 min of schedule. In Japan, the JR Central Shinkansen line averaged a 16-second delay per train in 2002. Using the buffer concept that was described for highways and air, these data suggest that HST travelers would likely need to have a schedule buffer less than 1 min (less than 1% of scheduled travel time) to account for unforeseen delay and reliability. This in-vehicle travel time buffer is extremely small compared to all other modes.

HST systems have proven worldwide to be far more reliable than conventional U.S. intercity rail services. Several factors account for this reliability.

- Intercity rail service involves mixed operations between conventional intercity passenger services and heavy freight traffic, whereas the HST service would not share tracks with heavy freight services.
- Depending on location and number of operations, the quality of train signal/control/dispatch systems for freight rail systems vary, whereas the HST services would use state-of-the-art automated control systems.
- Most conventional intercity passenger rail routes operate on freight railroads that are dispatched by the host freight railroad. Therefore, dispatching decisions may be based first on the needs of the host railroad, and then on the needs of the passenger train. For example, if a freight train is too long to go into a siding, the dispatcher will have to put the passenger train in the siding to wait until the longer freight train passes. This is just one type of delay for passenger trains using freight railroads.
- Grade crossings are inherently dangerous, providing the opportunity for vehicle and pedestrian collisions and delay due to malfunction of grade-crossing protection equipment. The HST service would be completely double-tracked, fenced, and grade-separated.

Although detailed statistics were not available, reports on rail operations in California suggest that conventional rail reliability is low (California Department of Transportation 2002). While Amtrak strives to complete a minimum of 90% of its train runs on time, the most recent data shows that the Capitol Corridor is on time about 84% of the time, while intercity service within the LOSSAN corridor is on time about 78% of the time. Monthly statistics for the Capitol Corridor show that the 90% on-time goal has only been reached in 2 of the past 24 months.

Alternatives Comparison for Reliability

A qualitative comparison of the alternatives was conducted by considering the relative reliability of the modes that are present in each alternative, the relative modal usage in each alternative, and any major changes such as highway lane additions or modal diversion that are present in an alternative. As described more fully below, the HST Alternative is projected to have the highest reliability, while the No Project Alternative is projected to have the lowest reliability.

No Project Alternative: Reliability under the No Project Alternative is likely to be lower than under the other alternatives for the following reasons.

- The No Project Alternative depends heavily on the automobile, which has been shown to have the worst reliability of the three modes.
- Existing congestion and reliability problems continue, because the No Project Alternative provides no new highway and airport base capacity.
- Greater highway and aviation congestion and more reliability problems accrue, because the No Project Alternative absorbs an increasing demand for travel with little increase in base capacity.

Modal Alternative: The Modal Alternative is likely to have better reliability than the No Project Alternative, but poorer reliability than the HST Alternative for the following reasons.

- The Modal Alternative depends heavily on the automobile, which has been shown to have the worst reliability of the three modes.
- Lower congestion and less susceptibility to reliability problems would result because the Modal Alternative could provide more base capacity to carry the expected increase in travel demand on highways and at airports than the No Project Alternative.

The Modal Alternative is likely to result in lower highway and air congestion levels than the HST Alternative since there is a measurable increase in capacity for both modes. Since the capacity increases between the No Project Alternative and the Modal Alternative but the number of intercity trips does not, less delay is accredited under the Modal Alternative to capacity constraints on both roadways and at airports. Nonetheless, Chapter 1 and Section 3.1 of this Program EIR/EIS have shown that the Modal Alternative would still experience near-capacity conditions on many highways and airports, increasing the likelihood of reliability problems. These problems would be compounded by the lack of a reliable alternative travel mode, such as the HST.

High-Speed Train Alternative: The HST Alternative is likely to provide the greatest degree of travel reliability for the following reasons.

- HST would divert significant levels of intercity demand from less reliable modes, particularly highways.
- HST provides a completely separate transportation system that would have less susceptibility to many factors influencing reliability.
- Highway and air travel reliability would improve because HST reduces travel demand on highways and air.

The various HST alignment options are not likely to exhibit appreciable differences in system reliability since system capacity and demand would be roughly equivalent. Major design differences (e.g., extent of tunneling) would not make a meaningful difference in reliability, and differences in base travel times on HST would not influence reliability.

Sensitivity to Travel Demand Forecasts: As with travel time, reliability is also influenced by the level of travel demand. Other things being equal, reliability is expected to be better on facilities that have lower travel demand (or experience lower V/C ratios) due to the non-linear relationship between volume and capacity, as mentioned above. Therefore, lower levels of highway or air travel demand, such as those suggested by the base Business Plan forecasts, would be expected to improve reliability for the highway and air modes for the Modal and HST Alternatives. The reliability improvement would likely be greatest for the No Project Alternative since its base capacity is most constrained and would experience the largest relative improvement in V/C ratios and delay. For the same reasons, the Modal Alternative would likely experience the second-largest reliability improvement, and the HST Alternative would experience the smallest improvement. Nonetheless, given the large reliability advantage enjoyed by the HST mode, the HST Alternative would still be expected to provide the greatest degree of travel reliability across the range of travel demand scenarios suggested in the Business Plan.

Safety

In transportation, three basic characteristics interact to influence the safety of a mode.

- Operator: His or her training, regulation, and experience.
- Vehicle: Its condition, regulation, control systems, and crashworthiness.
- Environment: Weather, guideway type, guideway condition, and terrain.

Each of these characteristics plays a role in the overall safety of the modes, which for this analysis is quantified as the probability of passenger fatality. Injuries are more difficult to compare between modes because they are categorized differently by mode and different injury ratings are used. For instance, automobile injuries are generally related to automobile crashes, while for air, bus, and rail they can include injuries that occur as part of a crash, while boarding/alighting, or in the terminal. The severity of these injuries can vary from scrapes and bruises to life-threatening ones. For the purposes of this analysis, injuries by mode will be discussed but are not measured as a key indicator of safety. This analysis also only considers injuries and fatalities of passengers and does not include employees or other staff.

To compare the relative impact of safety between alternatives, fatalities are measured by rate of fatality per 100 million passenger miles traveled. For this analysis the high-end forecasts were assumed because this approach will present the worst case for potential fatalities for all modes and alternatives. The safest mode is the one that has the lowest number of fatalities per 100 million passenger miles traveled (PMT).

Automobile Mode Characteristics: The automobile is unquestionably the most used and the most dangerous mode of transportation being considered in this Program EIR/EIS. The National Highway Traffic Safety Administration estimates that the national motor vehicle fatality rate is 0.80 fatalities per 100 million passenger miles traveled. Nationally in 2000, there were about 6.4 million reported motor vehicle crashes that resulted in 42,000 fatalities and 3.2 million injuries. About 4.2 million crashes involved property damage only (National Highway Traffic Safety Administration 2001). The National Highway Traffic Safety Administration estimates that deaths and injuries resulting from motor vehicle crashes are the leading cause of death for persons between the ages of 4 and 33, while traffic-related fatalities account for more than 90% of all transportation-related fatalities. According to the California Highway Patrol, in 2000 there were 3,331 fatal crashes in California alone (California Highway Patrol 2000). The risk to an individual depends most strongly on the time spent behind the wheel or in the passenger's seat. The longer the journey or the more frequently the journey is made, the greater the risk of a crash. Some of the factors that influence auto and highway safety are listed below.

- Operator.
  - Drivers vary in age, experience, ability, and many other factors.
  - Non-professional drivers typically operate automobiles.
  - Limited regulatory requirements govern who can operate an automobile and the type of training that is needed, and these requirements vary between states.
- Vehicle.
  - Privately owned vehicles are mechanically not as reliable as the public transportation modes.
  - Maintenance and inspections are not regulated, and are performed by mechanics of varying skill levels.
  - Crashworthiness and roadworthiness varies depending on make and model.
  - Minimum requirements rather than optimum standards dictate safe operating conditions.
- Environment.
  - Highways provide no latitudinal or longitudinal control to individual automobiles.
  - Fixed objects (e.g., trees, light poles, sign posts) are frequently placed within the highway right-of-way.
  - Weather and lighting conditions (wind, rain, fog, snow, ice, darkness, and sun glare) can adversely impact vehicle and driver performance.
  - Traffic control systems that regulate the speed and safe operation of an automobile are limited in influence.
  - Roadway conditions and designs are varied and can include systems based on different design speeds, vehicles, and operating conditions.
  - Drivers are subject to a multitude of potential distractions and interferences.

Air Mode Characteristics: Air travel is a safe mode of travel and in recent years has become even safer with the introduction of improved aircraft and state-of-the-art air traffic control systems. According to the U.S. Department of Transportation, the likelihood of fatality due to commercial air travel is relatively small (0.02 fatalities per 100 million PMT). According to the University Of Michigan Transportation Research Institute, flying a typical nonstop flight is 65 times safer than driving the same distance. Takeoff and landing presents the greatest safety risk during a flight; between 1991 and 2000, 95% of all airline fatalities occurred either during takeoff or landing, and just 5% of fatalities occurred at cruising altitudes (Sivak and Flannagan 2002). Consequently, the risks of flying depend mostly on the number of segments flown and not on the distance flown. Injuries associated with air travel can occur during the process of boarding and alighting, and during flight. Most are relatively minor and include scrapes, bruises, broken bones, and a few serious falls. Some of the factors that influence air travel safety are listed below.

- Operator.
  - Commercial aircraft can only be operated by professional pilots, who are rigorously trained and must update their proficiency regularly.
  - Other airline personnel such as flight attendants are trained to provide immediate assistance in emergency situations.
  - Pilots are subject to drug tests and are regulated by the Federal Aviation Administration.
  - Automation of fight operations is well developed and commonly installed.
- Vehicle.
  - Aircraft are regularly maintained to high standards and the Federal Aviation Administration regularly inspects these maintenance records.
  - Aircraft themselves are constructed of high-grade metals and, provided they are maintained regularly, can be in active service for decades.
  - All aircraft occupants are required to wear seatbelts during takeoffs and landings, the two procedures that present the greatest safety risk.
  - Air traffic control systems in the United States are standardized and are some of the safest, most reliable systems in the world for controlling commercial aircraft and warning them of potential dangers.
- Environment.
  - One of air travel's greatest weaknesses is its vulnerability to weather. Although most commercial aircraft can fly above or below most storm systems, they often have no choice during takeoffs and landings but to fly through thunderstorms, snow, ice, and fog. Particularly severe weather conditions can ground all aircraft and prevent those in flight from landing.
  - Unexpected turbulence during flight can injure passengers. For this reason, passengers are often required to wear seat restraints and are discouraged from walking or standing during flight.
  - Aircraft have no guideway to provide latitudinal or longitudinal control, and therefore run the risk of striking fixed or other flying objects while on the ground or during flight.

High-Speed Train Mode Characteristics: Based on statistics from Europe and Japan, HST is the safest mode of travel.[8] Since 1988, there have been 85 injuries and 14 fatalities[9] reported on all dedicated HST systems in Europe. In Japan's 34 years of HST operations, no passenger fatalities have been reported. For the purposes of this analysis and for comparison purposes only, it is assumed that the fatality rate for HST is less than air travel but greater than 0.0, or 0.001 per 100 million PMT. Similar to air travel, the likelihood of injury is associated with boarding and alighting, and during operation, with injuries ranging from minor to severe. The distinguishing reasons for the safety of HST travel relative to air and highway travel are summarized below. The HST mode would be much safer than conventional intercity rail services in California, which operate on freight railroads that have a mix of rail traffic and grade crossings.

[8] There are no statistics for HST safety in the United States.

[9] The worst accident on a dedicated high-speed right-of-way was a derailment in Piacenza, Italy in 1997, which resulted in eight fatalities.

- Operator.
  - HST operators would be rigorously trained and tested and are required to update their qualifications regularly.
  - HST operators would be required to submit to drug tests and are subject to regulation by the FRA and operating railroads.
  - The train would be completely automated and the train operator would be a failsafe redundant system component that could act in the unlikely case that a system malfunction or other problem occurs.
- Vehicle.
  - The FRA passenger equipment safety standards (49 C.F.R. Part 238) dictate the buff strength or amount of force a train can withstand in a collision, for all passenger equipment. The buff strength is adjusted to the operating and rail traffic conditions and is designed to minimize injuries of fatalities due to rail crashes.
  - The trains would be completely automated, allowing for centralized command and control of the train system, effectively eliminating the chance of operator error. Much like the BART system in the San Francisco Bay Area, a centralized system would control the operation of the train while the operator would be the physical eyes and ears of the train ensuring passenger safety.
  - Like airplanes, trains and the infrastructure they operate on (tracks, control systems, and electrification systems) would be maintained on a regular schedule. Maintenance records are subject to inspection by the FRA.
  - Like aircraft, passenger train equipment is built for a long service life. If maintained properly, a modern train car can have a useful life of at least 30 years.
  - HST traffic control and communications systems are state-of-the-art, regulated and managed during all hours of operation. These systems control the train's speed, schedule, routing, and headway (following distance behind another train). These systems combined with the operator have integral redundancy and ensure safety.
- Environment.
  - The HST system would be fully access controlled and grade-separated (including grade crossings), virtually eliminating pedestrian and motor vehicle conflicts.
  - The HST system would be closed to all other rail traffic, greatly reducing the possibility of collision with other trains. An exception is the Caltrain corridor between Gilroy and San Francisco, where the HST would travel at reduced speeds and share the track with express commuter passenger trains.
  - Inclement weather has only a minimal impact on HST operations. Because it is nearly impossible to read line side signals flashing by at 200 mph (322 kph), HSTs use a cab signaling system that transmits commands directly to the driver. This technology makes high-speed operation possible in darkness, rain, and fog. In Japan, even moderate snowfall does not slow the Shinkansen because of special ice-melting equipment built into the rail bed.
  - Unlike aircraft, HST systems are not subject to turbulence. Passengers may sit without seat restraints and may stand and walk comfortably even at maximum speeds and around curves.
  - Although HST systems do operate in highly seismic areas such as Japan, no fatalities have ever occurred as a result of a seismic event. Failsafe technology would stop the

trains when an earthquake is detected, and at-grade construction in fault zones would further improve safety.

- The HST system, like other public intercity modes, is inspected on a regular schedule as required in federal regulations. This regular inspection of both rolling stock and track would ensure the safety of the HST.

The safety characteristics of each mode are summarized in Table 3.2-10. This table shows that for all three safety characteristics, the HST mode has the best safety performance. While air and HST are similar in regard to operator and vehicle characteristics, HST performs better with regard to the environment because the HST is capable of operating safely and comfortably in a variety of climatic conditions compared to aircraft, without the need for passenger restraints. The automobile mode fares poorest in terms of safety.

Table 3.2-10
Safety Performance by Mode

	Safety Performance Characteristics		
Mode	Operator Training Regulation Experience	Vehicle Condition Regulation Control systems Crashworthiness	Environment Weather Guideway condition Terrain
Automobile	Poor	Good	Poor
Air	Excellent	Excellent	Poor
HST	Excellent	Excellent	Excellent

Alternatives Comparison for Safety

The safety performance for each alternative is shown in Table 3.2-11. The HST Alternative has the best overall safety performance primarily because it diverts 34 million annual passengers from the least safe automobile mode to HST[10], the safest mode. This demand shift combined with the rigorous requirements of HST operators, regular vehicle inspection, maintenance, control systems, crashworthiness, and ability to operate in virtually all weather conditions, make the HST Alternative superior to No Project and Modal Alternatives.

Table 3.2-11
Safety Performance by Alternatives

	Safety Performance Characteristics		
Alternative	Operator Training Regulation Experience	Vehicle Condition Regulation Control systems Crashworthiness	Environment Weather Guideway condition Terrain
No Project	Good	Good	Poor
Modal	Good	Good	Poor
HST	Excellent	Excellent	Excellent

[10] This number is based on the high-end ridership forecast for the HST based on the Business Plan. If the HST ridership were less (42 million instead of 68 million, including 10 million long-distance commuters for both the low and high forecasts), then fewer trips would be diverted from auto, effectively increasing the overall number of potential fatalities per year.

No Project Alternative: While the rate of injury or fatality is not expected to increase under the No Project Alternative, the increase in highway travel would be expected to cause the number of injuries and fatalities to increase as compared to existing conditions.

Modal Alternative: No significant safety benefits are associated with the Modal Alternative compared to the No Project Alternative, with about the same number of highway-related fatalities projected to occur under either scenario. However, because the Modal Alternative would provide some excess capacity not used by intercity highway or air trips, the additional capacity would likely be absorbed by commuting or other local trips. These induced trips could add to the amount of travel (PMT) on certain segments and could increase the number of fatalities. Furthermore, while the Modal Alternative also includes an improvement to air travel capacity and may ultimately increase the demand for air travel, these trips are more likely to use local and regional roadway systems to access the airports than under the HST Alternative, and this outcome could also pose a potential safety risk.

High-Speed Train Alternative: The HST Alternative would produce the greatest safety benefit compared to the No Project and Modal Alternatives. HST would divert about 34 million annual intercity highway trips from the Modal or No Project Alternatives, resulting in fewer injuries and fatalities annually.

Connectivity

Connectivity in the study area can be measured qualitatively and quantitatively using the number of modal options that offer competitive transportation services, the availability of intermodal connections, and the frequency of service (number of departures). A greater number of competitive modal options is considered a benefit because it increases the diversity, redundancy, and flexibility of the overall transportation system and provides travelers with greater choices.

- *Modal options* are a measure of the intercity modal diversity of each of the alternatives.
- An *intermodal connection* or facility allows passengers to transfer from one mode to another to complete a trip. A connection can be as simple as a timed connection between a train and a bus or as elaborate as the BART connection to SFO where air, rail, and bus all converge to give multiple transportation options.
- *Frequency* is measured as the number of departures available to travelers in the study area. High service frequency benefits travelers because it increases the number of possible connections to different modes and the number of options available for travel to a destination.

Modal Options: The No Project Alternative provides four modal options: automobile, air, intercity rail, and intercity bus. However, intercity travel in California is dominated by automobile and air transportation. The automobile accounts for over 88% of all intercity trips, with air transportation representing more than 10% and conventional rail carrying most of the remaining trips. Although the automobile and air modes compete against one another for the longer-distance intercity trips, such as San Francisco to Los Angeles, the automobile is without rival for many intermediate intercity trips. Table 3.2-12 shows intercity trips by mode between the major metropolitan regions in the study area. Between the San Francisco Bay Area and the Los Angeles Metropolitan Area, air transportation serves almost 52.5% of the travel market, with the automobile accounts for 47.3%, and conventional rail 0.2%. Only air transportation offers fast enough travel times to compete for the long-distance business travel market. Trips between the Central Valley and either the San Francisco Bay Area or the Los Angeles Metropolitan Area are good examples of intermediate intercity trips. For these markets, the automobile serves 97.3% of the travel market, while air transportation has 1.5% and conventional rail about 1.2%.

Table 3.2-12
1997 Intercity Trip Table Summary[a]

	1997 Base Trip Tables		
Market	**Air**	**Auto**	**Amtrak Rail**
Los Angeles to Sacramento	2,179,140	2,861,527	9,129
Los Angeles to San Diego	407,185	34,870,032	934,322
Los Angeles to San Francisco	9,376,455	8,442,469	36,525
Sacramento to San Francisco	40,797	20,475,524	502,956
Sacramento to San Diego	613,341	736,732	[b]
San Diego to San Francisco	2,417,203	2,387,001	[b]
Los Angeles/San Francisco to Valley Cities	368,805	23,747,021	290,896
Other	250,059	43,157,606	225,434
Total	15,652,986	136,677,910	2,000,351

[a] Air trips in this table are "local" (or true origin/destination) air trips between metropolitan areas. Connect air trips (which are not destined to a city within the corridor), and their potential for diversion to HST were forecast in the previous study using a separate procedure and subcontractor. The diversion to HST of connect trips is small in absolute numbers, and limited to a few shorter distance intercity markets. The previous connect air forecasts of HST ridership are used in this study as appropriate for the applicable Modal or HST Alternative.

[b] Amtrak trips for these markets are essentially zero and are therefore excluded from the table for clarity.

Source: U.S. Department of Transportation, Caltrans, and Charles River Associates, January 2000.

The Modal Alternative would provide additional capacity but no additional modal options beyond those existing or in the No Project Alternative.

The HST Alternative would provide a new intercity, interregional, and regional passenger mode that would improve connectivity to other existing transit modes and airports. HST would bring competitive travel times and frequent and reliable service to the traditional urban centers of the San Francisco Bay Area, Los Angeles Metropolitan Area, Sacramento, and San Diego. It would significantly improve the modal options available in the Central Valley and other areas of the state currently not well served by public transport (bus, rail, air) for intercity trips.

Tables 3.2-13 (low end) and 3.2-14 (high end) show intercity trips by mode between the major metropolitan regions in the study area projected for 2020 with a statewide HST system. Under the low-end or Business Plan assumptions, between the San Francisco Bay Area and the Los Angeles Metropolitan Area, HST is projected to capture at least 43% of the travel market. Air transportation would serve up to 24% of the travel market, the automobile up to 33%, and conventional rail virtually none of the market. For the high-end ridership assumptions, between the San Francisco Bay Area and the Los Angeles Metropolitan Area, HST is projected to capture up to 71% of the travel market, with the automobile as low as 28%, air transportation serving as little as 1%, and conventional rail virtually none of the market. For trips between the Central Valley and either the San Francisco Bay Area or the Los Angeles Metropolitan Area, the automobile would serve nearly 79% of the intercity travel market, while HST would capture nearly all the remaining 21% for the low-end forecasts (nearly 76% automobile trips and 24% HST trips for the high-end forecasts). The HST Alternative would provide similar benefits to other intermediate intercity markets served by the HST system. For longer-distance intercity trips, HST would provide a competitive alternative to driving and flying. For intermediate intercity trips, HST would also be an attractive alternative to driving.

Table 3.2-13
2020 Intercity Trip Table Summary Business Plan Scenario (Low End)

Market	2020 Business Plan Trip Tables			
	Air	Auto	Amtrak Rail	HST[a]
Los Angeles to Sacramento	1,132,827	2,720,332	97	3,384,964
Los Angeles to San Diego	20,805	42,023,218	298,843	5,304,220
Los Angeles to San Francisco	6,487,057	8,549,065	162	11,269,050
Sacramento to San Francisco	2,696	26,448,373	351,485	1,690,169
Sacramento to San Diego	745,079	644,200	61	702,630
San Diego to San Francisco	2,820,117	2,191,051	75	2,228,436
Los Angeles/San Francisco to Valley Cities	32,624	54,950,291	50,583	5,153,090
Other	5,286,399[b]	30,179,854	73,545	2,269,543
Total	16,527,605	167,706,384	774,851	32,002,103

[a] Low-end Business Plan ridership forecast.
[b] Other trips—connecting air trips from outside of the state.

Table 3.2-14
2020 Intercity Trip Table Summary Sensitivity Analysis Scenario (High End)[a]

Market	2020 Business Plan Trip Tables			
	Air	Auto	Amtrak Rail	HST[b]
Los Angeles to Sacramento	29,070	3,176,209	97	6,141,554
Los Angeles to San Diego	1,393	50,373,405	298,843	7,444,541
Los Angeles to San Francisco	287,089	9,503,243	162	24,338,901
Sacramento to San Francisco	2,546	30,853,989	351,485	2,246,588
Sacramento to San Diego	60,065	707,496	61	1,749,001
San Diego to San Francisco	177,361	2,315,668	75	6,609,892
Los Angeles/San Francisco to Valley Cities	7,636	64,680,617	50,583	7,228,074
Other	5,277,019[c]	34,315,568	73,545	2,638,702
Total	5,842,178	195,926,194	774,851	58,397,253

[a] Air trips in Tables 3.2 13 and 3.2 14 are "local" (or true origin/destination) air trips between metropolitan areas. Connect air trips (which are not destined to a city within the corridor), and their potential for diversion to HST were forecast in the previous study using a separate procedure and subcontractor. The diversion to HST of connect trips is small in absolute numbers, and limited to a few shorter-distance intercity markets. The previous connect air forecasts of HST ridership are used in this study as appropriate for the applicable Modal or HST Alternative.
[b] High-end Business Plan ridership forecast.
[c] Connecting air trips from outside of the state.
Source: Charles River Associates, January 2000.

Intermodal Connections: The automobile can be used to go virtually anywhere in California. Unlike common carrier transportation modes (air, bus, or rail), the automobile does not require or depend upon intermodal connections to get from the trip origin to the trip destination. The automobile mode would have the same flexibility in the Modal Alternative and the HST Alternative.

Scheduled airline service allows a traveler to reach any destination served by commercial airlines in a relatively short travel time. Unlike the automobile, commercial air travel requires intermodal connections to get to the airport and to a final destination. Moreover, airports are predominately located outside major city centers, a considerable distance from the major transit hubs, which are typically downtown. With the exception of the San Francisco and Burbank airports, which are served directly by rail, all airports in California require transfers to automobiles or road-based public transportation.

It is assumed that there would be limited new intermodal connections under the No Project and Modal Alternatives because a limited number of these improvements are currently planned and programmed.

HST stations would be generally located at existing transportation centers that can serve a wider area through public transit and would enhance intermodal connections in each region. HST stations in the traditional urban cores of the Sacramento, San Francisco Bay, and Los Angeles areas would connect to the heart of the established public transit networks. For example, Los Angeles Union Station (LAUS) is projected to be the most heavily used HST station. LAUS is the transit hub of Los Angeles County and is the primary destination for the Metrolink Commuter rail services, the Los Angeles Metro Red Line, the Pasadena Gold Line, the Amtrak Surfliner service, and the regional bus transit services. The potential station at the Transbay Terminal in San Francisco would be located in the heart of San Francisco's financial district and within walking distance of all major downtown hotels, the convention center, and Union Square retail. The Transbay Terminal would also serve Caltrain commuter rail, all the major bus services to downtown San Francisco, BART, and the extensive San Francisco Municipal Railway (Muni) light-rail system.

HST could have a profound effect on the Central Valley and on outlying areas that are not currently well served by other forms of public transportation. HST would provide convenient and reliable connections to the airports and downtowns of San Francisco and Los Angeles, and to Central Valley cities. All of the potential HST station sites in the Central Valley would either be in city centers or at transportation hubs (airports and Amtrak stations).

Frequency: The automobile, by offering unlimited potential frequency and because it can be driven at virtually any time and to virtually any destination, has the highest connectivity of any mode.

Although 17 commercial airports are included in this study, the range of city pairs served is considerably narrower because little to no commercial service exists between some of the city pairs. Air travel is market-driven and consequently airlines concentrate their operations on markets that are profitable. The San Francisco Bay Area to Los Angeles Metropolitan Area corridor is the most heavily traveled air corridor in the world. This intercity travel market and the long distance markets to/from Sacramento and to/from San Diego have many daily departures and arrivals. In other regions such as the Central Valley, where demand is lower and the distances shorter, the number of daily flights serving California intercity markets is far more limited. Table 3.2-15 shows the daily 1997 average air frequencies by airport pair (Charles River Associates, Inc. 2000). While LAX had service to eight airports within the study area with over ten flights daily in each direction, Fresno had only two (Los Angeles and San Francisco) and Bakersfield only one (Los Angles). Merced, Modesto, Stockton, and Visalia had virtually no air service within the study area.

The additional air transportation capacity provided by the Modal Alternative would likely result in frequency increases between the airports where improvements were made. In particular, based on the assumptions for the Modal Alternative, air service between Fresno and the major metropolitan areas (Sacramento, the San Francisco Bay Area, Los Angeles, and San Diego) could be significantly improved.

The HST system adds a new intercity service to the statewide intercity transportation network that would offer a variety of services with different stopping patterns (express, skip-stop, and local services) to serve long-distance, intermediate, and shorter-distance intercity trips. Consequently, HST would increase frequencies for some city pairs that are not well served by air transportation. In addition to the major city pairs, smaller cities in the Central Valley and suburban cities surrounding the major markets would be directly connected with frequent intercity service.

Table 3.2-15
Daily 1997 Average Air Frequencies by Airport Pair (Each Direction)[a,b]

	BFL	BUR	CLD	FAT	LAX	MCE	MOD	MRY	OAK	ONT	SAN	SCK	SFO	SJC	SMF	SNA
Bakersfield																
Burbank	0															
Carlsbad	0	0														
Fresno	0	4	0													
Los Angeles	19	0	13	30												
Merced	0	0	0	1	0											
Modesto	0	0	0	0	0	0										
Monterey	0	0	0	0	20	0	0									
Oakland	0	15	0	0	35	0	0	0								
Ontario	0	0	0	4	15	0	0	0	12							
San Diego	0	6	0	3	76	0	0	0	11	0						
Stockton	0	0	0	0	0	0	0	0	0	0	0					
San Francisco	5	13	0	17	49	2	5	15	0	8	25	0				
San Jose	0	8	0	0	27	0	0	0	1	7	14	0	0			
Sacramento	3	10	0	2	13	0	0	0	0	10	11	0	20	0		
Orange County	0	0	0	4	17	0	0	3	13	0	1	0	10	14	5	
Visalia	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0

[a] Three-digit codes for airports used as the column headings correspond to the airport names in the row headings.

[b] Data for this table has changed considerably since 1997. For example, there are currently 18 non-stop flights between Los Angeles and Fresno, and seven between San Francisco and Fresno.

Source: Official Airline Guide online database, with calculations by Charles River Associates.

The proposed HST system would serve about 20 to 30 stations (depending on alignment option selected). Table 3.2-16 shows the number of daily trains (for each direction) served for each station pair as assumed for the Business Plan. This table shows that, compared to air transportation, the addition of HST service would greatly increase the number of trains serving major and intermediate destinations. For example, Fresno is expected to have service to 20 stations/cities with frequencies of at least 10 trains daily in each direction, while Bakersfield would have service to 19 stations/cities with frequencies of at least 10 trains daily in each direction. Central Valley cities such as Merced, Modesto, Stockton, and Visalia as well as additional urban markets in the San Francisco Bay Area and southern California such as East San Gabriel Valley, Palo Alto/Redwood City, Riverside, Sylmar, and Escondido, would all receive frequent service to all HST stations.

Table 3.2-16
2020 High-Speed Train Frequencies by Station Pair (Each Direction)

	S.D.	M.M	ESC	TEM	RIV	ONT	E.S.G.	L.A.	BUR	SYL	BAK	TUL	FSN	L.B.	GIL	S.J.	R.C.	SFO	S.F.	MER	MOD	STK	SAC
San Diego																							
Mira Mesa	39																						
Escondido	39	39																					
Temecula	39	39	39																				
Riverside	39	39	39	39																			
Ontario	39	39	39	39	39																		
East San Gabriel	39	39	39	39	39	39																	
Los Angeles	52	39	39	39	39	39	39																
Burbank	31	31	31	31	31	31	31	34															
Sylmar	31	31	31	31	31	31	31	34	34														
Bakersfield	30	22	22	22	22	22	22	33	21	21													
Tulare Co	11	11	11	11	11	11	11	11	12	12	12												
Fresno	25	17	17	17	17	17	17	28	14	14	28	12											
Los Banos	7	8	8	8	8	8	8	8	8	8	8	8	10										
Gilroy	20	20	20	20	20	20	20	23	23	23	12	8	11	10									
San Jose	28	22	22	22	22	22	22	33	23	23	20	8	19	10	25								
Redwood City/Palo Alto	20	20	20	20	20	20	20	23	23	23	12	8	11	10	25	25							
SFO	20	20	20	20	20	20	20	23	23	23	12	8	11	10	25	25	25						
San Francisco	36	26	26	26	26	26	26	46	23	23	21	8	19	10	25	35	25	25					
Merced	4	4	4	4	4	4	4	4	4	4	4	4	4	4	9	9	9	9	9				
Modesto	8	5	5	5	5	5	5	8	4	4	8	4	8	9	9	9	9	9	9	13			
Stockton	13	10	10	10	10	10	10	13	9	9	10	4	11	9	9	9	9	9	9	13	17		
Sacramento	16	13	13	13	13	13	13	9	9	10	11	4	11	9	9	18	9	9	18	13	17	22	

Source: High Speed Rail Authority's final business plan 2000.

Alternatives Comparison for Connectivity

No Project Alternative: Under the No Project Alternative, there would be no net improvement to the connectivity options in the state over the existing conditions. There would no new modes introduced, no new intermodal terminals or connections, and no improvements in air transportation frequencies.

Modal Alternative: Under the Modal Alternative, there would be significant capacity improvements to the air and highway system, but no new modes introduced into the system or intermodal facilities. The additional air capacity would likely result in additional frequencies between the airports where improvements were made. In particular, based on the assumptions for the Modal Alternative, air service between Fresno and the major metropolitan areas (Sacramento, the San Francisco Bay Area, Los Angeles, and San Diego) could be substantially improved where capacity exists.

High-Speed Train Alternative: The HST Alternative would add a new mode to the state's intercity transportation system. The HST would create a variety of new intermodal connections to local, regional, and intercity modes. The HST would add frequencies to the state's intercity travel network, allowing greater flexibility in travel time and location; however, this alternative could result in some decreases in air frequencies in some markets. Of all the alternatives, the HST Alternative provides the highest level of connectivity in the study area, particularly between the Central Valley cities and the city centers of the major metropolitan areas.

Sustainable Capacity

Sustainable capacity is a measure of the transportation capacity of an alternative to meet not only the projected demand but to provide a sustainable capacity over time without the need to develop additional infrastructure. Sustainable capacity is quantitatively measured by the amount of additional transportation infrastructure required to accommodate potential future demand beyond the demand forecast for this system.

For this analysis the design demand is assumed to be the 283 million annual intercity trips by 2020,[11] and both the Modal and HST Alternatives have been developed to accommodate this demand. To test the sustainable capacity of the Modal and HST Alternatives, a theoretical system capacity to accommodate potential additional demand was identified. For the purposes of this analysis, the system capacity is assumed to be approximately 31,500 passengers per hour, which represents a reasonable capacity for a 2-track HST system.[12] The ability of any of the alternatives to accommodate the hypothetical capacity is evaluated by region in terms of capacity on intercity transportation facilities (i.e., 31,500 passengers per hour on the intercity highway segments, airports, or HST for the Bay Area to Merced region) and used as a benchmark to compare the sustainable capacity of No Project, Modal, and HST Alternatives. A description follows of how the theoretical sustainable capacity was developed for each mode and for each alternative.

Highway Mode Characteristics: The sustainable capacity of a highway facility depends largely on the availability of travel lanes and the speed that autos are able to travel. This relationship is expressed as LOS, which is defined in Section 3.1, *Traffic and Circulation*. While all modes are subject to capacity constraints that affect the vehicle's speed, given the small capacity of most

[11] This demand includes the baseline demand of 215 million annual intercity trips and the 58 million high-end representative intercity demand trips. Not included in this analysis are 10 million commute trips.

12 The figure 31,500 represents 75% of 42,000 passengers per hour. The 42,000 passengers per hour is based on a train separation of 3 minutes between trains and a train capacity of about 1,050 passengers per train for both directions on a double-track system. Trains could be designed with more seating and can accommodate standing passengers if needed and therefore could exceed 42,000 passengers per hour.

automobiles (five passengers), more vehicles are required to accommodate a large passenger demand. To meet a higher travel demand, automobiles have two basic options for increasing capacity.

- Vehicle size may be increased (buses): the higher the capacity of the vehicle, the more passengers can be carried at a high rate of speed, and this assumes or requires a change in typical driver behavior.
- Capacity of the roadway may be increased (highway expansion): the addition of lanes allows more autos to travel safely with sufficient stopping distance.

The capacity of an intercity highway lane has been assumed to be 2,300 vehicles per hour with an average auto occupancy rate of 2.4 passengers per intercity vehicle trip, or about 5,520 intercity passengers per hour per lane per direction. Under the No Project and Modal Alternatives, where travel demand is split primarily between the auto and air modes, the highway demand would be 86%[13] of the total 31,500 passengers per hour, or approximately 27,100 passengers per hour in two directions (or 13,500 passengers per direction). Based on an average intercity vehicle occupancy rate of 2.4 passengers per vehicle, 13,500 passengers per direction is equivalent to an additional 5,600 vehicles per direction in addition to the future 2020 peak hour traffic demand. To accommodate the theoretical system capacity, on average[14] every highway link in the study area in all regions would require three additional highway lanes in each direction above and beyond what is proposed under the No Project Alternative. For the Modal Alternative, two additional highway lanes in each direction above and beyond what is proposed would be needed to accommodate the theoretical system capacity. No additional lanes would be required for the HST Alternative because the additional travel demand could be shifted from the highway system to the HST system.

<u>Air Mode Characteristics</u>: The sustainable capacity of an air travel system depends on both the airport and the aircraft. The capacity of an airport includes both airside (e.g., terminals, gates, runways, taxiways, and airspace) and landside (e.g., curbsides, roadways, and parking spaces) systems and facilities. Typical commercial aircraft can range between small jets such as regional jets and Boeing 737s with passenger capacities of 20 to 135, and large jets such as Boeing 777s and 747s with passenger capacities of 200 to 350. As presented in Chapter 2, *Alternatives*, this analysis assumes the Boeing 737 with a seating capacity of 135 will be the typical aircraft used for the intercity market within California.

It is possible to increase the capacity of the air travel system either by increasing the capacity of individual aircraft or by using more small aircraft and by expanding airports. However, for the air travel system to function properly, all systems must be in balance to avoid bottlenecks and unnecessary congestion. For instance, while it is possible to use larger aircraft at all of the airports considered in this analysis, it is necessary that the airside and landside systems be sized to adequately accommodate the additional demand.

Average runway and gate capacity was used to estimate the sustainable capacity of airports. Determining peak-period runway capacity typically requires sophisticated computer simulation techniques and considers the number of runways and their physical relationship to each other for each airport (crossing runways have less capacity then parallel runways, and capacity is further reduced during inclement weather), and the aircraft types that operate during the peak period.

[13] Based on mode splits forecast for 2020 conditions by Charles River Associates 2000.

[14] Some areas, such as along I-5 between Bakersfield and Los Angeles, did not require additional lanes, as two lanes per direction would be added under the Modal Alternative; others, such as SR-58 and SR-14, required two additional lanes.

Consistent with the approach used for the Modal Alternative, the same ratios (i.e., 525,000 passengers per gate per year and 30 gates per runway) were used to calculate the additional gates and runways required to accommodate the theoretical demand. Similar to estimating the number of highway trips, the total number of air trips are estimated at 4,100 air trips per hour per region, based on the forecasted mode split of 13% of air trips[15] (see Chapter 2).

The addition of 4,100 peak hour trips to each of the regions would require, on average, 51 gates and one runway in each region in addition to the improvements proposed under the Modal Alternative.[16] However, since major urban areas such as the Los Angeles region and the Bay Area have several airports with multiple gates and runways, it is reasonable to expect that those regions could accommodate some of the peak demand with operational improvements. Since interstate and international flights are also competing for the additional slots, any growth in intrastate flights would require additional gate and runway capacity improvements. In the regions with fewer airport options such as the Northern and Southern Central Valley and San Diego, where the gate and runway capacity simply does not exist, additional gates and runways would be needed above and beyond the Modal Alternative's additions. No additional gates or runways would be required for the HST Alternative because the shift of demand from the air system to the HST system would allow airports to handle the peak demand without additional capacity.

<u>High-Speed Train Mode Characteristics</u>: Sustainable capacity of an HST system is determined by the attributes listed below.

- Capacity of rail line (e.g., single track or double track).
- Capacity of the train (number of trainsets, or locomotives and coaches).
- Capacity of stations and passenger facilities, and the lengths of platforms.
- Speed at which the train can travel.
- Train control system.
- Degree that shared-use track is used by other services, thereby reducing available capacity of the HST.

The HST Alternative is a double-track system that allows trains to travel in each direction without having to stop to meet and pass each other. The HST Alternative also incorporates off-line stopping tracks at stations, allowing through trains to pass local trains. The double-track system could sustain a theoretical line capacity of 31,500 passengers per hour without any additional guideway; however, the size and number of trains operating per hour would increase, and the support facilities (e.g., maintenance and storage yards and stations) may have to be sized accordingly. The HST line capacity of 31,500 passengers per hour is based on the design characteristics of the proposed HST system and the following assumptions.

- Trains will be separated by 3 minutes.

[15] Based on mode splits forecast for 2020 conditions by Charles River Associates 2000.

[16] Based on 4,100 passengers per hour, multiplied by an 18-hour operating day, multiplied by 365, which equals 26,937,000 annual trips.

- The capacity of a train will be about 1,050 passengers with a load factor of 75%.
- Traffic will reach 40 trains per hour (both directions on a double track system).

Train capacity can vary depending on the number of cars and how the seats are configured in those cars. The trains can even accommodate standees if the demand exceeds seating capacity. Station platforms need to be the same length as the total length of the train. In this case the train and platforms are designed for a maximum length of more than 1,300 ft (400 m). The train control system is one of the ultimate determinants for speed on the train system, and is assumed to be adequate for the additional capacity (Nash 2003). The train control system is responsible for safely spacing the trains so that there is adequate stopping distance between the trains. While the train control system requirements will determine the ultimate safe traveling speed for the train, the design speed of the train also affects the capacity of the system as a whole. All of these factors play a role in determining the sustainable capacity of an HST system.

In California, conventional rail largely depends on the capacity of the host railroads, which are primarily freight railroads and commuter rail authorities. Amtrak, the current intercity operator, does not own any tracks or have dispatch control in the state. Since conventional rail, especially intercity passenger rail, is a tenant on the host railroads, the ultimate capacity of the line is not in their direct control. Infrastructure conditions, freight demand, and commuter rail demand all play a role in determining the capacity of the railroad. Currently there are considerable capacity constraints in southern California in the Los Angeles area and between Sacramento and San Jose in the Bay Area. Because of these severe capacity constraints in the state, conventional intercity passenger rail has very limited sustainable capacity.

<u>Alternatives Comparison for Sustainable Capacity</u>
<u>No Project Alternative</u>: There is little to no sustainable capacity in the No Project Alternative. The future transportation infrastructure is severely constrained by the limited number of capacity improvements funded or programmed for 2020. Improvements associated with the No Project Alternative are generally to existing interchanges versus line capacity expansion or improvement projects. The highway system's sustainable capacity would require additional infrastructure to accommodate any growth in demand. To accommodate the theoretical system capacity of 31,500 passengers per hour, the highway system would require at least three additional lanes in each direction. The capacity of airports would have to be expanded somewhat more than improvements contemplated under the Modal Alternative. Therefore, the No Project Alternative would not accommodate the theoretical demand and would require extensive infrastructure expansion to have sustainable capacity.

<u>Modal Alternative</u>: There is insufficient capacity in the Modal Alternative to accommodate the additional theoretical demand in all regions. Additional highway and airport infrastructure beyond the Modal Alternative improvements would be required to accommodate the 31,500 peak passenger demand theoretical system capacity. While the Modal Alternative would include some excess highway and airport capacity in the potentially modified highway and airport system, it would not be sufficient in all areas to meet the additional demand and overall service levels would be degraded with use beyond the representative demand. Where the Modal Alternative would provide excess capacity (e.g., capacity gained through addition of a full lane), the capacity would probably be absorbed by other travelers (e.g., commuter or other trips). Additional capacity for highways and airports might be further increased with either higher auto occupancy rates or larger aircraft, respectively. However, auto occupancy rates are not likely to change on a statewide level.

Likewise, the prevailing trend in the aviation industry and projections for future aircraft operations are toward a greater reliance on small and regional jet aircraft (up to 135 passengers) compared to large aircraft for the short-haul intercity travel market under evaluation for this study. Additionally, if larger aircraft were used, landside improvements would still be required to accommodate demand. In both cases, it is important to note that without capacity increases through either lane widenings or additional runways and gates, service levels would worsen for both modes because in both cases performance is contingent on available capacity.

High-Speed Train Alternative: The HST Alternative would provide a train system with sufficient infrastructure to meet the projected demand and to allow for capacity expansion beyond the design year requirements. It would provide an additional mode for the state's intercity transportation system, effectively creating a capacity release valve for the existing intercity modes. The ultimate capacity of the HST could exceed the forecasted 20- to 40-year demand by increasing frequency of service, adding cars to trainsets, using double-deck passenger cars or linking multiple trainsets together on the proposed dual-track system. In addition, the HST Alternative presents a reasonable alternative to expanding highway and aviation infrastructure. Compared to the No Project and Modal Alternatives, the HST Alternative would require no additional infrastructure (with the exception of rolling stock, stations, and maintenance facilities) to provide substantially additional capacity; therefore, the HST Alternative would have the highest sustainable capacity.

Passenger Cost

Passenger cost is a measure of the relative differences in travel costs between the No Project, Modal, and HST Alternatives. Passenger cost for this analysis means the total cost of the trip, including the cost of traveling to the airport or station, the airplane or train fare, and other associated expenses. Cost is one of the key factors that can influence passenger choice of modes.

There is a range of existing intercity travel options, from relatively inexpensive intercity bus to premium air. For example, the cost of traveling round-trip between Los Angeles and San Francisco (one of the busiest travel corridors in the world) can be as little as $25 for an intercity bus ticket to as much as $350 for a walk-up fare for airline travel. The air travel market particularly features large variations in fares. Sources of these variations include the following factors.

- Time of travel: Peak-period travel tends to be more expensive, and Saturday night stays tend to be less expensive.
- Time of booking: Early bookings tend to be less expensive, while last-minute bookings are more expensive.
- Airport choice: Travel between major destinations such as Los Angeles and San Francisco boasts a variety of options and fares, while travel to or from smaller airports with limited service such as Fresno and Bakersfield have greatly limited fare and travel choices.

Passenger cost is quantitatively measured by actual costs to the passenger associated with a typical door-to-door trip. The representative city pairs presented in the travel time discussion earlier in the section are used as a basis to compare the relative differences in cost

Automobile Mode Characteristics: For highway travel, it is assumed that the entire door-to-door trip is made with a private automobile and that there are no ancillary access costs. Automobile travel costs are shown as the total costs per passenger and per auto. The total costs of owning and operating a vehicle include depreciation, maintenance, repairs, taxes, insurance, etc. and are shown on a per-auto basis in Table 3.2-17. The ridership and revenue estimates for the Business Plan are based on the perceived costs of making an automobile trip (e.g., fuel) and do not include all of the true costs associated with owning and operating a vehicle.

Table 3.2-18 summarizes the costs for making a one-way trip for the representative city pairs. Parking is not included even though this could be an additional significant expense. (All-day parking in downtown San Francisco or Los Angeles can be as high as $25.) As shown in the table, the door–to-door average perceived one-way cost per person for traveling between representative city pairs by highway range from $15 to $48 per passenger, and $25 to $81 for total costs.

Table 3.2-17
Auto Ownership and Operating Costs by Category (2003$)[a]

Cost Category	Percent of Cost	Cents
Financing	15	7.7
Depreciation	35	18.0
Fuel Tax	4	2.0
Fuel	9	4.6
Repairs	2	1.0
Maintenance	5	2.6
State Fees	3	1.5
Insurance	27	13.8
Total	100	51.2

[a] All costs escalated by 3% for 3 years to calculate 2003 dollars.
Source: Federal Highway Administration, Our Nation's Highways, 2000.

Table 3.2-18
One-Way Door-to-Door Trip Automobile Costs (2003$)[a,b]

City Pair	Average Total Cost per Passenger[c]	Total Costs per Auto[d]
Los Angeles downtown to San Francisco downtown	$81	$194
Fresno downtown to Los Angeles downtown	$47	$112
Los Angeles downtown to San Diego downtown	$25	$61
Burbank (airport) to San Jose downtown	$70	$169
Sacramento downtown to San Jose downtown	$25	$60

[a] California High Speed Rail Authority Business Plan cost numbers. HST ridership forecasts assumed only perceived auto costs. Average cost does not include parking.
[b] All costs escalated by 3% for 3 years to calculate 2003 dollars.
[c] Total cost based on average cost of owning and operating a vehicle of 51 cents per mile divided by the assumed average auto occupancy rate of 2.4 persons. Source: Federal Highway Administration, Our Nation's Highways, 2000.
[d] Full cost of driving a single-occupant auto based on average cost of owning and operating a vehicle of 51 cents per mile.
Source: Federal Highway Administration, Our Nation's Highways, 2000; Parsons Brinckerhoff 2003.

Air Mode Characteristics: The passenger cost of air travel is primarily determined by the available fare. Depending on the airport, airline, time of year, day of the week, and even certain hours of the day, the price of an air ticket can vary greatly. Regions with competing airports or alternative sub-markets (i.e., Ontario and Oakland) have more fare, schedule, and airline options compared to airports with limited service (e.g., Fresno and Bakersfield). In California, since most air operations are scheduled to serve longer distance markets, some major airports such as San Francisco and Los Angeles have a more limited choice of airlines and fare options for intra-California travel. Airports that provide more limited service, such as Fresno and Bakersfield, typically have only a few flights available per day and typically one or two airlines that serve that market. However, airports like Ontario and Oakland have frequent intra-California flights from a range of airlines at highly competitive fares.

Average total air costs were calculated as including access, egress, and airfare costs. The access and egress sum cost ranges from $10 to $24 per trip. Air trips require at least one other mode to travel from a different location (e.g., home/office) to the airport, which may include public transit (bus or rail), taxi/shuttle, or private auto (may require parking or drop-off).

A range of airfares are available that depend on time of purchase (e.g., 21-day advance purchase versus same-day fare), duration of visit (e.g., same-day or Saturday night stay), and departure time (e.g., peak versus off-peak). Table 3.2-19 summarizes the average total cost for air travel between city pair destinations based on the Business Plan estimates (escalated to 2003 dollars) for business and non-business travel.. As shown, airfares vary widely and can range from $94 between Burbank and San Jose to $224 between Sacramento and San Jose for business travel.[17]

Table 3.2-19
Average Business and Non-Business Fares One-Way Door-to-Door Air Trip Passenger Costs (2003$)[a]

City Pair	Average Total Costs[b] Business/Non-Busiiness
Los Angeles downtown to San Francisco downtown	$148/$89
Fresno downtown to Los Angeles downtown	$193/$112
Los Angeles downtown to San Diego downtown	$148/$89
Burbank (airport) to San Jose downtown	$94/$54
Sacramento downtown to San Jose downtown	N/A

[a] Based on low-end revenue and ridership forecasts from the Business Plan. Costs are escalated by 3% for 3 years.
[b] Sample costs include fares as well as parking, taxi fares, and other costs involved with traveling to and from the airport.
Source: Parsons Brinckerhoff 2003.

<u>High-Speed Train Mode Characteristics</u>: Similar to air travel, the primary cost associated with HST travel is the cost of the train ticket. For this analysis, the fare schedule identified in the Business Plan (escalated to 2003 dollars) was used to compare the representative city pairs (Table 3.2-20). However, based on experience in Asia and Europe, HST fares may vary the way airfares do with the time of year, day of week and duration of stay. New competition may also develop between the different modes that may affect HST fares. The HST could also offer premium and economy services with corresponding fares depending on the markets that develop.

As with air travel, both an access and egress fee of about $5 or $6 ($10 to $12 total) are part of the HST average total costs. HST travel requires at least one mode change to access the nearest HST station. Because the HST stations are generally located in the city centers they are assumed

[17] There is no direct air service between Sacramento and San Jose; therefore it is assumed that this trip would be between SMF and SFO with a shuttle connection to San Jose.

to be located in closer proximity to larger population and work centers than airports. The HST line-haul travel fare was estimated by using the fare schedule presented in the Business Plan (escalated to 2003 dollars).

Table 3.2-20
High-Speed Train One-Way Door-to-Door Trip Passenger Costs (2003$)[a]

City Pairs	Average Total Cost[b] Business/Non-Busiiness
Los Angeles downtown to San Francisco downtown	$59/$35
Fresno downtown to Los Angeles downtown	$50/$31
Los Angeles downtown to San Diego downtown	$47/$29
Burbank (airport) to San Jose downtown	$52/$31
Sacramento downtown to San Jose downtown	$48/$29

[a] Based on business fare costs provided in Business Plan.
[b] Sample costs include fares as well as parking, taxi fares, and other costs involved with traveling to and from the airport.
Source: Parsons Brinckerhoff (2003).

Depending on city pair, level of state support for fare subsidies, and competition, intercity passenger rail would be cost-competitive with the HST. On average, given current fares for Amtrak service and the proposed fares for HST, conventional intercity service would cost approximately 10% less than the HST for the representative city pairs listed above (assuming the same access and egress fees as the HST). Conventional rail would also be considerably less expensive than air based on the representative city pairs.

Alternatives Comparison for Passenger Costs
No Project Alternative: Overall, auto passenger costs are considerably lower for short- and mid-range trips than airfares for short haul routes, such as Los Angeles to San Diego, Los Angeles to Fresno or Sacramento to San Jose. For long-range trips, such as Los Angeles to San Francisco or Burbank to San Jose, the automobile remains competitive due to the access and egress costs associated with air travel.

Modal Alternative: Because no additional mode options are included in the Modal Alternative, passenger costs would be, on average, equal to those of the No Project Alternative. The same passenger cost analysis of short-, mid-, and long-range trips of the No Project Alternative pertains to the Modal Alternative.

High-Speed Train Alternative: The HST Alternative would provide an overall passenger cost savings for all city pairs analyzed. On average, the HST Alternative could save from 8% to 44%, depending on city pair, of the passenger costs associated with the No Project and Modal Alternatives. The HST mode is cost-competitive with the highway mode for all trips and is less expensive than the air mode. For all city pairs, the HST Alternative provides a price-competitive alternative to existing airline service and the automobile.

3.2.4 High-Speed Train Alignment Options Comparison

Travel time, connectivity and passenger cost for the HST can all be affected by which alignment option the HST travels on. This section discusses the relative differences by region of the alignment options for the HST Alternative.

A. BAY AREA TO MERCED

The selection of the Diablo Range direct options between the San Francisco Bay Area and the Central Valley would have significant implications for HST service. The Diablo Range direct alignments are a shorter and faster option between the San Francisco Bay Area and Sacramento/Northern San Joaquin Valley, providing for much shorter travel times between these markets. For example, for express trains between Sacramento and San Jose, the Diablo Range direct alignments travel times would be about 25 min less than for the Pacheco Pass (50 min for the Diablo alignments verses 1 hr and 15 min for the Pacheco Pass options). The Diablo Range direct options would permit express travel times between Sacramento and San Francisco in 1 hr and 20 min, compared to 1 hr and 45 min via the Pacheco Pass options.

The Diablo Range direct alignments would place Merced on the San Francisco to Los Angeles segment of the HST network, which would result in a higher frequency of service to/from Merced. However, the Pacheco Pass alignment options include potential stations at Gilroy (or Morgan Hill) and Los Banos, whereas the Diablo Range alignments do not have any stations between Merced and San Jose. The populations that would be served by the Gilroy and Los Banos stations would therefore have much shorter access times and access costs to the nearest HST station with the Pacheco Pass alignments. The potential Gilroy/Morgan Hill Station would have a particularly high impact on connectivity, travel times, and access costs, since in addition to serving Southern Santa Clara County, it would also be the most accessible station location for serving the Santa Cruz, Monterey/Carmel, and Salinas populations.

The decision on how best to serve the Bay Area cities would also have a major impact on the HST system. This Program EIR/EIS evaluates both potential service to the Bay Area along the San Francisco Peninsula and potential service along the East Bay to Oakland. If service to both sides of the Bay were pursued, service to each Bay Area station (north of San Jose) would be less frequent. However, if only one side of the Bay were directly served by the proposed HST system, the number of intermodal connections would be greatly reduced. The access times and access costs would increase significantly, and the competitiveness of the new mode on the side of the Bay not served would also be reduced. For example, if the East Bay is not directly served, all trains bound for the Bay Area would terminate in downtown San Francisco. However, there would be no HST link to directly serve Oakland, the Oakland Airport, or Southern Alameda County. Potential HST passengers from the East Bay would have to either use the Capitol Corridor, mass transit, or drive to San Francisco, San Jose, or the Peninsula to use the HST service.

The I-880 alignment would provide superior travel times to connect the HST system to the East Bay as compared to the Hayward/Niles/Mulford Line. The Mulford Line is a longer route and has tight curves that would severely restrict speeds between Fremont and Union City. For all potential markets to Oakland, the I-880 corridor would offer express and local travel times of about 6 min less than the Mulford Line. Using the I-880 corridor, travel times between Oakland and Los Angeles could be achieved in 2 hrs and 18 min, whereas using the Mulford Line the same trip would take a minimum of 2 hrs and 24 min.

Potential Station Locations

- For service to downtown San Francisco, the Transbay Terminal and the 4th and King Station were selected for further evaluation. The 4th and King Station is the existing terminus for the Caltrain commuter rail service. This station site (adjacent to Pacific Bell Stadium) is well connected to the San Francisco Muni system but stops more than a mile short of the financial district of downtown San Francisco and does not connect to BART. The Transbay Terminal would offer significantly greater connectivity to San Francisco and the greater Bay Area than the existing 4th and King site due to its location in the heart of the downtown San Francisco financial district, where many potential HST passengers could walk to the station. In addition, the Transbay Terminal would serve as the transit hub for all of the major services to downtown San Francisco, with the advantage of direct connections to BART and Muni. The 4th and King Station would have about a 2.5-min shorter line-haul travel time to San Francisco than the Transbay Terminal, since the trains would travel at relatively slow speeds between 4th and King and the Transbay Terminal, a distance of 1.2 mi (1.9 km). However, since the Transbay Terminal would offer much greater connectivity to San Francisco and the greater Bay Area than the existing 4th and King site, total travel times to downtown destinations via the Transbay Terminal are expected to be superior.

- West Oakland Station and 12th Street City Center Station were selected for further consideration for the Oakland terminus station. Both of these potential stations would directly connect with BART, and both would have good freeway access. The 12th Street City Center Station would have superior connectivity, as it is located in the heart of downtown Oakland where many potential HST passengers could walk to the station. The 12th Street City Center BART Station is also a transfer station providing greater connectivity to the regional rail transit system.
- A potential station to serve San Mateo County would be located either at Redwood City or Palo Alto. Both would be multi-modal stations at existing Caltrain station locations. The Palo Alto Station would be a stop for the Caltrain express services, and therefore would have better connectivity to the regional commuter service and to the Peninsula.
- A potential station to serve Southern Alameda County would be located at either Union City or Fremont (Auto Mall Parkway). Both station locations would offer a high level of connectivity. The Union City Station would connect to BART, the Capitol Corridor, and AC Transit; whereas the Auto Mall Parkway Station would have good access to the I-880 freeway and connect to the Capitol Corridor, ACE Commuter Rail, and AC Transit. The Union City Station site serves both alignment options for East Bay service, while the Auto Mall Parkway site is only served by the Mulford Line alignment.
- South Santa Clara County potentially would be served by a station at either Gilroy or Morgan Hill. Both of these two potential stations would be at Caltrain commuter rail station locations. The Gilroy Station is about 10 mi (16 km) south of Morgan Hill and therefore provides better connectivity, travel times, and lower access costs to the Santa Cruz, Monterey/Carmel, and Salinas markets. The Gilroy Station is only served by the Pacheco Pass/Gilroy/Caltrain alignment, and neither the Gilroy nor the Morgan Hill station sites would be served by the Diablo Range Northern alignment options.
- Four other potential stations are being considered for service to the Bay Area: Diridon Station in downtown San Jose, and stations to serve the three regional international airports, SFO, Oakland (Coliseum BART), and San Jose (Santa Clara). In addition, a potential station in the Central Valley to serve Los Banos is being considered for the Pacheco Pass alignment options. Diridon Station would be a multi-modal hub maximizing connectivity to downtown San Jose and the Southern Bay Area. Diridon Station would serve Caltrain, ACE Commuter Rail, the Capitol Corridor, Amtrak, VTA buses and light rail, and a possible link to BART. None of the three airport stations would be in the airport terminals, but each would permit easy access by people movers, or shuttles (at SFO, BART currently provides a direct connection from the Millbrae Caltrain Station to the SFO international terminal). All three potential airport stations would have direct connections to local and regional commuter rail

services and would minimize potential travel times and costs for HST passengers who would use the trains for access to the airports. The potential Los Banos Station would be north of the city of Los Banos with good accessibility to I-5 and would greatly reduce travel times and access costs to that population.

B. SACRAMENTO TO BAKERSFIELD

Between northern and southern California, the UPRR rail alignment is slightly more direct than the BNSF rail alignment, about 4 mi (6 km) less distance when measured from the BNSF and UPRR merge point, which is 2.3 mi (3.7 km) south of the Truxton Station on the BNSF and 3.6 mi (5.8 km) south of Bakersfield Golden State Station on the UPRR. However, since maximum speeds would be achieved throughout the Central Valley, the differences in travel times between northern and southern California would be marginal, with the UPRR providing potential travel times about 2 min less than the BNSF. The UPRR and BNSF rail alignments would serve the same populations and same number of potential stations. Therefore, the selection of the Central Valley alignment would not have an overall impact on Central Valley connectivity. Most of the potential stations locations throughout the Central Valley can be served by either the BNSF or the UPRR, and the preferred Central Valley alignment could even be a combination of these two existing freight rail corridors. The potential Modesto stations and potential station at either Hanford or Visalia are the exceptions, where the selection of the alignment (between Stockton and Merced for the Modesto Station and between Fresno and Bakersfield for Hanford/Visalia) would determine the potential station location since there are no practical connections between the UPRR and BNSF at these locations.

Potential Station Locations

- The Downtown Sacramento Valley Station would have better connectivity in Sacramento than the Power Inn Road Station location. The Valley Station is located in downtown Sacramento and is within walking distance of the state capitol. This multimodal station location serves the existing Amtrak services to Sacramento, including the Capitol Corridor, and will serve the Sacramento Light Rail Train (LRT) that is being extended to this station site. This site also has good access to I-5. Although the Power Inn site has good intermodal access to the Sacramento LRT and to US-50, it is located outside of downtown Sacramento, more than 5 mi (8 km) away from the state capitol. The Power Inn Station would have about a 3-minute shorter line-haul travel time to Sacramento then the Downtown Sacramento Valley Station, since the trains would travel at relatively slow speeds between Power Inn and the Valley Station, a distance of about 7.5 mi (12.1 km). However, the Sacramento Valley Station would offer greater connectivity to downtown Sacramento and the Sacramento region, and shorter total travel times to downtown destinations.

- Two potential station sites are evaluated to serve Modesto: a potential downtown station on the UPRR rail alignment, and the existing Amtrak Briggsmore Station on the BNSF alignment. The downtown station maximizes connectivity to downtown Modesto and provides convenient access to SR-99, whereas the Amtrak Briggsmore Station is about 5 mi (8 km) east of downtown Modesto. As noted above, the selection of the alignment between Stockton and Merced would determine the station site for Modesto.

- To serve Merced, potential station locations are evaluated at downtown Merced along the UPRR alignment, at Castle Air Force Base, and at the Merced Municipal Airport. The downtown station is located near the city center and transit hub of Merced, has good access to SR-99, and would have the highest level of connectivity of the three locations. The Castle Air Force Base site is about 7 mi (11 km) from downtown Merced, but would provide easy access to the developing University of California, Merced campus via a new highway alignment along Bellevue Avenue. The Merced Municipal Airport site would be less than 2 mi (3 km) from downtown Merced.

- Potential station sites in Tulare and Kings Counties are evaluated at Hanford and Visalia. The ultimate selection of an alignment between Bakersfield and Fresno would include the determination of station location. The Hanford site would connect to the Amtrak station in Hanford, whereas the Visalia Airport Station would best serve the more populated Tulare County cities of Visalia and Tulare. The BNSF serves Hanford and would result in faster travel times and lower access costs for Hanford residents and Kings County; the UPRR serves Visalia and would result in faster travel times and lower access costs for the Visalia population and Tulare County.
- The Truxton Station would have the highest connectivity of the three locations being evaluated to serve Bakersfield. The Truxton Station would connect to the new Bakersfield Amtrak Station and is in the city center of Bakersfield, within walking distance to the convention center and city hall. The Truxton station location also has good access to SR-99. The Golden State Station site is less than 2 mi (3 km) northeast of the city center next to SR-204. The Bakersfield Airport Station would be located outside of Bakersfield about 6 mi (10 km) northeast of the city center. The airport station would provide a high level of connectivity to the airport and has good access to SR-99.
- Two other potential stations are considered for Central Valley service, the ACE Stockton Downtown Station and Downtown Fresno Station. Both of these stations would maximize connectivity to downtown Stockton and to downtown Fresno. The ACE Stockton Station is the current terminus for the ACE Commuter Rail to San Jose and is located in the central part of Stockton. The Downtown Fresno Station is close to the city center and has convenient access to SR-99, SR-41, and SR-180 freeways.

C. BAKERSFIELD TO LOS ANGELES

The selection of the southern mountain crossing alignment option between Bakersfield and Los Angeles would have implications for the HST system and have an effect on the travel times between northern and southern California. The I-5 alignment would have express times about 10 min less than the SR-58/Soledad Canyon alignment, and local times about 12 min less. For example, the San Francisco to Los Angeles express travel time would be less than 2 hrs and 25 min for the I-5 alignment and just over 2 hrs and 35 min for the SR-58/Soledad Canyon alignment. The SR-58/Soledad Canyon alignment option includes a potential station at Palmdale, whereas the I-5 alignment does not have any stations between Bakersfield and Sylmar. The potential Palmdale Station would have a particularly high impact on connectivity since it would serve the growing communities of the Antelope Valley. The SR-58/Soledad Canyon alignment would also improve travel times and reduce access costs to and from the Antelope Valley population.

Between Sylmar and Los Angeles, the combined I-5/UPRR alignment would be shorter and have fewer speed-restricting curves than the UPRR/Metrolink alignment, resulting in travel time saved of about 1 min.

<u>Potential Station Locations</u>

- There are three station sites within the vicinity LAUS: LAUS, Union Station South, and Los Angeles River East. Of the three potential sites, the existing LAUS station has the best connectivity and therefore would also provide the fastest overall travel times to many destinations. LAUS is the transit/rail transportation hub of southern California. LAUS is the primary destination for the Metrolink commuter rail services, the Los Angeles Metro Red Line, the Pasadena Gold Line, the Amtrak Surfliner service, and the regional bus transit services. HST would serve LAUS on an elevated structure where transfers to other modes would be made directly under the HST platforms. The Los Angeles River East Station and Union Station South sites would require the construction of a pedestrian bridge/plaza across the US-101 freeway to connect with LAUS.

- The Palmdale Transportation Center is being considered as a potential station site for serving the Antelope Valley population. The Palmdale Transportation Center maximizes opportunities for intermodal connectivity. It is close to Palmdale Airport, with the opportunity for convenient shuttle or people-mover connections. The transportation center is the Metrolink Station for Palmdale and is a hub for local bus services. The Palmdale Transportation Center would provide short travel times and low access costs for the Antelope Valley population.
- The Sylmar Metrolink Station would provide a direct connection to the Metrolink regional commuter rail service and would have convenient access to the freeway network.
- The Burbank Metrolink Station would provide the highest connectivity to the Burbank area. This station site is in downtown Burbank, has a direct connection to the Metrolink regional commuter rail service, is a hub for bus transit in the Burbank area, has adjacent access to I-5, and is only 2.4 mi (3.9 km) from Burbank Airport. The Burbank Airport Station would be nearer to Burbank Airport at 1.6 mi (2.6 km) away, but would be outside the city center and does not connect with a Metrolink station or regional transit.

D. LOS ANGELES TO SAN DIEGO VIA INLAND EMPIRE

Between Los Angeles and Riverside, the UPRR Riverside and UPRR Colton rail alignments would serve the same populations and same number of potential stations, whereas the alignment options for either the UPRR Riverside or UPRR Colton that would directly serve the city center of San Bernardino and would offer greater connectivity with freeway, commuter rail, and local transit. Using the San Bernardino alignment would add between 4 min and 8 min to the travel time between Los Angeles and March ARB.

Decisions concerning how a proposed HST system would best serve San Diego would have implications for the HST system and its operations. The Miramar Road and Caroll Canyon alignment options would have considerable connectivity advantages over the Qualcomm alignment option. The Miramar Road alignment and the Carroll Canyon alignment options would directly serve downtown San Diego, while the Qualcomm Stadium Station would be about an 8-mi (13-km) drive or 10-mi (16-km) light rail ride to the city center. In addition, the Miramar Road and Carroll Canyon alignment options would provide an alternative to the potential Mira Mesa Station at University City.

The I-15 alignment to Qualcomm Station would have the shortest line-haul times (about 7 min less than the two options to downtown San Diego), but would not directly serve downtown San Diego. The line-haul time for the LRT between Qualcomm and the downtown San Diego Santa Fe Depot is more than 20 min long. The Miramar Road and Carroll Canyon alignment options would therefore be expected to provide considerably superior total travel times to downtown San Diego than the I-15 alignment to Qualcomm Stadium. Decisions on how best to serve San Diego with a proposed HST system could also impact total HST passenger costs for service to or from San Diego. The Miramar Road and Carroll Canyon alignment options that would serve downtown San Diego would be expected to have lower access costs to downtown San Diego than the I-15 alignment to Qualcomm Stadium.

Potential Station Locations

- Of the four potential stations sites serving East San Gabriel Valley, the Metrolink station sites at Pomona and City of Industry would have the widest range of multimodal connections to local and regional bus services, and to Metrolink commuter rail service. The City of Industry site would provide a more central location between the potential stations at LAUS and Ontario Airport. All of the potential station sites would have good access to the freeway network. The Pomona station area would be served by both the UPRR Colton and UPRR Riverside/Colton alignment options, whereas the El Monte station and City of Industry sites are on the UPRR Colton alignment and the South El Monte station on the UPRR Riverside alignment. The City of Industry site would provide a more central location between the potential stations at LAUS and Ontario Airport and therefore the lowest overall travel times.

- Of the four potential stations sites serving the Riverside/San Bernardino area, the San Bernardino Metrolink Station site would have the widest range of multimodal connections to local and regional bus services and to Metrolink commuter rail service. The UPRR Colton Station site would have the least connectivity to existing transit services, but would have the most central location for serving both the San Bernardino and Riverside populations and have good accessibility to I-10. The University of California, Riverside (UCR) site is furthest away from the freeway network but provides for the most convenient access to Riverside. Service to the San Bernardino Metrolink Station would provide the most convenient access to San Bernardino. The March ARB site would be adjacent to the airport, but would have the least connectivity, longest travel times, and highest access costs since the airport does not serve commercial air passengers and this site is furthest away from the Riverside/San Bernardino populations.
- For service to San Diego, the Downtown San Diego Santa Fe Depot site would have the highest connectivity. This station is located in the city center where many potential HST passengers could walk to their destination. The Santa Fe Depot is the terminus for the Coaster commuter rail service, the Amtrak Surfliner intercity service, provides direct connections to the San Diego LRT network, and is a bus transit hub for San Diego. San Diego International Airport is a unique airport in that is located adjacent to downtown San Diego and is only about 2 mi (3 km) from the city center. The San Diego Airport Station location would provide a convenient connection to the international airport and directly connect with the regional bus network and a San Diego LRT station. Although the San Diego airport location would not have as good connectivity to the city center as the Santa Fe Depot site, it would have a better connection to I-5. Qualcomm Stadium would provide a direct connection to the San Diego LRT network and good freeway access, but it would not have the same level of connectivity to the San Diego city center.
- The Escondido Downtown Transit Center would have somewhat higher connectivity than the Escondido I-15 Station Site. The Downtown Transit Center Station would be closer to the Escondido Transit Center, within 0.13 mi (0.20 km), and provide better connectivity with the proposed Escondido to Oceanside commuter rail service, but the Escondido I-15 site would provide more convenient freeway access.
- The University City station site in San Diego is located near a densely developed portion of San Diego, which could be served by the Coaster commuter rail service, would be served by San Diego LRT, and would provide a higher level of connectivity than the Mira Mesa station location. However, the University City site is not served by the I-15 alignment option that serves the Qualcomm Station.
- Potential stations are also being considered at the Ontario airport and Murietta. The Ontario Airport Station would provide a multi-modal connection to Ontario International Airport and link to region bus transit services. The Ontario Airport Station would provide the fastest HST travel times and reduce access costs for passengers looking to make an air connection at Ontario International Airport. A potential station at Murietta would serve the fast-growing Temecula/Murietta area. The Murietta at I-15/I-215 Interchange Station site would have convenient freeway access to both I-15 and I-215.

E. LOS ANGELES TO SAN DIEGO VIA ORANGE COUNTY

Decisions on how proposed rail improvements may best serve this region would have major implications for the HST system and operations. The Authority is considering optional service to LAX and Orange County. If service to LAX and/or Orange County were selected, frequencies to each station along the Los Angeles to San Diego via Inland Empire corridor could be less than if a single line south of Los Angeles were selected. However, if HST directly serves LAX and/or Orange County, the number of intermodal connections could be greatly increased. The travel times and access costs to these markets would be greatly decreased with the HST, and the competitiveness of the HST would be greatly increased for the southwest portions of Los Angeles County and/or Orange County intercity transportation markets. If the airport is not directly served, local transportation (shuttle, regional transit, or the automobile) would be needed between LAUS and the airport or to western Los Angeles County. For the link to Orange County, potential stations are being considered at Norwalk (southern Los Angeles County, serving the gateway cities), Anaheim, and Irvine. If Orange County is not directly served, passengers to southern Los Angeles County and Orange County would need to transfer to non-electric, conventional intercity rail Amtrak Surfliner service at LAUS.

The LOSSAN alignment between LAUS and Anaheim would provide a high level of connectivity with Metrolink, Amtrak Surfliner, and regional and local bus transit. However, because this alignment would require sharing tracks with existing services, it is severely constrained in terms of sustainable capacity and the potential frequency for HST service to Orange County. Operations models suggest that the HST operations may be limited to 18 to 45 trains per day (in each direction) to Orange County if the LOSSAN alignment is selected. In contrast, the UPRR Santa Ana alignment would be dedicated to HST service and would have the capacity to serve up to 20 trains per hour, but it does not provide direct connectivity to Metrolink or Amtrak.

<u>Potential Station Locations</u>

- South Los Angeles County could have a potential HST station at Norwalk either along the LOSSAN rail alignment or the UPRR Santa Ana alignment. The selection of the alignment between Los Angeles and Orange County would determine the preferred station location for serving the gateway cities of south Los Angeles County. The Norwalk LOSSAN site would be at Norwalk Metrolink Station with direct connectivity to the regional commuter rail service. This site is a bus transit hub for the area and is well served by I-5 and the Imperial Highway. The Norwalk UPRR site has no existing passenger rail connection, as it is located about 1 mi (1.6 km) east of the Green Line LRT terminus, but it has existing bus connections and good freeway access.
- Three other potential HST stations are being considered for this region: a potential station at LAX, and potential stations at Anaheim and Irvine to serve Orange County. The LAX station would be adjacent to the airport terminals and would permit easy access by a potential people mover, shuttle, or by walking. It would have direct connections to regional bus transit services and be the only HST station directly serving western Los Angeles County. The Anaheim Edison Field Amtrak Station and the Irvine Transportation Center are transit hubs with high connectivity for central and south Orange County respectively. These stations are OCTA bus transit hubs and serve existing Amtrak and Metrolink commuter rail services.

3.3 AIR QUALITY

This section provides an overview of the six air basins studied for this Program EIR/EIS and describes the composition of air pollutants in and the status of these air basins. In addition, this section describes the potential impacts that may directly and indirectly affect state and regional air quality under the No Project, Modal, and proposed High-Speed Train (HST) Alternatives, using the existing and No Project conditions for comparison.

Air pollution is a general term that refers to one or more chemical substances that degrade the quality of the atmosphere. Eight air pollutants have been identified by the U.S. Environmental Protection Agency (EPA) as being of concern nationwide: carbon monoxide (CO), sulfur oxides (SO_x), hydrocarbons (HC), oxides of nitrogen (NO_x), ozone (O_3), particulate matter 10 microns in diameter or less (PM10), particulate matter 2.5 microns in diameter or less (PM2.5) and lead (Pb). Except for HC (also referred to as total organic gases (TOG), all of these pollutants (NO_x in the form of NO_2 and SO_x in the form of SO_2) are collectively referred to as criteria pollutants. Pollutants that are considered *greenhouse gases* also affect air quality. Greenhouse gases include, NO_x, TOG, and carbon dioxide (CO_2). The sources of these pollutants, their effects on human health and general welfare, and their final deposition in the atmosphere vary considerably.

3.3.1 Regulatory Requirements and Methods of Evaluation

A. REGULATORY REQUIREMENTS

Federal Regulations

Air quality is regulated at the federal level under the Clean Air Act of 1970 (CAA) and the Final Conformity Rule (40 C.F.R. Parts 51 and 93). The Clean Air Act Amendments of 1990 (Public Law [P.L.] 101-549, November 15, 1990) direct the U.S. EPA to implement strong environmental policies and regulations that will ensure cleaner air quality. According to Title I, Section 101, Paragraph F of the Clean Air Act Amendments (42 U.S.C. § 7401 *et seq.*): "No federal agency may approve, accept, or fund any transportation plan, program, or project unless such plan, program or project has been found to conform to any applicable state implementation plan (SIP) in effect under this act." Title 1, Section 101, Paragraph F of the amendments, amends Section 176(c) of the CAA to define *conformity* as follows: conformity to an implementation plan's purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards (NAAQS) and achieving expeditious attainment of such standards; and that such activities will not cause any of the following occurrences.

- Cause or contribute to any new violation of any NAAQS in any area.
- Increase the frequency or severity of any existing violation of any NAAQS in any area.
- Delay timely attainment of any NAAQS or any required interim emissions reductions or other milestones in any area. (42 U.S.C. § 7506[c][1].)

State Regulations

Air quality is regulated at the state level by the California Air Resources Board (CARB), the agency designated to prepare the SIP required by the federal CAA, under the California Clean Air Act of 1988 (Assembly Bill [AB] 2595) and other provisions of the California Health and Safety Code (Health and Safety Code § 39000 *et seq.*). California's Clean Air Act (CCAA) requires all districts designated as nonattainment for any pollutant to "adopt and enforce rules and regulations to achieve and maintain the state and federal ambient air quality standards in all areas affected by emission sources under their jurisdiction."

The responsibility for controlling air pollution in California is shared by 35 local or regional air pollution control and air quality management districts, CARB, and EPA. The districts issue permits for industrial pollutant sources and adopt air quality management plans and rules. CARB establishes the state ambient air quality standards, adopts and enforces emission standards for mobile sources, adopts standards and suggested control measures for toxic air contaminants, provides technical support to the districts, oversees district compliance, approves local air quality plans, and prepares and submits the SIP to EPA. EPA establishes NAAQS, sets emission standards for certain mobile sources (airplanes and locomotives), oversees the state air programs, and reviews and approves the SIP. CARB inventories sources of air pollution in California's air basins and is required to update the inventory triennially, starting in 1998 (Health and Safety Code §§ 39607 and 30607.3). CARB also identifies air basins that are affected by transported air pollution (Health and Safety Code § 39610; 17 C.C.R. Part 70500).

National and State Ambient Air Quality Standards

As required by the CAA Amendments of 1970 (P.L. 91-064, December 31, 1970) and the CAA Amendment of 1977 (P.L. 95-95, August 7, 1977), EPA has established NAAQS for the following air pollutants: CO, O_3, NO_2, PM10, SO_x, and Pb. CARB has also established standards for these pollutants. Recent legislation requires CARB to develop and adopt regulations to reduce greenhouse gases (AB 1493, 2002). The federal and state governments have both adopted health-based standards for pollutants. For some pollutants, the national and state standards are very similar; for other pollutants, the state standards are more stringent. The differences in the standards are generally due to the different health effect studies considered during the standard-setting process and how these studies were interpreted.

Table 3.3-1 lists the federal and state standards. The federal primary standards are intended to protect the public health with an adequate margin of safety. The federal secondary standards are intended to protect the nation's welfare and account for air-pollutant impacts on soil, water, visibility, vegetation, and other aspects of the general welfare. Areas that violate these standards are designated nonattainment areas. Areas that once violated the standards but now meet the standards are classified as maintenance areas. Classification of each area under the federal standards is done by EPA based on state recommendations and after an extensive review of monitored data. Classification under the state standards is done by CARB.

Table 3.3-1
State and National Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards[a]		Federal Standards[b]		
		Concentration[c]	Method[d]	Primary[c,e]	Secondary[c,f,g]	Method[g]
O_3	1 hour	0.09 ppm (180 µg/m^3)	Ultraviolet photometry	0.12 ppm (235 µg/m^3)[h]	Same as primary standard	Ultraviolet photometry
	8 hour	N/A		0.08 ppm (157 µg/m^3)[h]		
PM10	24 hour	50 µg/m^3	Gravimetric or beta attenuation	150 µg/m^3	Same as primary standard	Inertial separation and gravimetric analysis
	Annual arithmetic mean	20 µg/m^3		50 µg/m^3		
PM2.5	24 hour	No separate state standard	Gravimetric or beta attenuation	65 µg/m^3	Same as primary standard	Inertial separation and gravimetric analysis
	Annual arithmetic mean	12 µg/m^3		15 µg/m^3		
CO	8 hour	9.0 ppm (10 mg/m^3)	NDIR	9 ppm (10 mg/m^3)	None	NDIR
	1 hour	20 ppm (23 mg/m^3)		35 ppm (40 mg/m^3)		
	8 hour (Lake Tahoe)	6 ppm (7 mg/m^3)		N/A		
NO_2	Annual arithmetic mean	N/A	Gas phase chemilum-incescence	0.053 ppm (100 µg/m^3)	Same as primary standard	Gas phase chemilum-incescence
	1 hour	0.25 ppm (470 µg/m^3)		N/A		
Pb[i]	30 days average	1.5 µg/m^3	Atomic absorption	N/A	N/A	High volume sampler and atomic absorption
	Calendar quarter	N/A		1.5 µg/m^3	Same as primary standard	
SO_2	Annual arithmetic mean	N/A	Ultraviolet Fluorescence	0.030 ppm (80 µg/m^3)	N/A	Spectro-photometry (Pararosoani-line method)
	24 hour	0.04 ppm (105 µg/m^3)		0.14 ppm (365 µg/m^3)	N/A	
	3 hour	N/A		N/A	0.5 ppm (1300 µg/m^3)	
	1 hour	0.25 ppm (655 µg/m^3)		N/A	N/A	
Visibility reducing particles	8 hour (10 a.m. to 6 p.m., Pacific Standard Time)	In sufficient amount to produce an extinction coefficient of 0.23 per km-visibility of 10 mi (16 km) or more (0.07–30 mi [.011–48 km] or more for Lake Tahoe) due to particles when the relative humidity is less than 70%. Method: Beta attenuation and transmittance through filter tape.		No federal standards		

Pollutant	Averaging Time	California Standards[a]		Federal Standards[b]		
		Concentration[c]	Method[d]	Primary[c,e]	Secondary[c,f,g]	Method[g]
Sulfates	24 hour	25 µg/m³				
Hydrogen sulfide	1 hour	0.03 ppm (42 µg/m³)	Ultraviolet fluorescence			
Vinyl Chloride[h]	24 hour	0.01 ppm (26 µg/m³)	Gas chroma-tography			

µg/m³ = micrograms per cubic meter.
mg/m³ = milligrams per cubic meter.
N/A = not available.
NDIR = Non-dispersive infrared photometry.
ppm = parts per million.

[a] California standards for O_3, CO (except Lake Tahoe), SO_2 (1 and 24 hour), NO_2, suspended particulate matter-PM10, PM2.5, and visibility reducing particles, are values that are not to be exceeded. All others are not to be equaled or exceeded. California ambient air quality standards are listed in the Table of Standards in Section 70200 of Title 17 C.C.R.

[b] National standards (other than O_3, particulate matter, and those based on annual averages or annual arithmetic mean) are not to be exceeded more than once a year. The ozone standard is attained when the fourth highest 8-hour concentration in a year, averaged over 3 years, is equal to or less than the standard. For PM10, the 24-hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 µg/m3 is equal to or less than one. For PM2.5, the 24-hour standard is attained when 98% of the daily concentrations, averaged over 3 years, are equal to or less than the standards.

[c] Concentration expressed first in units in which it was promulgated. Equivalent units given in parentheses are based upon a reference temperature of 25 °C (77 °F) and a reference pressure of 760 mm (30 in) of mercury. Most measurements of air quality are to be corrected to a reference temperature of 25 °C (77 °F) and reference pressure measurements of air quality are to be corrected to a reference temperature of 25 °C (77 °F) and a reference pressure of 760 mm (30 in) of mercury (1,013.2 millibar [1 atmosphere]); ppm in this table refers to ppm volume, or micromoles of pollutant per mole of gas.

[d] Any equivalent procedure that can be shown to the satisfaction of CARB to give equivalent results at or near the level of the air quality standard may be used.

[e] National Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health.

National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

[f] Reference method as described by EPA. An "equivalent method" of measurement may be used but must have a "consistent relationship to the reference method" and must be approved by EPA.

[g] New federal 8-hour O_3 and PM2.5 standards were promulgated by EPA on July 18, 1997.

[h] ARB has identified lead and vinyl chloride as "toxic air contaminants" with no threshold level of exposure for adverse health effects determined. These actions allow for the implementation of control measures at levels below the ambient concentrations specified for these pollutants.

Source: California Air Resources Board 2003.

B. METHOD OF EVALUATION OF IMPACTS

Pollutants

Pollutants that can be traced principally to transportation sources and are thus relevant to the evaluation of the project alternatives include CO, O_3 precursors (NO_x and ROG), PM10, and CO_2. Since high CO levels are mostly the result of congested traffic conditions combined with adverse meteorological conditions, high CO concentrations are generally occur within 300 ft (91 m) to 600 ft (183 m) of heavily traveled roadways. Concentrations of CO on a regional and localized or microscale basis can consequently be predicted appropriately. As discussed above in the affected environment section, TOG and NO_x emissions from mobile sources are of concern primarily because of their role as precursors in the formation of O_3 and particulate matter. O_3 is formed through a series of reactions that occur in the atmosphere in the presence of sunlight over a period of hours. Since the reactions are slow and occur as the pollutants are diffusing downwind, elevated O_3 levels are often found many miles from sources of the precursor pollutants. The impacts of TOG and NO_x emissions are therefore generally examined on a regional level. CO_2 emission burdens, because of their global impact, are currently expressed only on the statewide level by CARB and EPA. In this analysis, therefore, CO_2 impacts are discussed on the statewide level. It is appropriate to predict concentrations of PM10 on a regional and localized basis. EPA is currently developing a standardized methodology to evaluate PM10 on a local level.

Pollutant Burdens

The air quality analysis for this Program EIR/EIS focuses on the potential statewide, regional, and localized impacts on air quality. The regional pollutant burdens were estimated based on changes that would occur, including the following, under each of the alternatives.

- Highway vehicle miles traveled (VMT).
- Number of plane operations.
- Number of train movements (proposed HST and existing LOSSAN system).
- Power requirements for the proposed HST system.

Localized air quality impacts were estimated near proposed station locations and airports potentially affected by the Modal and HST Alternatives. The potential impacts of these alternatives were compared to existing conditions and the No Project Alternative.

A comparison of the 2002 conditions to the 2020 No Project conditions illustrates the expected trends in air quality. The potential impacts from proposed alternatives were then added to the 2020 conditions. Changes in VMT for on-road mobile sources (vehicles) and for off-road mobile sources (number of plane operations and train movements) were estimated for each of the alternatives. Changes in emissions of stationary sources (electrical power generators) were also assessed.

Highway VMT: On-road pollutant burdens were calculated as a ratio of baseline VMT to estimated VMT changes under each alternative. Although vehicular speeds affect emission rates, the potential basin-wide speed changes were considered too small to affect overall emission estimates; thus changes in future on-road mobile source emission burdens for the project were based solely on VMT changes and did not consider speed.

Number of Plane Operations: The Federal Aviation Administration's (FAA's) Emission and Dispersion Modeling System (EDMS) is used to estimate airplane emissions. The EDMS model estimates the emissions generated from a specified number of landing and take-off (LTO) cycles. Along with the emissions from the planes themselves, emissions generated from associated ground maintenance requirements are also included. Average plane emissions are calculated based on a typical 737 aircraft. The pollutant burdens generated by the LTOs under each alternative were added to CARB's off-road mobile sources (planes) emission budgets for each air basin to determine the potential impacts of the alternatives.

Number of Train Movements: Ridership projections for the HST system varied between 42 million and 68 million passengers (including 10 million long-distance commuters) for 2020, with potential for significantly higher ridership beyond 2020 (Charles River Associates 1996). The figures on the lower end of these estimates are considered *investment-grade forecasts,* which were used in the California High Speed Rail Authority's (Authority's) final business plan (Business Plan) and are based conservatively on current costs, travel times, and congestion levels of air and automobile transportation. The figures on the higher end are based on a *sensitivity analysis*, which assumes the increased costs and congestion associated with air and automobile travel would result in greater potential ridership for the intercity HST system. The sensitivity analysis started with the investment-grade ridership forecasts and applied variations in mode characteristics that tend to increase HST ridership and revenue to determine how sensitive HST ridership is to travel times, fares, etc. This sensitivity analysis produced a higher ridership forecast, which is used in this Program EIR/EIS to define a maximum impact potential of the Modal and HST Alternatives.

For this report and the overall Program EIR/EIS process, the higher demand forecast of 68 million riders (58 million intercity trips and 10 million commute trips), based on the sensitivity analysis, offers a more reasonable scenario to represent total capacity, while serving as a representative worst-case scenario for defining the physical and operational aspects of the alternatives in 2020. This higher forecast is generally used as a basis for defining the Modal and HST Alternatives and is referred to in this report as the *representative demand*. In some specific analyses such as this air quality analysis, the high-end forecasts result in a benefit because of additional VMT being removed from the road and a decrease in LTO cycles for planes. In those cases, additional analysis is included in this Program EIS/EIR also to address the impacts associated with the low-end (investment-grade) forecasts.

To determine the number of plane trips potentially replaced from the No Project scenario daily by the HST Alternative, the following calculations were performed using sensitivity ridership variation projections as defined above. The number of annual air trips that could be removed by the proposed HST system (25.3 million) was divided by an average number of passengers per flight (101.25). The resulting number of flights per year (250,551) was then divided by the number of days per year to reach the number of flights per day (771) that could potentially be removed by the proposed HST system. (See Chapter 2 *Alternatives*, for definition of system alternatives.)

25.3 million trips = 25.3 million flying passengers (1 trip = 1 takeoff and 1 landing)

1 flight = 101.25 passengers (135 seats X 75% load factor, as per Table 3.2-3 in the *System Definition Report*)

Therefore,

250,551 flights/year = (25,368,285 passengers/year) / (101.25 passengers/flight)

771 flights/day = 250,551 flights/year X 1 year / 325 days

Similar calculations were prepared for the proposed HST Alternative based on the investment-grade ridership forecasts.

Additional train emissions from potentially increased feeder service to the proposed HST service were also assessed based on predicted ridership forecasts.

<u>Power Requirements</u>: In addition to the on-road and off-road emission burdens, emissions resulting from the power generated to run the HST system were estimated and included in the emission burden of the HST Alternative. Emission estimates are based on British thermal unit (BTU) requirements calculated in the energy analysis for the project (see Section 3.5). BTU emission factors are based on information from *Conserving Energy and Preserving the Environment: The Role of Public Transportation* (Shapiro et al. 2002), and the *Transportation Energy Data Book* (U.S. Department of Energy 2002).

Pollutant burdens generated by on-road (vehicles), off-road (planes, trains), and stationary (electric power generation) sources were combined and compared to the No Project Alternative and to each other, i.e. among the Modal and HST Alternatives. Because of the nature of electrical power generation and the use of a grid system to distribute electrical power, it is not yet clear which facilities would be supplying power to the proposed HST system. Emission changes from power generation can therefore be predicted on a statewide level only.

C. RATING SCHEME

The relevance of the potential emission changes was assessed from a total pollutant burden and percentage change compared to the No Project Alternative in the affected air basins and statewide. Depending on each air basin's attainment status (see Table 3.3-3), the predicted differences were ranked as a high (+ or -), medium (+ or -), or low (+ or -) impact. The ranking of high, medium, or low is based on the potential magnitude of the emission changes compared to U.S. EPA's General Conformity threshold levels for nonattainment and maintenance areas and the No Project emission inventory (for on-road sources, planes, and trains) for each air basin.

This assessment is based on the total pollutant burden of an area under the No Project Alternative and the change in emissions estimated under a proposed alternative. Both positive and negative impacts were considered. A positive (+) impact indicates a potential benefit (i.e., a decrease in emissions) to an air basin for a specific pollutant; a negative (-) impact indicates a potential detriment (i.e., an increase in emissions) to an air basin.

The following factors were used to rate the potential affects of each proposed project alternative:

- The threshold values provided in EPA's Conformity Rule (see Table 3.3-2) that determine when a detailed conformity analysis is required for a proposed federal project located in a nonattainment or maintenance area;
- The conformity rule's definition (40 C.F.R. P 55.852) of a regionally significant project, which is one that would increase emissions of an applicable pollutant in a nonattainment or maintenance area by 10 percent or more; and
- CARB's emission inventories, which are the estimated amounts of pollutants emitted into the atmosphere in 2020 in each air basin from major stationary, area-wide, and natural source categories.

For the purpose of this analysis, a project alternative is considered to cause a low impact for a pollutant when it is estimated to increase or decrease the emissions of that pollutant in an air basin by an amount less than the appropriate conformity threshold value. A project alternative is considered to cause a medium impact when it is estimated to increase or decrease emissions by an amount greater than the conformity threshold value but less than 10 percent of the total emissions generated in the basin. A project alternative is considered to cause a high impact when it is estimated to increase or decrease emissions by an amount greater than 10 percent of the total emissions generated in the basin.

Changes in the amounts of carbon dioxide (which is a major component of greenhouse gases) as a result of the project alternatives were estimated on a statewide basis. These results are provided to indicate how changes in CO_2 emissions, as a result of the HSR alternatives, might affect global warming. These estimates were based on the estimated changes in fuel use and electrical energy production associated with each alternative.

Table 3.3-2
General Conformity's Significant Impact Thresholds

Pollutant	Area's Attainment Status	Impact Thresholds (Tons (Metric Tons)/Year)
O_3 (VOCs or NO_x)	Nonattainment—serious	50 (45)
	Nonattainment—severe	25 (23)
	Nonattainment—extreme	20 (18)
	Nonattainment—outside an ozone transport region	100 (91)
	Nonattainment—moderate/marginal inside an ozone transport region	50/100 (45/91) (VOC/NO_x)
	NO_x maintenance	100 (91)
	VOC maintenance—outside ozone transport region	100 (91)
	VOC maintenance—inside ozone transport region	50 (45)
CO	Nonattainment—all	100 (91)
	Maintenance	100 (91)
PM10	Nonattainment—moderate	100 (91)
	Nonattainment—serious	70 (64)
	Maintenance	100 (91)

VOC = volatile organic compound.

Source: Code of Federal Regulations, Title 40, Part 51, Subpart W.

D. LOCALIZED AIR QUALITY IMPACTS

To quantify a project's impact on local pollutant levels, a screening analysis was conducted based on overall traffic volumes and projected changes in volume-to-capacity (V/C) ratios and level of service estimates. Per state and national guidelines (California Department of Transportation 1997), baseline intersection level of service estimates of D or below that would degrade because of a project have the potential to affect local air quality. Similarly, volume increases of greater than 5% could potentially impact local air quality levels. The traffic analyses determined which roadways would experience an impact (positive or negative) under the project alternatives.

For this level of analysis, however, detailed intersection information has not been generated. Rather, traffic screenlines have been developed. *Screenlines* describe defined segments of a roadway that were selected to reasonably represent the routes affected by the proposed alternatives, as discussed in detail in Section 3.1, *Traffic and Circulation*. The estimated traffic volume generated or reduced by the Modal and HST Alternatives was added to No Project traffic volumes and expressed as overall screenline volumes (typical values based on averages over time), level of service, and V/C ratios. These factors were compared to No Project values, and locations with potentially high impacts were identified. The screenlines do not include an analysis of intersections and are therefore not detailed enough to be used for an air quality intersection screening analysis. However, the screenline numbers provide a general idea of the project's impact on the roadway network. Based on these numbers, general potential impacts on the local roadway network for each of the alternatives are discussed below.

3.3.2 Affected Environment

A. STUDY AREAS DEFINED

California is divided into 15 air basins (17 C.C.R. § 60100 *et seq.*). Each has unique terrain, meteorology, and emission sources. This analysis has been structured to estimate the potential impacts on the six air basins directly affected by the proposed alternatives, as illustrated in Figure 3.3-1. The following basins are considered in this study.

- Sacramento Valley.
- San Francisco Bay Area.
- San Joaquin Valley.
- Mojave Desert.
- South Coast.
- San Diego County.

Air quality in nearby air basins could also be affected by changes in travel patterns, miles traveled, and regional pollutant transport resulting from the proposed alternatives. These effects are expected to be less than those experienced by the basins that physically contain the project. For this program-level analysis, potential impacts on air quality are described only for the air basins that physically contain the proposed alternatives. Nearby air basins are not discussed in this program-level analysis. Once the alternatives are refined and more detailed analyses are conducted, nearby basins should be studied.

B. GENERAL DISCUSSION OF AIR QUALITY RESOURCES

Each pollutant is briefly described below.

- Carbon monoxide (CO) is a colorless, odorless gas that is generated in the urban environment primarily by the incomplete combustion of fossil fuels in motor vehicles. Relatively high concentrations of CO can be found near crowded intersections and along heavily used roadways carrying slow-moving traffic. CO chemically combines with the hemoglobin in red blood cells to decrease the oxygen-carrying capacity of the blood. Prolonged exposure can cause headaches, drowsiness, or loss of equilibrium.
- Sulfur oxides (SO_x) constitute a class of compounds of which sulfur dioxide (SO_2) and sulfur trioxide (SO_3) are of great importance in air quality. SO_x is also generated by the incomplete combustion of fossil fuels in motor vehicles. However, relatively little SO_x is emitted from motor vehicles. The health effects of SO_x include respiratory illness, damage to the respiratory tract, and bronchio-constriction.
- Hydrocarbons (HC) comprise a wide variety of organic compounds, including methane (CH_4), emitted principally from the storage, handling, and combustion of fossil fuels. Hydrocarbons are classified according to their level of photochemical reactivity: relatively reactive or relatively non-reactive. Non-reactive hydrocarbons consist mostly of methane. Emissions of total organic gases (TOG) and reactive organic gases (ROG) are two classes of hydrocarbons measured for California's emission inventory. TOG includes all hydrocarbons, both reactive and non-reactive. In contrast, ROG includes only the reactive HC. TOG is measured because non-reactive HC have enough reactivity to play an important role in photochemistry. Though HC can cause eye irritation and breathing difficulty, their principal health effects are related to their role in the formation of ozone. HC is also considered a greenhouse gas.

- Nitrogen oxides (NO_x) constitute a class of compounds that include nitrogen dioxide (NO_2) and nitric oxide (NO), both of which are emitted by motor vehicles. Although NO_2 and NO can irritate the eyes and nose and impair the respiratory system, NO_x, like HC, is of concern primarily because of its role in the formation of ozone. Nitrogen oxide is also considered a greenhouse gas.
- Ozone (O_3) is a photochemical oxidant that is a major cause of lung and eye irritation in urban environments. It is formed through a series of reactions involving HC and NO_x that take place in the atmosphere in the presence of sunlight. Relatively high concentrations of O_3 are normally found only in the summer because low wind speeds or stagnant air coupled with warm temperatures and cloudless skies provide the optimum conditions for O_3 formation. Because of the long reaction time involved, peak ozone concentrations often occur far downwind of the precursor emissions. Thus, ozone is considered a regional pollutant rather than a localized pollutant.
- Particulate matter includes both airborne and deposited particles of a wide range of size and composition. Of particular concern for air quality are particles smaller than or equal to 10 microns and 2.5 microns in size, PM10 and PM2.5, respectively. The data collected through many nationwide studies indicate that most PM10 is the product of fugitive dust, wind erosion, and agricultural and forestry sources, while a small portion is produced by fuel combustion processes. However, combustion of fossil fuels account for a significant portion of PM2.5. Airborne particulate matter mainly affects the respiratory system.
- Lead (Pb) is a stable chemical element that persists and accumulates both in the environment and in humans and animals. There are many sources of lead pollution, including mobile sources such as motor vehicles and other gasoline-powered engines, and non-mobile sources such as petroleum refineries. Lead levels in the urban environment from mobile sources have significantly decreased due to the federally mandated switch to lead-free gasoline. The principal effects of lead on humans are on the blood-forming, nervous, and renal systems.
- Carbon dioxide (CO_2) is a colorless, odorless gas that occurs naturally in the earth's atmosphere. Significant quantities are also emitted into the air by fossil fuel combustion. CO_2 is considered a greenhouse gas. The natural *greenhouse effect* allows the earth to remain warm and sustain life. Greenhouse gases trap the sun's heat in the atmosphere and help determine our climate. As atmospheric concentrations of greenhouse gases rise, so may temperatures. Higher temperatures may result in more emissions, increased smog, and respiratory disease.

The existing (Year 2001) baseline pollutant burden for each of the six air basins is described in the following section. The existing baseline represents the current air quality conditions in each of the air basins in the study area. The future No Project conditions are considered the estimated 2020 future baseline pollutant burden for each of the affected air basins. The existing and future baseline information was developed using the CARB pollutant burden projections for the years 2001 and 2020 available at the CARB Web site, with the year 2020 corresponding to the comparison year for the system alternatives. CARB projections are based on future growth levels in stationary, area-wide, and mobile sources. CARB projections account for emission reductions resulting from clean vehicles and clean fuel programs. There are two categories of mobile sources: on road and off road. Vehicles licensed for highway use are considered on-road mobile sources; airplanes, marine vessels, locomotives, construction and garden equipment, and recreational off-road vehicles are considered off-road mobile sources.

C. AIR RESOURCES BY AIR BASIN

The air quality attainment status based on state and federal standards for CO, particulate matter, and O_3 for each of the air basins in the study area is shown in Table 3.3-3. All air basins are assigned an *attainment status* for air pollutants based on meeting state and federal pollutant standards. There are some differences between state and federal standards, so a pollutant might not have the same status under each standard. A basin is considered in *attainment* for a particular pollutant if it meets the standards set for that pollutant. A basin is considered in *maintenance* for a pollutant if the standards were once violated but are now met. And a basin is considered *nonattainment* for a particular pollutant if its air quality exceeds standards for that pollutant. A basin is considered unclassified if the area cannot be classified on the basis of available information as meeting or not meeting the applicable standard. The standards and status designations are discussed in more detail above in Section 3.3.1, *Regulatory Requirements and Methods of Evaluation*.

Table 3.3-3
Attainment Status of Affected Air Basins

	COCO		PM2.5	PM10		O_3		
Air Basin	National Standard	State Standard National Standard	National State Standard	National Standard	State Standard	National Standard	State Standard	
Sacramento Valley	Maintenance	Unclassified/ Attainment Maintenance	Attainment Unclassified/ attainment	Portions Unclassified/ Portions Moderate nonattainment	Nonattainment	Portions Unclassified-Attainment/ Portions Serious/ Nonattainment	Nonattainment /Portions Nonattainment -Transitional	
San Francisco Bay Area	Maintenance	Attainment Maintenance	Attainment	Unclassified	Nonattainment	Marginal Nonattainment	Nonattainment	
San Joaquin Valley	Maintenance	Unclassified/ Attainment Maintenance	Nonattainment Unclassified/ attainment	Serious Nonattainment	Nonattainment	Serious Nonattainment	Nonattainment	
Mojave Desert	Unclassified/ Attainment	Unclassified/ Attainment Unclassified/ attainment	Attainment Unclassified/ attainment	Moderate Nonattainment	Nonattainment	Portions Unclassified-Attainment/ Portions Moderate Nonattainment	Nonattainment	
South Coast	Serious Nonattainment	Nonattainment /Transitional Nonattainment	Nonattainment Non-attainment/ transitional	Serious Nonattainment	Nonattainment	Severe Nonattainment	Nonattainment	
San Diego County	Maintenance	Attainment Maintenance	NonAttainment	Unclassified	Nonattainment	Nonattainment	Nonattainment	

Source: California Air Resources Board 2002.

San Francisco Bay Area Air Basin

The San Francisco Bay Area Air Basin covers California's second largest metropolitan area. The counties in the air basin include Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, and Santa Clara, as well as the southern half of Sonoma County and the southwestern portion of Solano County. The unifying feature of the basin is the San Francisco Bay, which is oriented north-south and covers about 400 square miles (sq mi) (1,036 square kilometers [sq km]) of the area's total 5,545 sq mi (14,361 sq km). Approximately 20% of California's population resides in this air basin. The area is surrounded by hills, but low passes and the Sacramento–San Joaquin River Delta, which extends to the San Francisco Bay, allow some air pollutant transport to the Central Valley.

Pollution sources in the basin account for about 16% of the total statewide criteria pollutant emissions. The basin is classified as follows: maintenance for CO, attainment for PM2.5, unclassified for PM10, and marginal nonattainment for ozone.

Emissions of O_3 precursors (NO_x and TOG) have decreased since 1975 and are projected to continue declining through 2010. This is the result of strict motor vehicle controls that have reduced emissions from mobile sources of these pollutants. Stationary source emissions of TOG have declined over the last 20 years because of new controls on oil refinery fugitive emissions and new rules for control of TOG from various industrial coatings and solvent operations.

PM10 emissions are predicted to increase through 2010. This increase is due to growth in emissions from area-wide sources, primarily fugitive dust sources. Mobile source emissions from diesel motor vehicles have been decreasing since 1990 even though population and VMT have been growing. This is due to stringent emission standards.

CO emissions have been declining in the basin over the last 25 years, and this trend is expected to continue. Motor vehicles and other mobile sources are the largest sources of CO emissions in the air basin. Due to stringent controls measures, CO emissions from motor vehicles have been declining.

Sacramento Valley Air Basin

The Sacramento Valley Air Basin encompasses the northern portion of the Central Valley. The air basin includes the counties of Butte, Colusa, Glenn, Sacramento, Shasta, Sutter, Tehama, Yolo, and Yuba, along with the western urbanized portion of Placer County and the eastern portion of Solano County. The basin covers more than 15,000 sq mi (38,850 sq km) and accounts for approximately 6% of the state's population. It is the fifth-most-populated air basin in California.

Portions of the basin are classified as follows: maintenance for CO, attainment for PM2.5, unclassified and moderate attainment for PM10, and unclassified/attainment and serious nonattainment for ozone.

Population in the air basin grew between 1981 and 2000 by 51%, a rate higher than the 39% increase statewide. VMT increased by 95%, slightly higher than the 91% increase statewide. However, emissions of the O_3 precursors, NO_x and TOG, have decreased since 1990 and are projected to continue declining through 2010 because of more stringent mobile source emission standards and cleaner-burning fuels. TOG levels have also declined because of new rules controlling various industrial coating and solvent operations.

While emission levels of O_3 precursors are decreasing, peak O_3 values in the Sacramento Valley Air Basin have not declined as quickly as in other urban areas. Additional emission controls will be needed to bring the area into attainment for the state and national ozone standards.

Direct emissions of PM10 are increasing in the basin. This increase is due to growth in emissions from area-wide sources, primarily fugitive dust from paved and unpaved roads, construction and demolition, and residential fuel combustion. These area-wide emission sources have increased because of population growth and increased VMT.

CO emissions are declining in the basin. With new stringent emission standards, CO emissions from motor vehicles have declined. Stationary and area-wide source CO emissions have remained relatively steady, with additional emission controls offsetting growth. These controls will help keep the area in attainment for both the state and national CO standards.

San Joaquin Valley Air Basin

The San Joaquin Valley Air Basin encompasses the southern two-thirds of California's Central Valley. The counties in this basin include Fresno, Kings, Madera, Merced, San Joaquin, Stanislaus, Tulare, and the western portion of Kern. The basin spreads across 25,000 sq mi (64,750 sq km). The basin is mostly flat and unbroken with most of the area below 400 ft (122 m) elevation. The San Joaquin River runs along the western side of the basin from south to north. The San Joaquin Valley has cool wet winters and hot dry summers. Generally the temperature increases and rainfall decreases from north to south.

Air quality is not dominated by emissions from one large urban area in this basin. Instead, there are a number of moderately sized urban areas spread along the main axis of the valley. Approximately 9% of the state's population lives in the San Joaquin Valley. Pollution sources in the region account for about 14% of the total statewide criteria pollutant emissions.

The basin is classified as follows: maintenance for CO, nonattainment for PM2.5, serious nonattainment for PM10, and serious nonattainment for ozone.

The population in the San Joaquin Valley Air Basin increased by 56% from 1981 to 2000. This is a much higher rate than the statewide average of 39%. During the same time period, the daily VMT increased by 136%, again much higher than the overall statewide average of 91%. Overall, except for PM10, the emission levels in the San Joaquin Valley Air Basin have been decreasing since 1990. The rate of improvement, however, has not been the same as for other air basins. This is due mainly to the large growth rates this area has experienced.

Emissions of the O_3 precursors, NO_x and TOG, are decreasing in the air basin. NO_x emissions have decreased by approximately 24% since 1985, and are predicted to decrease another 26% by 2010. ROG emissions have decreased by approximately 48% since 1985. They are predicted to decrease another 11% by 2010. These reductions have resulted from more stringent mobile and stationary source emission controls and standards. The basin has shown less improvement than other areas due in large part to the growth rates in population and VMT.

Direct emissions of PM10 have been increasing in the air basin and are expected to continue increasing. This increase is due to growth in emissions from area-wide sources, primarily fugitive dust from vehicle travel on unpaved and paved roads, waste burning, and residential fuel combustion. These increases are a direct result of the large growth in population and VMT. Mobile sources (emissions directly emitted from motor vehicles) are predicted to decrease through 2010 because of new diesel standards.

CO emissions have been trending downward since 1985 and are expect to continue downward through 2010. Motor vehicles are the largest source of CO emissions in the air basin. Emissions from motor vehicles have been declining since 1985, despite increased VMT. This is due to stringent emission control measures and standards.

Mojave Desert Air Basin

The Mojave Desert Air Basin is located in the southeastern section of California. It is bordered on the south by the Salton Sea Air Basin, on the west by the South Coast and the San Joaquin Valley Air Basins, on the north by the Great Basin Valleys Air Basin, and on the east by the states of Nevada and Arizona. It encompasses the high desert region of San Bernardino County and the desert portions of Kern and Los Angeles Counties. With an area in excess of 25,950 sq mi (67,210 sq km), it is the second largest of California's air basins and accommodates approximately 2.5% of the state population. Air quality is dominated by emissions from urban areas in the western portions of the basin and from transported emissions from the large urban areas to the south and west.

Communities such as Hesperia and Phelan, which are in close proximity to the Cajon Pass, historically experience the highest O_3 levels in the basin. This is due to pollutants funneled into the high desert through the pass from Los Angeles and the San Bernardino Valley. These pollutants are dispersed as they are blown inland. Locally generated O_3 precursor emissions of NO_x and ROG also contribute to the high O_3 levels that affect the basin. Emission controls, mainly for exhaust emissions, have resulted in reductions in NO_x, ROG, and CO levels. Emissions of the O_3 precursors NO_x and ROG have been trending downward since 1990, as have been CO emissions. PM10 emissions in the basin, however, continue to rise as the volume of vehicles on unpaved roads and off road increases.

Portions of the basin are classified as follows: unclassified/attainment for CO, attainment for PM2.5, moderate attainment for PM10, and unclassified/attainment and moderate nonattainment for ozone.

South Coast Air Basin

The South Coast Air Basin encompasses 6,729 sq mi (17,428 sq km). It includes California's largest metropolitan region: all of Orange County, the western highly urbanized portions of San Bernardino and Riverside Counties, and the southern two-thirds of Los Angeles County. It accommodates a population of 14.9 million, or more than 40% of California's population, and is the most populous air basin in the state. About 30% of the state's total criteria pollutant emissions are generated in the basin. The basin is generally a lowland plain bounded by the Pacific Ocean on the west and by mountains on the other three sides.

The population in the South Coast Air Basin grew at high rates from 1981 to 2000, increasing 34% from 11.1 million in 1981 to 14.9 in 2000. Daily VMT increased about 84% during that same period. While high growth rates are generally associated with increased emissions, the implemented control programs in the basin have resulted in emission decreases.

The warm weather associated with predominantly high-pressure systems in the basin is conducive to the formation of O_3. The surrounding mountains help cause frequent low inversion heights and stagnant air conditions. These factors combine to trap pollutants in the air basin, and resulting concentrations are among the highest in the state. Aggressive emission controls have resulted in a downward trend in O_3 levels.

The basin is classified as follows: serious nonattainment for CO, nonattainment for PM2.5, serious nonattainment for PM10, and serious nonattainment for ozone.

NO_x emissions in the basin fell by about 38% from 1985 to 2000 and are forecasted to continue that trend to 2010. ROG emissions remained relatively flat from 1975 to 1985. Between 1985 and 2000 they decreased by approximately 60%. ROG emissions are predicted to decrease another 40% by 2010. Emissions of CO in the South Coast Air Basin have been trending downward since 1975, even though VMT has increased and industry activity has grown.

Direct emissions of PM10 have increased in the South Coast Air Basin since 1975. The increase is attributed to emissions from area-wide sources such as fugitive dust from paved and unpaved roads. Growth in activity of the area-wide sources reflects the increased population growth and VMT in the basin. PM10 continues to be a problem in the South Coast Air Basin, which is designated as nonattainment for both the state and national ambient air quality standards. More controls specific to PM10 will be needed to reach attainment.

San Diego Air Basin

The San Diego Air Basin is located in the southwestern corner of California and comprises all of San Diego County. It is bounded on the south by Mexico, on the west by the Pacific Ocean, on the north by Orange and Riverside Counties, and on the east by Imperial County. Its 4,260-sq-mi (11,033-sq-km) area accommodates a population of 2.9 million, or 8% of the state's population, and produces about 7% of the state's criteria pollutant emissions.

In the last 20 years, the San Diego Air Basin has experienced one of the highest population growth rates of the state's urban areas. Population grew from more than 1.9 million in 1981 to 2.9 million in 2000. VMT more than doubled during that same period from 35 million to approximately 74 million mi (56 million to 119 million km). Despite this growth trend, the overall air quality of the basin has improved, reflecting the benefits of cleaner technology.

Much of the San Diego Air Basin has a relatively mild climate due to its southern location and proximity to the ocean. The majority of the population is concentrated in the western portion of the basin, and the emissions are concentrated there. The basin is impacted by locally produced emissions as well as pollutants transported from other areas. O_3 and O_3 precursor emissions are transported from the South Coast Air Basin and Mexico. Implemented controls have resulted in a downward trend in O_3 levels and reductions in emissions from its precursors NO_x and TOG in the basin. However, O_3 levels continue to pose problems because exceedances of the state and national ambient air quality standards persist.

CO concentrations in the San Diego Air Basin decreased approximately 56% from 1981 to 2000. As a result, the national CO standards have not been exceeded since 1989, and the state standard has not been exceeded since 1990. The basin will likely maintain its attainment status for both national and state standards by continuing the enforcement of the stringent motor vehicle regulations currently in place.

Direct emissions of PM10 in the San Diego Air Basin increased 69% from 1975 to 2000, and the forecast is for a continued increase at a rate of approximately 7% to 2010. Growth in area-wide source emissions, mainly fugitive dust from vehicles on paved and unpaved roads, dust from construction and demolition operations, and particulates from residential fuel combustion are mainly responsible for this increase. The growth in these area-wide sources primarily derives from the increase in population and VMT in the basin.

The basin is classified as follows: maintenance for CO, attainment for PM2.5, unclassified for PM10, and nonattainment for ozone.

3.3.3 Environmental Consequences

A. EXISTING CONDITIONS COMPARED TO NO PROJECT ALTERNATIVE

Pollutant burden levels of CO, NO_x, and TOG are predicted to decrease statewide through 2020 compared to 2002 levels (Figure 3.3-2). This decrease is due to the implementation of stringent standards, control measures, and state-of-the-art emission control technologies. Emissions per vehicle are dropping significantly in California as a result of CARB's clean vehicle and clean fuel programs. Consequently, motor vehicle emissions are declining overall despite an increase in VMT. The low emission vehicle (LEV) and LEVII regulations adopted in 1990 and 1998, respectively, require a declining average fleet emission rate for new cars, pickup trucks, and medium-duty vehicles (including sport utility vehicles). These regulations, which are being implemented between 1994 and 2010, are expected to result in about a 90% decline in new vehicle emissions. Similar emission reductions are occurring in the heavy-duty diesel truck fleet as progressively lower emission standards for new trucks are introduced. The next phase of tighter diesel truck standards, scheduled to be implemented between 2007 and 2010, is expected to produce an overall reduction of 98% from uncontrolled engine emissions.

According to CARB pollutant burden projections, emissions of PM10 are expected to increase statewide for the No Project Alternative compared to existing conditions. The upward trend in PM10 emissions is primarily due to increased emissions from area-wide sources, including dust from increased VMT on unpaved and paved roads. PM10 emissions from stationary sources are also expected to increase slightly in the future because of industrial growth.

CO_2 levels for 2002 are not currently available. In the November 2002 report "Inventory of California Greenhouse Gas Emissions and Sinks: 1990–1999," by the California Energy Commission, 1999 CO_2 emissions are estimated at 362.8 million metric tons. This estimate is not broken down by source type; therefore a direct comparison to No Project, which includes only on-road mobile, planes, trains, and electric power sources, cannot be made.

The percentage of each pollutant source that may be affected by the proposed alternatives is shown in Figure 3.3-3. Of the four sources of concern shown in the figure, on-road mobile is the largest single contributor for all the pollutants. For CO, on-road mobile sources would contribute 32% of the statewide total; for NO_x on-road mobile sources would contribute 24% of the statewide total. By detailing the potential overall contribution to statewide pollution levels of each of these sources, the relationship between changes in sources and overall pollution concentrations becomes clearer.

B. NO PROJECT ALTERNATIVE COMPARED TO MODAL AND HIGH–SPEED TRAIN ALTERNATIVES

No Project Alternative Compared to Modal Alternative (Sensitivity Analysis Variations in Ridership Forecast)

Roadways: The highway component of the Modal Alternative would add approximately 2,970 lane mi (4,780 km) to the highway system. According to the analysis in Chapter 5 addressing economic growth effects, the added lanes of the Modal Alternative would result in approximately 1.1% more VMT in 2020 than the No Project Alternative in 2020. Therefore, the Modal Alternative is predicted to increase the amount of on-road mobile source regional pollutants by 1.1% compared to No Project (Table 3.3-4).

Air Travel: The same number of air trips would occur under both the No Project and Modal Alternatives. In the No Project Alternative these trips would be handled in an inefficient manner (i.e., more flights leaving at off-peak times). In the Modal Alternative these flights would be handled in a more efficient manner. Airport gates would need to be added, however, to efficiently handle the forecasted future demand (representative demand). The air travel component of the Modal Alternative is based on an estimated additional 91 airport gates required statewide to efficiently service the 34 million trips (68 million boarding/departing passengers) as defined for the Modal Alternative in Chapter 2. The additional gates would handle the trips projected for year 2020 more efficiently than No Project. Since additional gates would be built under the Modal Alternative to serve demand already projected under No Project, the Modal Alternative would generate no more LTOs than the No Project Alternative; therefore, no more airplane pollutant burdens would be generated as compared to the No Project Alternative. No Project and Modal Alternative plane emission burdens are shown in Table 3.3-5.

Train Travel and Electrical Power: Conventional rail service is not predicted to increase nor is additional electrical power predicted to be required under the Modal Alternative. Thus, the Modal Alternative would generate no more train or electrical power stationary pollutant burdens than No Project.

Table 3.3-4
On-Road Mobile Source Regional Analysis—No Project and Modal Alternatives

Air Basin	No Project VMT (Km) (2020) (in millions)	Modal VMT (Km) (2020) (in millions)	No Project Emission Burden in Tons (Metric Tons) / Day				Modal Alternative Emission Burden in Tons (Metric Tons) / Day				Incremental Change from No Project in Tons (Metric Tons) / Day and % Change from No Project			
			CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG
Sacramento Valley	84.079 (135.312)	85.004 (136.801)	187.28 (169.90)	3.79 (3.44)	35.85 (32.52)	26.12 (23.7)	189.34 (171.77)	3.83 (3.47)	36.24 (32.88)	26.41 (23.96)	2.06 (1.87) /1.1 %	0.04 (0.04) / 1.1%	0.39 (0.35) / 1.1%	0.28 (.25)/ 1.1 %
San Francisco Bay Area	213.901 (344.240)	216.253 (348.025)	522.13 (473.38)	10.71 (9.72)	101.30 (91.90)	66.81 (60.6)	527.87 (478.89)	10.83 (9.83)	102.41 (92.91)	67.54 (61.27)	5.74 (5.21)/ 1.1%	0.12 (0.11)/ 1.1%	1.11 (1.01)/ 1.1%	0.73 (0.66)/ 1.1%
San Joaquin	135.617 (218.254)	137.109 (220.656)	297.28 (269.69)	6.78 (6.15)	68.28 (61.94)	36.68 (33.3)	300.55 (272.66)	6.85 (6.21)	69.03 (62.62)	37.08 (33.64)	3.27 (2.97)/ 1.1%	0.07 (0.06)/ 1.1%	0.75 (0.68)/ 1.1%	0.4 (0.36)/ 1.1%
Mojave Desert	44.681 (71.907)	45.172 (72.697)	95.33 (86.48)	2.07 (1.88)	15.82 (14.35)	9.81 (8.9)	96.38 (87.44)	2.09 (1.90)	15.99 (14.51)	9.92 (8.99)	1.05 (0.95)/ 1.1%t	0.02 (0.02)/ 1.1%	0.17 (0.15)/ 1.1%	0.14 (0.13)/ 1.1%t
South Coast	402.116 (647.143)	406.539 (654.261)	944.92 (857.23)	19.57 (17.75)	180.01 (163.31)	121.67 (110.4)	955.31 (866.66)	19.79 (17.95)	181.99 (165.10)	123.01 (111.6)	10.39 (9.43)/ 1.1 %	0.22 (0.20)/ 1.1 %	1.98 (1.80)/ 1.1 %	1.34 (1.22)/ 1.1 %
San Diego County	97.542 (156.977)	98.614 (158.704)	224.86 (204.00)	4.77 (4.33)	41.48 (37.63)	28.45 (25.8)	227.33 (206.23)	4.82 (4.37)	41.94 (38.05)	28.76 (26.1)	2.47 (2.24)/ 1.1 %	0.05 (0.05)/ 1.1 %	0.46 (0.42)/ 1.1 %	0.31 (0.28)/ 1.1 %
Statewide (on-road mobile only)	1,109.510 (1,785.583)	1,099.637 (1,769.694)	2649.61 (2403.7)	53.58 (48.61)	515.11 (467.31)	341.44 (309.8)	2674.6 (2426.4)	54.1 (49.08)	519.98 (471.73)	344.62 (312.6)	24.99 (22.67) / 0.9 %	0.52 (0.47)/ 0.9 %	4.87 (4.42)/ 0.9 %	5.19 (4.7)/ 0.9 %

Table 3.3-5
Airplane Pollutant Burdens—No Project and Modal Alternatives

Air Basin	2020 Planes No Project Alternative in Tons (Metric Tons) / Day				2020 Burden per Flight in Tons (Metric Tons) / Day*				Number of Additional Planes for Modal Alternative	2020 Additional Burden Modal Alternative in Tons (Metric Tons) / Day				2020 Total Plane Burden Modal Alternative in Tons (Metric Tons) / Day			
	CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG		CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG
Sacramento Valley	19.35 (17.55)	0.16 (0.15)	2.45 (2.22)	2.50 (2.27)	0.024 (0.022)	.0001 (.00009)	.008 (.007)	.001 (.0009)	0	0.0	0.0	0.0	0.0	19.35 (17.6)	0.16 (0.15)	2.45 (2.2)	2.50 (2.3)
San Francisco Bay Area	54.46 (49.4)	2.66 (2.4)	28.60 (25.9)	14.59 (13.2)	0.024 (0.022)	.0001 (.00009)	.008 (.007)	.001 (.0009)	0	0.0	0.0	0.0	0.0	54.46 (49.4)	2.66 (2.41)	28.60 (25.9)	14.59 (13.2)
San Joaquin	76.98 (69.8)	0.45 (0.4)	4.29 (3.9)	15.96 (14.5)	0.024 (0.022)	.0001 (.00009)	.008 (.007)	.001 (.0009)	0	0.0	0.0	0.0	0.0	76.98 (69.8)	0.45 (0.41)	4.29 (3.9)	15.96 (14.5)
Mojave Desert	24.63 (22.3)	3.15 (2.9)	3.77 (3.4)	6.18 (5.6)	0.024 (0.022)	.0001 (.00009)	.008 (.007)	.001 (.0009)	0	0.0	0.0	0.0	0.0	24.63 (22.3)	3.15 (2.86)	3.77 (3.4)	6.18 (5.6)
South Coast	67.57 (61.3)	0.52 (0.5)	25.49 (23.1)	8.93 (8.1)	0.024 (0.022)	.0001 (.00009)	.008 (.007)	.001 (.0009)	0	0.0	0.0	0.0	0.0	67.57 (61.3)	0.52 (0.47)	25.49 (23.1)	8.93 (8.1)
San Diego County	19.65 (17.83)	1.69 (1.53)	8.42 (7.64)	3.81 (3.46)	0.024 (0.022)	.0001 (.00009)	.008 (.007)	.001 (.0009)	0	0.0	0.0	0.0	0.0	19.65 (17.8)	1.69 (1.53)	8.42 (7.6)	3.81 (3.5)
Statewide (on-road mobile only)	310.94 (282.1)	9.25 (8.4)	76.61 (69.5)	58.26 (52.9)	0.024 (0.022)	.0001 (.00009)	.008 (.007)	.001 (.0009)	0	0.0	0.0	0.0	0.0	310.94 (282.1)	9.25 (8.39)	76.61 (69.5)	58.26 (52.9)

* Flight emissions from FAA EDMS model. Flight emission information is for default 737 and associated ground support.

No Project Alternative Compared to High-Speed Train Alternative (Sensitivity Analysis Variations in Ridership Forecast)

The proposed HST Alternative (with sensitivity analysis forecasts) would have the capacity to accommodate an estimated 68 million annual trips that would otherwise use roadways and airports statewide. The highway component is based on potential VMT reductions resulting from 42.7 million annual trips. The air travel component is based on potential reductions from 25.3 million trips.

Roadways: The proposed HST Alternative could potentially take the place of a 42.7 million city-to-city annual trips using on-road mobile sources and would therefore potentially reduce VMT on the state highway system compared to the No Project and Modal Alternatives. Changes in VMT and estimated on-road mobile source emission reductions resulting from the use of the proposed HST have been calculated for each of the five air basins (Table 3.3-6). The highest on-road mobile source emission reductions are predicted for the San Joaquin Valley Air Basin. The HST Alternative is predicted to reduce the 2020 CARB CO mobile source emission budget for San Joaquin Valley Air Basin by about 3.3% or 9.8 tons (8.9 metric tons). The South Coast Air Basin would receive the next highest potential pollutant reductions (on-road mobile source only), followed by the San Francisco Bay Area, San Diego County, Sacramento Valley, and Mojave Desert Air Basins.

Air Travel: The air-travel component is based on 25.3 million trips (1 trip = 1 takeoff and 1 landing) being shifted from the airplane component of No Project future conditions to the proposed HST. The emission burden reductions projected from the reduced number of flights, shown in Table 3.3-7, was calculated by determining the number of flights that could be accommodated by the proposed HST and multiplying that number by the emission estimates of an average flight, as described above in the discussion of methods of evaluating impacts. The emission changes by air basin resulting from the reduced number of flights range from an estimated 17% reduction in NO_x in the Sacramento Valley Air Basin to no change in the Mojave Desert Air Basin. The South Coast Air Basin is projected to have the largest potential reductions, followed by San Francisco Bay Area, San Diego County, Sacramento Valley, and San Joaquin Valley Air Basins. No reductions would be expected in the Mojave Desert Air Basin.

Statewide, an estimated 99% reduction is predicted in the plane portion of the CO_2 budget estimated for the No Project Alternative. This is approximately 37% of the calculated CO_2 budget for the No Project. CO_2 calculations for No Project Alternative reflect only emissions from electrical power stations, planes, and a portion of on-road VMT. For the plane portion of CARB's projected 2020 emission burden budgets, an 8% reduction is predicted in NO_x, a 6% reduction is predicted in CO, a 2% reduction in TOG, and a 1% reduction in PM10.

Train Travel and Electrical Power: Conventional rail service is not predicted to increase under the proposed HST Alternative therefore no change in pollutant burdens is predicted due to train travel.

Additional electrical power would be required to operate the HST system. Because of the nature of electrical power generation and the use of a grid system to distribute electrical power, it is not yet clear which facilities would be supplying power to the HST system. Emission changes from power generation can therefore be predicted on a statewide level only. As shown in Table 3.3-8, CO, PM10, NO_x, and TOG burden levels would be predicted to increase because of the power requirements of the proposed HST Alternative. A 11.6% increase representing approximately 14 tons (13 metric tons) statewide daily is predicted in the electric utilities portion of the CO 2020 CARB emission burden projection. This increase would represent less than 0.2% of the overall CO budget for the State of California.

Summary of Pollutants by Alternative: Table 3.3-9 summarizes the combined source categories for the existing conditions and No Project, Modal, and HST (with sensitivity analysis forecasts) Alternatives. Compared to the No Project Alternative, the HST Alternative (with sensitivity analysis forecasts) is predicted to decrease the amount of pollutants statewide in all air basins analyzed. Potential air quality benefits range from medium to low. CO_2 levels are also detailed in Table 3.3-9. CO_2 burden levels were estimated based on energy projections developed for each alternative.

Local Impacts: A total of 508 local screenline locations were analyzed. The general trend in screenline data shows that the level of service in the vicinity of proposed HST station locations would degrade under the HST Alternative. Capacity improvements under the Modal Alternative would generally prevent degradation in level of service at the proposed station sites, but V/C ratios would increase slightly. A V/C ratio is the comparison of the roadway volume to roadway capacity. A V/C of 1.0 would indicate a roadway at capacity. As the alternatives are refined and more in-depth studies are undertaken in future analyses, intersections near proposed HST station locations and any location where volumes would likely increase and V/C ratios degrade should be screened to determine if more detailed local analyses should be conducted to insure that the project does not cause a violation of the ambient air quality standards.

Table 3.3-6
On-Road Mobile Source Regional Emissions Analysis—No Project Alternative and HST Sensitivity Analysis Alternative

Air Basin	No Project VMT (Km) 2020 (in millions)	HST Sensitivity Analysis Alt. VMT (Km) 2020 (in millions)	No Project Emission Burden in Tons (Metric Tons)/Day				HST Sensitivity Analysis Alternative Emission Burden in Tons (Metric Tons)/Day				Incremental Change from No Project in Tons (Metric Tons)/Day and % Reduction from No Project			
			CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG
Sacramento Valley	84.079 (135.312)	83.832 (134.914)	187.28 (169.90)	3.79 (3.44)	35.85 (32.52)	26.12 (23.7)	186.73 (169.40)	3.78 (3.43)	35.74 (32.42)	26.04 (23.6)	-0.55 (0.50)/ 0.29 %	-0.01 (0.01)/ 0.3 %	-0.11 (0.10)/ 0.3 %	-0.078 (0.07)/ 0.29 %
San Francisco Bay Area	213.901 (344.240)	212.734 (342.362)	522.13 (473.38)	10.71 (9.72)	101.30 (91.90)	66.81 (60.6)	519.28 (471.09)	10.65 (9.66)	100.75 (91.40)	66.45 (60.28)	-2.85 (2.56)/ 0.52 %	-0.06 (0.05)/ 0.5 %	-0.55 (0.50)/ 0.5 %	-0.37 (0.33)/ 0.55 %
San Joaquin	135.617 (218.254)	131.132 (211.037)	297.28 (269.69)	6.78 (6.15)	68.28 (61.94)	36.68 (33.3)	287.45 (260.78)	6.56 (5.95)	66.02 (58.89)	35.47 (32.18)	-9.83 (8.92)/ 3.3 %	-0.22 (0.20)/ 3.3 %	-2.26 (2.05)/ 3.3 %	-1.21 (1.10)/ 3.2 %
Mojave Desert	44.681 (71.907)	44.671 (71.891)	95.33 (86.48)	2.07 (1.88)	15.82 (14.35)	9.81 (8.9)	95.31 (86.47)	2.07 (1.88)	15.82 (14.35)	9.81 (8.90)	-0.02 (.02)/ 0.02 %	0.0 (0.0)/ 0.0 %	-.004 (.003)/ 0.0 %	-0.002 (0.002)/ 0.02 %
South Coast	402.116 (647.143)	398.682 (641.617)	944.92 (857.23)	19.57 (17.75)	180.01 (163.31)	121.67 (110.4)	936.85 (849.91)	19.40 (17.60)	178.47 (161.91)	120.63 (109.44)	-8.07 (7.32)/ 0.85 %	-0.17 (0.15)/ 0.9 %	-1.54 (1.40)/ 0.9 %	-1.04 (0.94)/ 0.85 %
San Diego County	97.542 (156.977)	97.013 (156.127)	224.86 (204.00)	4.77 (4.33)	41.48 (37.63)	28.45 (25.8)	223.64 (202.89)	4.74 (4.30)	41.25 (37.42)	28.30 (25.67)	-1.22 (1.11)/ 0.53 %	-0.03 (0.02)/ 0.5 %	-0.23 (0.20)/ 0.5 %	-0.154 (.14)/ 0.54 %
Statewide (on-road mobile only)	1,109.510 (1,785.583)	1,088.880 (1,752.382)	2649.61 (2403.7)	53.58 (48.61)	515.11 (467.31)	341.44 (309.8)	2,627.07 (2,383.29)	53.09 (48.16)	438.06 (397.4)	338.59 (307.17)	-22.54 (20.5)/ 0.85 %	-0.49 (0.44)/ 0.9 %	-4.68 (4.25)/ 0.9 %	-2.85 (2.59)/ 0.85 %

Table 3.3-7
Airplane Emission Burdens—No Project Alternative and HST Sensitivity Analysis Alternative

	2020 Airplanes—No Project in Tons (Metric Tons)/Day				2020 Emissions Burden per Flight in Tons (Metric Tons)/Day*				Number of Planes Removed	2020 Additional Emissions Burden—HST Sensitivity Analysis Alternative in Tons (Metric Tons)/Day				2020 Total Plane Emissions Burden—HST Sensitivity Analysis Alternative in Tons (Metric Tons)/ Day and % Change from No Project			
Air Basin	CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG		CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG
Sacramento Valley	19.35 (17.55)	0.16 (0.15)	2.45 (2.22)	2.50 (2.27)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	-52	-1.26 (-1.2)	-0.003 (-0.003)	-0.41 (-0.4)	-0.07 (-0.1)	18.09 (16.4)/ -7%	0.16 (0.2)/ -2%	2.05 (1.86)/ -17%	2.43 (2.20)/ -3%
San Francisco Bay Area	54.46 (49.41)	2.66 (2.41)	28.60 (25.95)	14.59 (13.24)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	-297	-7.22 (-6.5)	-0.018 (-0.02)	-2.31 (-2.1)	-0.38 (-0.4)	47.24 (42.8)/ -13%	2.64 (2.4)/ -1%	26.29 (23.9)/ -8%	14.21 (12.9)/ -3%
San Joaquin	76.98 (69.84)	0.45 (0.41)	4.29 (3.89)	15.96 (14.48)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	-15	-0.37 (-0.4)	-0.001 (-0.001)	-0.12 (-0.1)	0.02 (.02)	76.62 (69.5)/ 0%	0.45 (0.4)/ 0%	4.17 (3.8)/ -3%	15.94 (14.4)/ 0%
Mojave Desert	24.63 (22.34)	3.15 (2.86)	3.77 (3.42)	6.18 (5.61)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	0	0.0	0.0	0.0	0.0	24.60 (22.3)/ 0%	3.15 (2.9)/ 0%	3.77 (3.42)/ 0%	6.18 (5.61)/ 0%
South Coast	67.57 (61.30)	0.52 (0.47)	25.49 (23.12)	8.93 (8.10)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	-305	-7.42 (-6.7)	-0.018 (-0.02)	-2.37 (-2.2)	-0.39 (-0.4)	60.16 (54.6)/ -11%	0.50 (0.5)/ -4%	23.12 (21.0/ -9%	8.54 (7.75)/ -4%
San Diego County	19.65 (17.83)	1.69 (1.53)	8.42 (7.64)	3.81 (3.46)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	-102	-2.48 (-2.25)	-0.006 (-0.005)	-0.79 (-0.72)	-0.13 (-0.1)	17.17 (15.6)/ -13%	1.68 (1.5)/ 0%	7.63 (6.9)/ -9%	3.68 (3.3)/ -3%
Statewide (on-road mobile only)	310.94 (282.09)	9.25 (8.39)	76.61(6 9.50)	58.26 (52.85)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	-771	-18.74 (-17.0)	-0.05 (-0.04)	-6.0 (-5.4)	-0.98 (-0.9)	292.2 (265.1)/ -6%	9.20 (8.4)/ -1%	70.61 (64.1)/ -8%	57.28 (51.9)/ -2%

Table 3.3-8
Electrical Power Station Emissions—No Project Alternative and HST Sensitivity Analysis Alternative

	No Project Emission Burden—Electric in Tons (Metric Tons) / Day				HST Sensitivity Analysis Alternative Emission Burden—Electric in Tons (Metric Tons) / Day				Incremental Change from No Project in Tons (Metric Tons) / Day and % Change from No Project			
Air Basin	CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG
Statewide	120.1 (109.)	10.5 (9.6)	71.9 (65.3)	36.8 (33.4)	134.1 (121.7)	10.6 (9.6)	72.1 (65.4)	37.9 (34.4)	14. (12.7)/ 11.6 %	0.02 (.02)/ 0.19 %	0.14 (.13)/ 0.19 %	1.09 (.99)/ 2.96 %

Table 3.3-9
Potential Impacts on Air Quality Statewide—Existing, No Project, Modal, and HST Sensitivity Analysis Alternatives

	Sacramento Valley Air Basin	San Francisco Bay Area Air Basin	San Joaquin Valley Air Basin	Mojave Desert Air Basin	South Coast Air Basin	San Diego County Air Basin	Statewide
Existing (2002) on-road mobile, trains, planes, and electrical utilities* emission burdens in tons (metric tons)/day							
CO	726.8 (659.35)	1,841.27 (1,670.4))	1,142.85 (1,036.8)	339.47 (307.9)	3,468.44 (3,146.5)	795.49 (721.7)	9,726.42 (8,823.8)
PM10	4.24 (3.8)	12.14 (10.9)	7.0 (6.4)	5.12 (4.6	19.74 (17.9)	6.19 (5.6)	66.29 (60.14)
O_3 precursor—NO_x	153.93 (139.6)	360.42 (326.9)	245.74 (222.93)	80.49 (72.9)	691.62 (627.43)	142.63 (129.39)	1,978.6 (1,795.00)
O_3 precursor—TOG	83.63 (75.8)	211.69 (192.0)	126.1 (114.4)	36.57 (33.2)	379.26 (344.1)	85.24 (77.3)	1,109.06 (1,006.1)
No project on-road mobile, trains, planes, and electrical utilities* emission burdens in tons (metric tons)/day							
CO	208.62 (189.26)	578.00 (524.36)	376.75 (341.79)	126.32 (114.60)	1,017.37 (922.96)	244.70 (221.99)	3,101.17 (2,813.39)
PM10	4.20 (3.81)	13.50 (12.2)	7.46 (6.77)	5.68 (5.15)	20.59 (18.7)	6.49 (5.89)	75.37 (68.4)
O_3 precursor—NO_x	46.24 (41.95)	134.58 (122.10)	80.78 (73.28)	33.99 (30.84)	217.91 (197.7)	50.77 (46.06)	722.97 (655.9)
O_3 precursor—TOG	29.06 (26.36)	81.72 (74.14)	53.21 (48.27)	17.54 (15.91)	131.83 (119.6)	32.31 (29.31)	466.24 (423)
CO_2	N/A	N/A	N/A	N/A	N/A	N/A	1,438,816.9 (1,305,272.7)
Modal Alternative (2020) burden in tons (metric tons)/day and % change in CO, PM10, NO_x, TOG, CO_2 emission burdens compared to No Project							
CO	210.68 (191.13)/ 0.99 %	583.74 (529.6)/ 0.99 %	380.0 (344.7)/ 0.87 %	127.4 (115.6)/ 0.83 %	1,027.8(932.9)/ 1.02 %	247.2 (224.2)/ 1.01 %	3,126.2 (2,836.1)/ 0.81 %
PM10	4.24 (3.85)/ 0.99 %	13.62 (12.4)/ 0.87 %	7.53 (6.84)/ 1.00 %	5.70 (5.17)/ 0.40 %	20.81 (18.9) / 1.05 %	6.54 (5.94) / 0.81 %	75.89 (68.9) / 0.70 %
O_3 precursor—NO_x	46.63 (42.31) / 0.85 %	135.69 (123.1) / 0.83 %	81.53 (73.97) / 0.93 %	34.16 (30.99) / 0.51 %	219.89 (199.5) / 0.91 %	51.23 (46.47) / 0.90 %	727.8 (660.3) / 0.67 %
O_3 precursor—TOG	29.35 (26.62) / 0.99 %	82.45 (74.8) / 0.90 %	53.61 (48.64) / 0.76 %	17.65 (16.01) / 0.62 %	133.2 (120.8) / 1.02 %	32.62 (29.6) / 0.97 %	469.4 (425.9) / 0.68 %
CO_2	N/A	N/A	N/A	N/A	N/A	N/A	1,439,163.08 (1,305,586.78) / 0.00 %

	Sacramento Valley Air Basin	San Francisco Bay Area Air Basin	San Joaquin Valley Air Basin	Mojave Desert Air Basin	South Coast Air Basin	San Diego County Air Basin	Statewide
Potential Modal Impacts*							
CO	Medium -	Medium -	Medium -	Medium -	Medium -	Medium -	Medium -
PM10	Low -	Low -	Low -	Low -	Medium -	Low -	Medium -
NO_x	Medium -	Medium -	Medium -	Low -	Medium -	Medium -	Medium -
TOG	Medium -	Medium -	Medium -	Low -	Medium -	Medium -	Medium -
CO_2	Medium -	Medium -	Medium -	Medium -	Medium -	Medium -	Medium -
HST Alternative (2020) burden in tons (metric tons) and % change in CO, PM10, NO_x, TOG, CO_2 emission burdens compared to No Project							
CO	206.81 (187.62) / -0.87 %	567.93 (515.23) / -1.74 %	366.55 (332.54) / -2.71 %	126.30 (114.58) / -0.02 %	1,001.89 (908.91) / -1.52 %	241.00 (218.64) / -1.51 %	3,073.86 (2,788.62) / -0.88 %
PM10	4.19 (3.8) / -0.34 %	13.42 (12.2) / -0.56 %	7.23 (6.56) / -3.02 %	5.68 (5.15) / -0.01 %	20.40 (18.5) / -0.90 %	6.46 (5.86) / -0.49 %	74.86 (67.9) / -0.68 %
O_3 precursor—NO_x	45.73 (41.49) / -1.10 %	131.7 (119.5) / -2.13 %	78.41 (71.13) / -2.94 %	33.99 (30.83) / -0.01 %	214.0 (194.1) / -1.79 %	49.75 (54.13) / -2.01 %	712.4 (646.3) / -1.46 %
O_3 precursor—TOG	28.92 (26.23) / -0.49 %	80.98 (73.46) / -0.91 %	51.98 (47.15) / -2.32 %	17.54 (15.91) / -0.01 %	130.4 (118.3) / -1.08 %	32.03 (29.05) / -0.88 %	463.5 (420.5) / -0.59 %
CO_2	N/A	N/A	N/A	N/A	N/A	N/A	1,418,265.15 / -1.43 %
Potential HST Regional Impacts*							
CO	Medium +	Medium +	Medium +	Low +	Medium +	Medium +	Medium +
PM10	Low +	Low +	Low +	Low +	Low +	Low +	Medium +
NO_x	Medium +	Medium +	Medium +	Low +	Medium +	Medium +	Medium +
TOG	Medium +	Medium +	Medium +	Low +	Medium +	Medium +	Medium +
CO_2	N/A	N/A	N/A	N/A	N/A	N/A	Low +

	Sacramento Valley Air Basin	San Francisco Bay Area Air Basin	San Joaquin Valley Air Basin	Mojave Desert Air Basin	South Coast Air Basin	San Diego County Air Basin	Statewide

Notes:

Potential impacts determined using threshold levels and attainment status detailed in Section 3.3.1.

+ = Benefit to air quality.

- = Deterioration in air quality.

N/A = Not Applicable.

CO_2 is analyzed only on a statewide level.

* Emission burdens from electrical utilities are included only in the statewide totals. CO_2 burdens do not include train emissions.

No Project Alternative Compared to High-Speed Train Alternative (Investment-Grade Ridership Forecasts)

The proposed HST Alternative, using investment-grade ridership forecasts, would potentially accommodate an estimated 42 million annual trips, which would otherwise use roadways and airports statewide. The highway component is based on potential VMT reductions from 26.6 million annual trips. The air-travel component is based on 15.4 million trips.

Roadways: The proposed HST Alternative (using investment-grade ridership forecasts) would accommodate city-to-city trips, reducing VMT on the state highway system compared to the No Project and Modal Alternatives. Changes in VMT and on-road mobile source emission burdens have been calculated for each potentially affected air basin (Table 3.3-10) resulting from the estimated 26.6 million vehicle trips that would use the proposed HST Alternative. The highest on-road mobile source emission burden reductions are projected for the San Joaquin Valley Air Basin. The proposed HST system is predicted to reduce the 2020 CARB CO mobile source emissions for the San Joaquin Valley Air Basin by approximately 1.6% or 4.75 tons (4.31metric tons) daily. The South Coast Air Basin would have the next highest predicted pollutant burden reductions (on-road mobile source only), followed by the San Francisco Bay Area, San Diego County, Sacramento Valley, and Mojave Desert Air Basins.

Air Travel: The HST Alternative would replace city-to-city trips using off-road mobile (air) travel modes. The air-travel component is based on 15.4 million trips (1 trip = 1 takeoff and 1 landing) from the airplane component of No Project conditions. The emissions projected to be saved from the reduced flights, shown in Table 3.3-11, were calculated by determining the number of flights that could be reduced by the proposed HST and multiplying that number by the emission estimates for an average flight, as described above in the discussion of methods of evaluating impacts. The emission burdens by air basin calculated for the reduced flights would range from a 10% reduction in NO_x for the Sacramento Valley Air Basin to no change in the Mojave Desert Air Basin. The South Coast Air Basin is projected to have the largest burden reductions, followed by San Francisco Bay Area, San Diego County, Sacramento Valley, and San Joaquin Valley Air Basins. No reductions would be expected in the Mojave Desert Air Basin.

Statewide, a 60% reduction is projected in the plane portion of the CO_2 budget estimated for No Project. This reduction would be approximately 23% of the calculated CO_2 budget for the No Project Alternative. CO_2 calculations for the No Project Alternative reflect only emissions from electrical power stations, planes, and a portion of on-road VMT. For the plane portion of CARB's projected 2020 emission budgets, a 5% reduction is projected in NO_x; a 4% reduction is predicted in CO; a 1% reduction in TOG; and a reduction of less than 1% in PM10.

Train Travel and Electrical Power: Conventional rail service is not predicted to increase under the proposed HST Alternative.

Additional electrical power would be required to operate the proposed HST system. Because of the nature of electrical power generation and the use of a grid system to distribute electrical power, it is not yet clear which facilities would be supplying power to the proposed HST system. Emission changes from power generation can therefore be predicted on a statewide level only. As shown in Table 3.3-12, CO, PM10, NO_x, and TOG burden levels are predicted to increase statewide because of the power requirements of the HST. A 9.9% increase in emissions representing approximately 12 tons (11 metric tons) daily is predicted in the electric utilities portion of the CO 2020 CARB emission projection. This increase would represent less than 0.2% of the overall CO budget for the State of California.

Table 3.3-10
On-Road Mobile Source Emission Regional Analysis—No Project Alternative and HST Investment-Grade Ridership Forecast Alternative

	No Project VMT (Km) 2020 (in millions)	HST Investment -Grade Ridership Forecast Alt. VMT (Km) 2020 (in millions)	No Project Emission Burden in Tons (Metric Tons)/Day				HST Investment-Grade Ridership Forecast Alternative Emission Burden in Tons (Metric Tons)/Day				Incremental Change from No Project in Tons (Metric Tons)/Day and % Reduction from No Project			
Air Basin			CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG
Sacramento Valley	84.079 (135.312)	83.948 (135.101)	187.28 (169.90)	3.79 (3.44)	35.85 (32.52)	26.12 (23.7)	186.99 (169.64)	3.78 (3.43)	35.79 (32.47)	26.08 (23.66)	-0.29 (0.26) / -0.2 %	-0.01 (0.01) / -0.2 %	-0.06 (0.05) / -0.2 %	-0.04 (0.04) / -0.2 %
San Francisco Bay Area	213.901 (344.240)	213.215 (343.136)	522.13 (473.38)	10.71 (9.72)	101.30 (91.90)	66.81 (60.6)	520.45 (472.16)	10.68 (9.68)	100.97 (91.60)	66.60 (60.42)	-1.68 (1.52) / -0.3 %	-0.03 (0.03) / -0.3 %	-0.33 (0.29) / -0.3 %	-0.21 (0.19) / -0.3 %
San Joaquin Valley	135.617 (218.254)	133.449 (214.765)	297.28 (269.69)	6.78 (6.15)	68.28 (61.94)	36.68 (33.3)	292.53 (265.38)	6.67 (6.05)	67.19 (60.95)	36.09 (32.74)	-4.75 (4.31) / -1.6 %	-.11 (0.10) / -1.6 %	-1.09 (0.99) / -1.6 %	-0.59 (0.53) / -1.6 %
Mojave Desert	44.681 (71.907)	44.673 (71.894)	95.33 (86.48)	2.07 (1.88)	15.82 (14.35)	9.81 (8.9)	95.31 (86.47)	2.07 (1.88)	15.82 (14.35)	9.81 (8.90)	-0.02 (0.02) / 0.0 %	0.00 (0.00) / 0.0 %	0.00 (0.00) / 0.0 %	-0.002 (0.002) / 0.0 %
South Coast	402.116 (647.143)	399.899 (643.575)	944.92 (857.23)	19.57 (17.8)	180.01 (163.3)	121.67 (110.4)	939.71 (852.51)	19.46 (17.66)	179.02 (162.41)	121.00 (109.8)	-5.21 (4.73) / -0.6 %	-0.11 (0.10) / -0.6 %	-0.99 (0.90) / -0.6 %	-0.67 (0.61) / -0.6 %
San Diego County	97.542 (156.977)	97.279 (156.555)	224.86 (204.00)	4.77 (4.33)	41.48 (37.63)	28.45 (25.8)	224.25 (203.44)	4.76 (4.32)	41.37 (37.53)	28.37 (25.74)	-0.61 (0.55) / -0.3 %	-0.01 (0.01) / -0.3 %	-0.11 (0.10) / -0.3 %	-0.67 (0.61) / -0.6 %
Statewide (on-road mobile only)	1,109.510 (1,785.583)	1,104.036 (1,776.774)	2649.61 (2403.7)	53.58 (48.6)	515.11 (467.3)	341.44 (309.8)	2637.06 (2,392.3)	53.31 (48.3)	512.53 (464.97)	339.85 (308.3)	-12.55 (11.39) / -0.5 %	-0.27 (0.24) / -0.5 %	-2.58 (2.34) / -0.5 %	-1.59 (1.44) / -0.5 %

Table 3.3-11
Airplane Emission Burdens—No Project Alternative and HST Investment-Grade Ridership Forecast Alternative

	2020 Planes—No Project in Tons (Metric Tons)/Day				2020 Emission Burden per Flight in Tons (Metric Tons)/Day*				# of Planes Removed by HST Invest-ment Grade Rider-ship Forecast Alt.	2020 Additional Emission Burden—HST Investment-Grade Ridership Forecast Alternative in Tons (Metric Tons)/Day				2020 Total Plane Emissions Burden—HST Investment-Grade Ridership Forecast Alternative in Tons (Metric Tons)/Day and % Change from No Project			
Air Basin	**CO**	**PM10**	**NO_x**	**TOG**	**CO**	**PM10**	**NO_x**	**TOG**		**CO**	**PM10**	**NO_x**	**TOG**	**CO**	**PM10**	**NO_x**	**TOG**
Sacramento Valley	19.35 (17.55)	0.16 (0.15)	2.45 (2.22)	2.50 (2.27)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	31	-0.75 (-0.68)	-0.002 (-0.002)	-0.241 (-0.219)	-0.039 (-0.035)	18.596 (16.87)/ -4 %	0.16 (0.14)/ -1 %	2.21 (2.000)/ -10 %	2.46(2.23)/ -2 %
San Francisco Bay Area	54.46 (49.41)	2.66 (2.41)	28.60 (25.95)	14.59 (13.24)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	181	-4.4 (-4.0)	-0.011 (-0.010)	-1.408 (-1.277)	-0.230 (-0.209)	50.06 (45.41)/ -8 %	2.65 (2.40)/ 0 %	27.192 (24.67)/ -5 %	14.36 (13.03)/ -2 %
San Joaquin Valley	76.98 (69.84)	0.45 (0.41)	4.29 (3.89)	15.96 (14.48)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	9	-0.219 (-0.199)	-0.001 (-0.001)	-0.070 (-0.064)	-0.011 (-0.010)	76.76 (69.64)/ 0 %	0.45 (0.41)/ 0 %	4.220 (3.83)/ -2 %	15.95 (14.47)/ 0 %
Mojave Desert	24.63 (22.34)	3.15 (2.86)	3.77 (3.42)	6.18 (5.61)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	0	0.00	0.00	0.00	0.00	24.63 (22.34)/ 0 %	3.15 (2.86)/ 0 %	3.77 (3.42)/ 0 %	6.18 (5.61)/ 0 %
South Coast	67.57 (61.30)	0.52 (0.47)	25.49 (23.12)	8.93 (8.10)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	186	-4.522 (-4.102)	-0.011 (-0.010)	-1.447 (-1.313)	-0.236 (-0.214)	63.05 (57.20)/ -7 %	0.51 (0.46)/ -2 %	24.04 (21.81)/ -6 %	8.69 (7.89)/ -3 %
San Diego County	19.65 (17.83)	1.69 (1.53)	8.42 (7.64)	3.81 (3.46)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	62	-1.507 (-1.367)	-0.004 (-0.004)	-0.482 (-0.437)	-0.079 (-0.072)	18.14 (16.46)/ -8 %	1.69 (1.53)/ 0 %	7.94 (7.20)/ -6 %	3.73 (3.39)/ -2 %
Statewide (on-road mobile only)	310.94 (282.09)	9.25 (8.39)	76.61 (69.50)	58.26 (52.85)	0.024 (0.022)	.0001 (.0001)	.008 (.007)	.001 (.0009)	469	-11.40 (-10.34)	-0.028 (-0.025)	-3.649 (-3.310)	-0.596 (-0.541)	299.54 (271.74)/ -4 %	9.22 (8.37)/ 0 %	72.96 (66.19)/ -4 %	57.66 (52.31)/ -1 %

Table 3.3-12
Electrical Power—No Project Alternative and HST Investment-Grade Ridership Forecast Alternative

	No Project Emission Burden—Electric in Tons (Metric Tons)/Day				HST Investment-Grade Ridership Forecast Alternative Emission Burden—Electric in Tons (Metric Tons)/Day				Incremental Change from No Project in Tons (Metric Tons)/Day/Percent Change from No Project			
Air Basin	CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG	CO	PM10	NO_x	TOG
Statewide	120.1 (108.96)	10.53 (9.55)	71.92 (65.25)	36.79 (33.38)	132.0 (67.01)	10.5 (5.55)	72.0 (34.88)	37.7 (36.43)	11.88 (10.78)/9.9 %	0.02 (0.02)/ 0.16 %	0.12 (0.11)/ 0.16 %	1.93 (0.84)/ 2.51 %

Table 3.3-13
Potential Impacts on Air Quality Statewide—Existing, No Project, Modal, and HST Investment-Grade Ridership Alternatives

	Sacramento Valley Air Basin	San Francisco Bay Area Air Basin	San Joaquin Valley Air Basin	Mojave Desert Air Basin	South Coast Air Basin	San Diego Air Basin	Statewide
Existing (2002) on-road mobile, trains, planes, and electrical utilities* emission burdens in tons (metric tons)/day							
CO	726.8 (659.35)	1,841.27 (1,670.4))	1,142.85 (1,036.8)	339.47 (307.9)	3,468.44 (3,146.5)	795.49 (721.7)	9,726.42 (8,823.8)
PM10	4.24 (3.8)	12.14 (10.9)	7.0 (6.4)	5.12 (4.6	19.74 (17.9)	6.19 (5.6)	66.29 (60.14)
O_3 precursor—NO_x	153.93 (139.6)	360.42 (326.9)	245.74 (222.93)	80.49 (72.9)	691.62 (627.43)	142.63 (129.39)	1,978.6 (1,795.00)
O_3 precursor—TOG	83.63 (75.8)	211.69 (192.0)	126.1 (114.4)	36.57 (33.2)	379.26 (344.1)	85.24 (77.3)	1,109.06 (1,006.1)
No Project (2020) on-road mobile, trains, planes, and electrical utilities* emission burdens in tons (metric tons)/day							
CO	208.62 (189.26)	578.00 (524.36)	376.75 (341.79)	126.32 (114.60)	1,017.37 (922.96)	244.70 (221.99)	3,101.17 (2,813.39)
PM10	4.20 (3.81)	13.50 (12.2)	7.46 (6.77)	5.68 (5.15)	20.59 (18.7)	6.49 (5.89)	75.37 (68.4)
O_3 precursor—NO_x	46.24 (41.95)	134.58 (122.10)	80.78 (73.28)	33.99 (30.84)	217.91 (197.7)	50.77 (46.06)	722.97 (655.9)
O_3 precursor—TOG	29.06 (26.36)	81.72 (74.14)	53.21 (48.27)	17.54 (15.91)	131.83 (119.6)	32.31 (29.31)	466.24 (423)
CO_2	N/A	N/A	N/A	N/A	N/A	N/A	1,438,816.9 (1,305,272.7)
Modal Alternative (2020) burden in tons (metric tons)/day and % change in CO, PM10, NO_x, TOG, CO_2 emission burdens compared to No Project							
CO	210.68 (191.13)/ 0.99 %	583.74 (529.6)/ 0.99 %	380.0 (344.7)/ 0.87 %	127.4 (115.6)/ 0.83 %	1,027.8(932.9)/ 1.02 %	247.2 (224.2)/ 1.01 %	3,126.2 (2,836.1)/ 0.81 %
PM10	4.24 (3.85)/ 0.99 %	13.62 (12.4)/ 0.87 %	7.53 (6.84)/ 1.00 %	5.70 (5.17)/ 0.40 %	20.81 (18.9) / 1.05 %	6.54 (5.94) / 0.81 %	75.89 (68.9) / 0.70 %
O_3 precursor—NO_x	46.63 (42.31) / 0.85 %	135.69 (123.1) / 0.83 %	81.53 (73.97) / 0.93 %	34.16 (30.99) / 0.51 %	219.89 (199.5) / 0.91 %	51.23 (46.47) / 0.90 %	727.8 (660.3) / 0.67 %
O_3 precursor—TOG	29.35 (26.62) / 0.99 %	82.45 (74.8) / 0.90 %	53.61 (48.64) / 0.76 %	17.65 (16.01) / 0.62 %	133.2 (120.8) / 1.02 %	32.62 (29.6) / 0.97 %	469.4 (425.9) / 0.68 %
CO_2	N/A	N/A	N/A	N/A	N/A	N/A	1,439,163.08 (1,305,586.78)/ 0.00 %
Potential Modal Impacts*							
CO	Medium -	Medium -	Medium -	Medium -	Medium -	Medium -	Medium -
PM10	Low -	Low -	Low -	Low -	Medium -	Low -	Medium -

	Sacramento Valley Air Basin	San Francisco Bay Area Air Basin	San Joaquin Valley Air Basin	Mojave Desert Air Basin	South Coast Air Basin	San Diego Air Basin	Statewide
NO_x	Medium -	Medium -	Medium -	Low -	Medium -	Medium -	Medium -
TOG	Medium -	Medium -	Medium -	Low -	Medium -	Medium -	Medium -
CO_2	N/A	N/A	N/A	N/A	N/A	N/A	Low -
HST Investment Grade Alternative (2020) burden in tons (metric tons)/day and % change in CO, PM10, NO_x, TOG, CO_2 emission burdens compared to No Project							
CO	207.58 (188.31) / -0.50 %	571.92 (518.85) / -1.05 %	371.78 (337.28) / -1.32 %	126.30 (114.58) / -0.01 %	1007.64 (914.13) / -0.96 %	242.59 (220.07) / -0.86 %	3089.10 (2802.44) / -0.39 %
PM10	4.19 (3.80) / -0.18 %	13.45 (12.21) / -0.34 %	7.35 (6.67) / -1.46 %	5.68 (5.15) / -0.01 %	20.47 (18.57) / -0.58 %	6.47 (5.87) / -0.26 %	75.09 (68.12) / -0.37 %
O_3 precursor—NO_x	45.94 (41.68) / -0.64 %	132.85 (120.52) / -1.29 %	79.62 (72.23) / -1.44 %	33.99 (30.83) / --0.01 %	215.5 (195.5) / -1.12 %	50.18 (45.52) / -1.17 %	716.9 (650.3) / -0.85 %
O_3 precursor—TOG	28.98 (26.29) / -0.28 %	81.28 (73.73) / -0.54 %	52.61 (47.73) / -1.12 %	17.54 (15.91) / -0.01 %	130.9(118.8) / -0.69 %	32.15 (29.17) / -0.48 %	464.98 (421.8) / -0.27 %
CO_2	N/A	N/A	N/A	N/A	N/A	N/A	1,432,412.18 (1,299,488.38)/-0.45 %
Potential HST Investment Grade Regional Impacts*							
CO	Medium +	Medium +	Medium +	Low +	Medium +	Medium +	Medium +
PM10	Low +	Low +	Low +	Low +	Low +	Low +	Low +
NO_x	Medium +	Medium +	Medium +	Low +	Medium +	Medium +	Medium +
TOG	Low +	Medium +	Medium +	Low +	Medium +	Medium +	Medium +
CO_2	N/A	N/A	N/A	N/A	N/A	N/A	Low +

Notes:

Potential Impacts determined using threshold levels and attainment status as detailed in Section 3.3.1.

+ = Benefit to air quality

- = Deterioration in air quality

N/A = Not Applicable

CO_2 is analyzed only on a statewide level.

* Emission burdens from electrical utilities are included only in the statewide totals. CO_2 burdens do not include train emissions.

Summary of Pollutants by Alternatives: Table 3.3-13 summarizes the combined source categories for existing conditions and the No Project, Modal, and HST Alternatives. Compared to the No Project Alternative, the proposed HST Alternative (with investment-grade ridership forecasts) is projected to result in a decrease in the amount of pollutants statewide and in all air basins analyzed. Potential air quality benefits would range from a medium to a low rating.

Local Impacts: A total of 508 local screenline locations were analyzed. The general trend in screenline data shows that the level of service in the vicinity of proposed HST station locations would degrade under the HST Alternative. Capacity improvements under the Modal Alternative would generally prevent degradation in level of service at the proposed station sites, but V/C ratios would increase slightly. As the alternatives are refined and more in-depth studies are undertaken in future analyses, intersections near proposed HST station locations and any location where volumes would likely increase and V/C ratios degrade should be screened to determine if more detailed local analyses should be conducted to insure that the project does not cause a violation of the ambient air quality standards.

3.3.4 Design Practices

The HST system would use electrical propulsion to serve the forecast ridership, which is primarily diverted from highway or air travel. The HST Alternative is estimated to have a beneficial effect on the emissions levels throughout the air basins involved. In addition, the Authority will pursue the identification and utilization of energy produced from clean/efficient sources to the extent possible.

As described in Section 3.1 Traffic and Circulation, utilizing existing/planned multimodal hubs for station locations would also minimize air emission increases in and around station areas.

3.3.5 Mitigation Strategies and CEQA Significance Conclusions

Based on the analysis above, and considering the CEQA Appendix G thresholds of significance for air quality, the proposed HST system alternative would have a less than significant effect on air quality when viewed on a systemwide basis. Continued improvements in air pollution controls on vehicles, as new vehicles replace older vehicles, will result in an overall reduction of the average air pollutant emissions per vehicle mile of operation in the future. Use of the proposed HST system, however, would reduce vehicle miles otherwise traveled and result in an air quality benefit when viewed on a systemwide basis. Temporary, short-term increases in emissions associated with construction activities would be reduced with the application of mitigation strategies. The potential for localized air pollutant increases associated with traffic near proposed HST stations would be addressed by mitigation strategies discussed in section 3.1.6, as well as design practices, applied to reduce these impacts. See section 3.1.6.

The program-level analysis in this document reviews the potential statewide air quality impacts of a proposed HST system and the analysis would support determination of conformity for the proposed HST system. At the project level potential mitigation strategies should be explored to address potential localized impacts. Emissions from power plants supplying power to the proposed HST system could be controlled at those power plants as required under air pollution control permits. The proposed HST system could be designed to use state-of-the-art, energy-efficient equipment to minimize potential air pollution impacts associated with power used by the proposed HST system. Potential localized impacts could be addressed at the project level by promoting the following measures.

- Increase use of public transit.
- Increase use of alternative-fueled vehicles.
- Increase parking for carpools, bicycles, and other alternative transportation methods.

Potential construction impacts, which should be analyzed once more detailed project plans are available, can be mitigated by following local and state guidelines.

Potential mitigation strategies for air quality impacts associated with the HST Alternative would focus on the alleviation of traffic congestion around passenger station areas as described in the Traffic and Circulation section and on the reduction of air emissions during the construction process. The potential strategies listed below are related to the reduction of air emissions during construction.

- Water all active construction areas at least twice daily.
- Cover all trucks hauling soil, sand, and other loose materials or require that all trucks maintain at least two feet of freeboard.
- Pave, apply water three times daily, or apply (non-toxic) soil stabilizers on all unpaved access roads, parking areas and staging areas at construction sites.
- Sweep daily (with water sweepers) all paved access roads, parking areas and staging areas at construction sites.
- Sweep streets daily (with water sweepers) if visible soil material is carried onto adjacent public streets.
- Hydroseed or apply (non-toxic) soil stabilizers to inactive construction areas (previously graded areas inactive for ten days or more).
- Enclose, cover, water twice daily or apply (non-toxic) soil binders to exposed stockpiles (dirt, sand, etc.).
- Limit traffic speeds on unpaved roads to 15 miles per hour.
- Install sandbags or other erosion control measures to prevent silt runoff to public roadways.
- Replant vegetation in disturbed areas as quickly as possible.
- Use alternative fuels for construction equipment when feasible.
- Minimize equipment idling time.
- Maintain properly tuned equipment.

The proposed HST system alternative is expected to result in an air quality improvement when viewed on a systemwide basis. Temporary, short-term emissions increases associated with construction activities, and potential localized air pollution increases associated with traffic near proposed HST stations would be substantially reduced by the application of mitigation strategies and design practices. See section 3.1.6 for further discussion of mitigation strategies for increased traffic near stations. At the second-tier, project-level review, applications of these mitigation strategies are expected to reduce localized air quality impacts to a less-than-significant level in most locations. Additional environmental assessment will allow more precise evaluation in the second-tier, project-level environmental analyses.

3.3.6 Subsequent Analysis

More detail on the impact of the potential changes in vehicle hours traveled (VHT) in the regional analysis should be available for the next phase of the environmental analysis. HST alignment options should also be refined for the next phase of analysis. Once alignments are selected, if a decision is made to proceed with the proposed HST system, then local traffic counts could be conducted at access roads serving major station locations. These counts would provide more accurate information for determining potential local air quality hotspot locations. Hotspots are areas where the potential for elevated pollutant levels exist. Once hotspot locations (if any) are determined, a detailed analysis following the guidelines at the time of analysis should be conducted.

Potential construction impacts and potential mitigation measures should also be addressed in subsequent analyses. Once an alternative and alignment is established a full construction analysis should be conducted. This analysis should quantify emissions from construction vehicles, excavation, worker trips, and other related construction activities. Mitigation measures, if required, should be detailed and a construction monitoring program, if required should be established.

3.4 NOISE AND VIBRATION

This section identifies potential noise and vibration impacts on sensitive receptors or receivers, such as people in residential areas, schools, and hospitals, for the No Project, Modal, and High-Speed Train (HST) Alternatives. This analysis generally describes the sensitive noise receptors in the five regions and the methodology for determining the potential noise and vibration impacts on those receptors for each alternative. The differences in potential impacts of all three alternatives are compared to each other. This comparison considers the potential noise impacts from airplanes, automobiles on intercity highways, and the proposed HST system. The section also discusses the potential benefits of adding grade separations[1] for existing railroads in some areas, thereby reducing noise generated at grade crossings. Since this is a program-level environmental document, the analysis of potential noise and vibration impacts broadly compares the relative differences in potential impacts between the alternatives and HST alignment options.

3.4.1 Regulatory Requirements and Methods of Evaluation

A. REGULATORY REQUIREMENTS

Noise and vibration are among the environmental issues to be evaluated for a proposed HST project under NEPA and CEQA. The FRA has a regulation governing compliance with the Noise Emission Regulation adopted by the U.S. Environmental Protection Agency (EPA) for noise emissions from interstate railroads. The FRA's Railroad Noise Emission Compliance Regulation (49 C.F.R. Part 210) prescribes minimum compliance regulations for enforcement of the railroad noise emission standards adopted by the EPA (40 C.F.R. Part 201). The FRA has also established criteria for assessment of noise and vibration impacts for high-speed ground transportation projects (U.S. Department of Transportation 1998). The methodology and impact criteria for noise and vibration from the FRA guidance manual have been used in the assessment of the HST Alternative.

Assessment of the components comprising the No Project and Modal Alternatives are based on relevant criteria adopted by the U.S. Department of Transportation Federal Highway Administration (FHWA), Federal Aviation Administration (FAA), and Federal Transit Administration (FTA), each of which has established criteria for assessing noise impacts. As described below, each agency's criteria were used to define a screening distance for assessing the potential for noise impact from relevant sources. The FRA and FTA have also established vibration impact criteria related to rail transportation. The other transportation agencies have not established vibration criteria for the transportation modes under their jurisdiction, airports and highways.

At the state level, the California Noise Control Act was enacted in 1973 (Health and Safety Code § 46010 *et seq.*) and provides for the Office of Noise Control in the Department of Health Services to 1) provide assistance to local communities developing local noise control programs, and 2) work with the Office of Planning and Research to provide guidance for the preparation of the required noise elements in city and county general plans, pursuant to Government Code § 65302(f). In preparing the noise element, a city or county must identify local noise sources and analyze and quantify to the extent practicable current and projected noise levels for various sources, including highways and freeways, passenger and freight railroad operations, ground rapid transit systems, commercial, general, and military aviation and airport operations, and other ground stationary noise sources. Noise level contours must be mapped for these sources, using both community noise equivalent level (CNEL) and day-night average level (L_{dn}) and are to be used as a guide in land use decisions to

[1] For this analysis, a grade separation is the literal separation, using overpasses or underpasses, of the rail and roadway components of an at-grade crossing. This eliminates the need for trains to blow horns or sound warning devices at the grade separated (previous grade crossing) locations.

minimize the exposure of community residents to excessive noise. Airports are subject to the noise requirements set by the FAA and noise standards under C.C.R. Title 21, § 5000.

B. METHOD OF EVALUATION OF IMPACTS

Two basic evaluation techniques were used for this analysis: a screening analysis for each travel mode (highway, air, and HST) and more specific analysis of typologies derived from representative locations for the proposed HST Alternative. The screening analysis for each travel mode provides a basis for a comparison of relative differences in potential noise impacts between the No Project, Modal, and HST Alternatives. The representative typologies were used to verify screening level assumptions and to provide a basis for comparison of HST options, including consideration of the potential effectiveness of mitigation and the potential impacts or benefits associated with grade separation of existing rail lines.

Screening Procedure

Transportation noise impacts are assessed according to the number of people and noise-sensitive land uses potentially impacted by new noise sources from a project. However, for a statewide project such as the proposed HST Alternative (especially before many project-level details have been defined) it is not possible to develop a specific measure of the potential noise impacts because information necessary for performing a detailed noise analysis is not available. Consequently, a screening method was used to develop a general estimate of the relative potential for impact among alternatives. Screening distances were applied from the center of potential alignments to estimate all potentially impacted land uses in noise-sensitive environmental settings. Appendix 3.4-A defines the screening distances used. The number of people and noise-sensitive land uses were tabulated within the defined screening distance. Appendix 3.4-B describes the rating methods used to determine these numbers. The method is conservative in that it overestimates the potential impact. The method identifies all potentially impacted developed lands by type of use within the study area, but subsequent project-level analysis using better-defined system parameters and affected populations is likely to indicate lower levels of potential impact. Because potential noise impacts decrease dramatically if a structure blocks the path to the receptor, this is a conservative approach.

Noise screening analyses were performed for the No Project, Modal, and HST Alternatives. Screening distances were selected for the HST, railroads, highways, and airports based on criteria established by the agencies that regulate these modes.

- FRA and FTA for HST and conventional rail (see Appendix 3.4-C).
- FHWA for highways.
- FAA for aircraft and airports.

The analyses were accomplished using available GIS data for land use and alignment geometry for each alternative. The number of people potentially affected and the area of noise-sensitive land uses within the screening distance were determined using GIS and census data.

The potential impacts were subsequently combined to develop an impact rating for each HST and highway sub-segment assessed for the No Project, Modal, and HST Alternatives (Appendix 3.4-B). The impact rating for each segment is described as low, medium, or high, as an indication of the potential for noise impact.

Application of Screening Method to Highway and Air Modes

Highway noise impact measures used by FHWA are slightly different from the other transportation modes. Highway noise impact is based on the traffic equivalent noise level (L_{eq})

during 1 hour of the day, the hour with the greatest impact on a regular basis. For comparison with the proposed HST Alternative, the potential impacts associated with peak hourly L_{eq} are methodologically equivalent with impacts based on the FRA and FAA modal-specific criteria based on L_{dn} and CNEL. This is because, despite the different ways of measuring noise impacts, the FHWA, FRA, FTA, and FAA criteria are based on similar patterns of negative reaction exhibited by people exposed to gradations of noise from the different transportation modes. Screening distances for highways were calculated for various roadway types by number of lanes, using the FHWA traffic noise model to determine the distance at which the noise contour of 65 A-weighted decibels (dBA) L_{eq} is reached. Highway noise screening distances are described in Appendix 3.4-A.

The screening distances were applied to all of the highway segments that would be improved (additional lanes) under the highway component of the Modal Alternative. In general, the highway-related noise is a function of the volume and speed of traffic (given a representative mix of autos, trucks, and buses) and the road surface. The additional capacity (lanes) added as part of the Modal Alternative would increase both the volume and speed of traffic on the improved highway segments.

Aviation noise was assessed using the CNEL figure used in California, and noise impact would be considered to occur where CNEL exceeds 65 dBA, which is the equivalent to the 65-dBA L_{dn} contour used by the FAA for impact purposes. Noise contours around airports are routinely developed to identify the area and number of people exposed to noise levels in excess of the 65-dBA L_{dn} impact threshold.

For each of the airport improvements (additional gates and runways) that would be part of the aviation component of the Modal Alternative, the 65-dBA L_{dn} noise contour was redrawn and reassessed and overlaid with census data to assess the potential for noise impact. In general, airport noise contours expand around an airport depending on the number of operations of each type of aircraft. A 40% increase in number of flights will result in about a 17% increase in area enclosed by a given noise contour, (i.e., the 65-dBA CNEL noise contour). New runways result in new noise contours, encompassing relatively large areas of previously unexposed land uses—often including homes and other sensitive receptors to aircraft noise. While this area might increase the number of people potentially affected, it would not necessarily increase the severity of potential impact.

Vibration is assumed not to be an issue with highways or aviation primarily because there are no FHWA or FAA regulations that mandate its consideration.

Application of Screening Method to Conventional Rail and High-Speed Train Modes

Railroad noise and vibration criteria developed by FTA are consistent with criteria adopted by the FRA for high-speed trains. They were used to assess conventional rail operations in the No Project and Modal Alternatives as well as the HST Alternative.

Criteria for HST noise impact assessment are based on activity interference and annoyance ratings developed by EPA. These criteria, described and presented in graphical form in Appendix 3.4-C, provide the basis for the rail noise analysis procedures used in the screening and the representative typologies (U.S. Department of Transportation 1998).

The screening procedure used by the FRA takes into account the noise impact criteria, the type of corridor, and the ambient noise conditions in typical communities. Distances within which potential impacts may occur are defined based on operations of a typical HST system. These distances were developed from detailed noise models based on empirical measurements of noise emissions of existing steel-wheel/steel-rail high-speed trains, expected maximum operation levels and speeds, and residential land use. The width of the potential impact along the length of the HST alignment is the area in which there is potential for noise impact. The FRA screening procedure was developed for HST speeds from 125 mph to 210 mph (201 kph to 338 kph). For speeds less than 125 mph (201 kph) and for areas near stations, the FTA screening method was used in concert with the FRA method. The FRA and FTA screening distances for noise are included in Appendix 3.4-A.

The screening distances are different for the different types of developed areas along a potential alignment 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 dBA L_{dn}. Similarly, “quiet suburban” and “rural” or “natural open-space” areas are grouped as areas where ambient noise levels are less than 55 dBA L_{dn}. For developed land with L_{dn} between 55 and 60 dBA, the classification is dependant on other factors such as proximity of major transportation facilities and density of population. The screening procedure was applied to first allow for the comparison of impacts between alternatives and to identify areas of potential impacts for further consideration in project-level analysis. The screening procedure estimates the affected receptors to ensure that all potential impacts are included at the program level.

While the screening procedure is based on the type of equipment (technology and power type), operational characteristics of the new services (speeds and frequencies), the type of support structure (aerial or at grade), and the general ambient noise level, it does not address the horn and bell noise associated with existing passenger and freight trains because these are regarded as part of the existing environment and are assumed to be held constant for all three alternatives. To develop a relative comparison of the HST and Modal Alternatives, the results of the screening analysis were adjusted to account for noise reductions from the elimination of grade crossings on existing rail lines, where the HST alignment options would share the rail corridor. The degree of adjustment was based on the representative typologies for similar circumstances and is defined in the following section.

As a final step for those areas rated medium or high for potential impacts, the screening analysis assessed the potential use of noise barriers and other mitigation options to assess the potential for reducing noise impacts. The mitigation analysis is discussed in Section 3.4.5.

Vibration impact screening was performed for the HST Alternative only. The highway and aviation modes are assumed to cause less-than-significant ground-borne vibration, and neither FHWA nor FAA have adopted vibration impact assessment criteria. The vibration screening procedure is used to compare potential impacts among regional HST alignment design options and to provide an estimate of the length of alignments where consideration of vibration attenuation features may be appropriate.

Representative Typologies for High-Speed Trains

To better understand the potential impacts of the HST Alternative, several noise impact assessment studies were prepared for representative situations of noise- and vibration-sensitive land uses. The more detailed General Assessment Method of FTA’s and FRA’s guidance manuals were used to provide noise impact estimations. The FRA and FTA noise impact criteria of *severe impact*, *impact* and *no impact* were applied to the results. These typological studies verified the general results from the screening procedure. Representative situations were chosen to provide a range of potential impact types and levels. This approach provides a means of considering at the program level the potential impacts on communities along any potential proposed HST alignment. The typology locations are illustrated on maps by region in Appendix 3.4-F.

Developed land use categories consist of individual medium- and low-density residential zones, schools, hospitals, parks, and other unique institutional receptors such as museums, libraries, etc.

Residential land uses were chosen for the typologies for new and shared corridors that varied in local zoning densities, ambient noise conditions, set back distances from the alternative corridors, and HST operational speeds. Institutional uses as mentioned above and parks were individually identified for each focused study. These representative typologies were evaluated on the topics listed below.

- Verification of screening distances (noise and vibration).
- Effectiveness of noise barriers.
- Benefits from elimination of grade crossings.
- Costs and benefits of a high-speed downtown bypass loop.

<u>Verification of Screening Distances (Noise and Vibration)</u>
The results of the representative typologies confirm that the screening method used an appropriate upper boundary as an indicator of potential for noise impact. Impacts were found to occur in 90% of the cases identified in the screening procedure; in 75% of those studied, consideration of mitigation may be appropriate. Those that would have insignificantly low noise impact were either at outer edges of the screening distance or were shielded sufficiently by other buildings. Shielding by terrain features or buildings is not taken into account in the screening process, except to indicate some receptors would not need further analysis.

Representative studies were also completed that assess the range of the potential vibration impact levels that are likely to be encountered in project-level analyses. The results generally show that the nearer buildings would be to a proposed alignment, the greater the likelihood of impact. Where speeds are expected to be low, the vibration potential impacts are confined to within 100 ft (30 m) of the track. At top speeds, the potential impacts extend to 200 ft (61 m). The special typologies generally validate the vibration screening distances that are included in Appendix 3.4-A.

<u>Effectiveness of Noise Barriers</u>
Noise barriers are used extensively in Europe and Japan to mitigate noise impacts from HST systems. The representative typology studies generally indicated that mitigation by sound barrier walls can be an effective means of reducing the potential impacts by one category, for example, from severe impact (mitigation appropriate) to impact. Noise barrier mitigation is shown to be especially effective for receivers close to the tracks. While noise barrier walls would not be the only potential mitigation strategy to be considered, they were used to represent mitigation potential in this Program EIR/EIS.

<u>Benefits from Elimination of Grade Crossings</u>
The representative typology studies were also used to estimate the potential benefit of noise reduction resulting from grade separations. A focused noise study in the Bay Area to Merced region (at Charleston Road in Palo Alto) showed the potential benefit of eliminating horn blowing at a typical Caltrain grade crossing on the Peninsula. Assessment of noise impact from horns at grade crossings was performed with FRA's horn noise model and annoyance based criteria. The horn noise model indicated an 81% reduction in the number of people impacted within 0.25 mi (0.40 km) of that intersection by elimination of horn noise from commuter trains. Another focused noise study in the Los Angeles to San Diego via Orange County region showed similar results. The elimination of the grade crossing at Tamarak Street in Oceanside was analyzed and found to result in a 77% reduction in the number of people impacted in the vicinity. Although the results vary depending on the local population density and proximity of residences and other sensitive land uses at each grade crossing, they illustrate the magnitude of the potential change to be expected if the sounding of horns and bells at existing rail crossings could be eliminated.

Removing all potential remaining horn noise would not eliminate noise impacts, however, because the sound of the trains would remain. The proposed HST would add its own noise to that of other trains using the railroad corridor. Carrying the focused study further, it was found that approximately 75% of the grade crossings to be eliminated with the proposed HST are located adjacent to residential areas with a high potential noise impact rating. There would be a clear benefit from the elimination of the horns and warning signals. While with the HST, there would be additional train noise and vibration primarily from the high train speed and frequency of service.

Based on these results, the potential noise impact ratings from screening were adjusted to account for segments where grade crossings would be eliminated for existing passenger and freight trains as part of the implementation of HST service along that segment. A reduction in one impact rating level (high to medium or medium to low) was made only for segments where HST speeds would be less than 150 mph (241 kph). Where speeds are above that level, no adjustment was made since the noise created by the proposed new service at higher speeds would likely overshadow the reduction in horn and bell noise due to grade separation.

This adjustment was made on the segments listed below.

- Caltrain corridor from San Francisco to San Jose.
- Hayward/Niles/Mulford Line from south of Oakland to north of Union City.
- Metrolink/UPRR from south of Sylmar to Burbank.
- LOSSAN from Fullerton to Irvine.

Costs and Benefits of a High-Speed Bypass Loop

The HST Alternative has rail alignment options that would allow express trains to bypass certain intermediate stations in urban centers. Such bypass tracks are referred to as express loops. The costs and benefits of express loops are based on the analysis of one line through the city (express tracks and off-line station tracks) versus two lines for the city (line through the city for stopping trains at reduced speeds < 125 mph [200 kph] and express tracks bypassing the urban area at high speeds). Without a high-speed loop, there is a greater potential for noise impacts on people in urban areas because of the higher speed of express trains, the greater number of trains, and the greater density of people along urban alignments. Express loops considered skirt the populated areas of several cities in the Central Valley, including Modesto, Atwater, Merced, Fresno, and Tulare. A noise analysis for the Sacramento to Bakersfield region was used to quantify and compare the differences between the two configurations, i.e., with and without high-speed loops.

The high-speed loop that skirts Fresno was chosen as an example to illustrate the potential noise benefits that might be obtained by implementing high-speed loops. The focused evaluation compares the number of people impacted by the option without the loop and the number of people impacted by the option that includes the high-speed loop around Fresno. Fresno has two potential high-speed loops, depending on which of the two rail alignments is selected as the mainline HST route, Union Pacific Railroad (UPRR) or Burlington Northern Santa Fe (BNSF).

The screening distance used for the high-speed loop is the distance associated with express high-speed trains at a maximum operating speed of 220 mph (354 kph). With the high-speed loop included as part of the option, the screening distance used for the mainline is that associated with stopping or accelerating trains at the station, or speeds slower than 125 mph (201 kph). Using the GIS database, the numbers of people potentially impacted for the two scenarios were determined.

The UPRR alignment high-speed loop option analysis indicates that if express trains use the mainline track (no high-speed loop), the number of people potentially impacted by noise would be somewhat higher (16%) particularly in the downtown area compared to the number of people potentially impacted by including a high-speed loop. The BNSF high-speed loop option analysis indicates that 12% more people would be potentially impacted if all trains use the mainline compared with the high-speed loop option. This comparative evaluation shows that fewer people would be impacted by noise with the high-speed loop, although the difference would not be large. While the high-speed loops would reduce noise impacts along the HST line through the urban center, the implementation of two lines (express loop and stopping tracks in the city) creates some additional noise impacts around the outskirts of the urban area and would affect a greater total area. The marginal reduction in potential noise impact in the urban locations from using an express (high-speed) loop might be achieved at a lower cost through noise barrier mitigation of the direct route in which all the trains (both stopping and express trains) pass through all the stations in urban areas.

3.4.2 Affected Environment

A. STUDY AREA DEFINED

The study area for the noise and vibration assessment is defined by the screening distances that are used by the FRA (U.S. Department of Transportation 1998) and FTA (U.S. Department of Transportation 1995) to evaluate rail and highway corridors. Rail and highway study areas are within 1,000 ft (305 m) of the centerline of the alignment options for each alternative. For airport noise in California, the study area is the area within the 65-decibel (dB) CNEL noise contour established for the particular airport. This is the extent of the area where a change in noise would be most noticeable to receptors, and noise impacts from new projects could begin to dominate the noise environment.

B. GENERAL DISCUSSION OF NOISE AND VIBRATION

This section describes the characteristics and associated terms and measurements used for transportation-related noise and vibration. When noise from a highway, plane, or train reaches a receptor, whether it is a person outdoors or indoors, it combines with other sounds in the environment (the ambient noise level) and may or may not stand out in comparison. The distant sources may include traffic, aircraft, industrial activities, or sounds in nature. These distant sources create a background noise in which usually no particular source is identifiable and to which several sources may contribute, 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 passing of a train, the over flight of an airplane, the sound of a horn or siren, 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 an annoyance. The descriptors used in the measurement of noise environments are summarized below.

The fundamental measure of noise is the dB, a unit of sound level based on the ratio between two sound pressures—the sound pressure of the source of interest (e.g., the HST) and the reference pressure (the quietest sound that a human can hear). Because the range of actual sound pressures is very large (a painful sound level can be over 1 million times the sound pressure of the faintest sound), the expression of sound is compressed to a smaller range with the use of logarithms. The resulting value is expressed in terms of dB. For example, instead of a sound pressure ratio of 1 million, the same ratio is 120 dB.

The human ear does not respond equally to high- and low- pitched sounds. In the 1930s, acoustical scientists determined how humans hear various sounds and developed response characteristics to represent the sensitivity of a typical ear. One of the characteristics, called the *A-curve*, represents the sensitivity of the ear at sound levels commonly found in the environment. The A-curve has been standardized. The abbreviation dBA is intended to denote that a sound level is expressed as if a measurement has been made with filters in accordance with that standard.

- *Maximum Sound Level (L_{max})*, measured in dBA, is the highest noise level achieved during a noise event.
- *Equivalent Sound Level (L_{eq})*, measured in dBA, describes a receptor's cumulative noise exposure from all noise events that occur in a specified period of time. The hourly L_{eq} is a measure of the accumulated sound exposure over a full hour. The L_{eq} is computed from the measured sound energy averaged over an hour (nothing one would read from moment to moment on a meter) representing the magnitude of noise energy received in that hour. FHWA uses the peak traffic hour L_{eq} as the metric for establishing highway noise impact.
- *Day-Night Sound Level (L_{dn})* describes a receptor's cumulative noise exposure from all noise events that occur in a 24-hour period, with events between 10 p.m. and 7 a.m. increased by *10* dB to account for greater nighttime sensitivity to noise. The L_{dn} is used to describe the general noise environment in a location, the so-called "noise climate." The unit is a computed number, not one to be read from moment to moment on a meter. Its magnitude is related to the general noisiness of an area. EPA developed the L_{dn} descriptor and now most federal agencies, including the FRA, use it to evaluate potential noise impacts. Typical L_{dns} in the environment are shown in Figure 3.4-1.
- *CNEL*, a variant of Ldn, is used in noise assessments in California. Rather than dividing the day into two periods, daytime and nighttime, CNEL adds a third to account for increased sensitivity to noise in the evening when people are likely to be engaged in outdoor activities around the home. An evening addition of 5 dB is applied to noise events between the hours of 7 p.m. and 10 p.m. to reflect the additional annoyance noise causes at that time. In general, the difference between Ldn and CNEL is slight and the two measures will be considered interchangeable for purposes of this noise analysis.

The way people react to noise in their environment has been studied extensively by researchers throughout the world. Based on these studies, noise impact criteria have been adopted by the FRA (U.S. Department of Transportation 1998) and other federal agencies to assess the contribution of the noise from a source like HST to the existing environment. The FRA bases noise impact criteria on the estimated increase in L_{dn} (for buildings with nighttime occupancy) or increase in L_{eq} (for institutional) buildings caused by the project for direct and indirect impacts. Criteria are discussed in Section 3.4.1 and Appendix 3.4-C.

Transportation Noise

Noise from highways, airports, and rail lines tends to dominate the noise environment in its immediate vicinity. Each mode has distinctive noise characteristics in both shape and source levels. Highway and rail noise affects an area that is linear in shape, extending to both sides of the alignment. Airport noise, in contrast, affects a closed area around the facility, with the shape of the closed loop determined by runway orientation.

Highway Noise and Vibration: Individual highway vehicles are generally relatively quiet, but the accumulation of noise from the volume of traffic throughout the majority of the day and night results in a nearly continuous high sound level. Noise from road traffic is generated by a wide variety of vehicle types, makes, and models. In general, the noise associated with highway vehicles can be divided into three classes of vehicle: automobiles, medium trucks, and heavy trucks. Each class has its own noise characteristic depending on vehicle type, speed, and the condition of the roadway surface.

The cumulative effect of all the vehicles added together comprises the noise environment in the vicinity of a highway. The noise level along a highway facility is strongly influenced by the traffic flow—its speed and the number of vehicles of each type using it. Busy freeways have a nearly continuous noise, whereas rural roads have noise levels that rise and fall depending on clusters of traffic. Multi-lane freeways spread the noise sources out over many lanes, resulting in a large area affected by noise. However, highway noise is generated at or very near the ground surface so that topographical conditions at the roadside have a major effect on propagation. Highway noise is described as a line source, since the noise is generated along a long line of highway. Noise levels are mapped using contour lines for given noise levels and they are roughly parallel to the highway. While these contours are directly influenced by the width of the facility (number of lanes), the volume and speed of the traffic are the primary factors that influence the amount of noise and the location of the noise contour.

Vibration created by truck traffic can be felt in areas adjacent to highways. However, there are no established vibration criteria for highways and consequently highway vibration is not part of this analysis.

Aircraft and Airport Noise and Vibration: Airport noise sources can be among the loudest sounds in the environment, but the aircraft pass-bys tend to be rather short in duration and are concentrated along the alignments of the runways. The area of noise impact around an airport depends on the number of operations, the type of aircraft, and the flight tracks used at that airport. Noise near airports is generated by a complex sound source consisting of flight operations and ground operations. Flight operations associated with an airport include takeoffs and landings, requiring extra power, and increased noise levels. When the aircraft are airborne, they propagate sound to great distances. For airborne operations, sound reaching the ground depends highly on atmospheric conditions. Ground operations include aircraft taxiing, run-up operations, and surface transportation near the terminal and its runways. Noise generated by ground operations has to spread out over the ground, thereby being strongly affected by topographical conditions, vegetation, ground types, and buildings.

Noise levels can vary considerably for different types of aircraft, by type, engine power settings, and flight paths. As with highway noise, the cumulative effect of airport noise depends on the number of flight operations and runway utilization. As opposed to a highway where the source is linear in nature, an airport is described as an aerial source, affecting a defined area with closed contours around the airport. The noise contours tend to be elongated in the direction of the major runways.

Vibrations from aircraft, particularly low flying aircraft and their engines, can potentially impact homes and businesses; however since the FAA does not have a criteria for measuring these vibrations, it is not included in this analysis.

Conventional and High-Speed Train Noise and Vibration: While high-speed trains have some similar noise and vibration characteristics to conventional trains, they also have several unique features resulting from the reduced size and weight, the electrical power, and the higher speed of travel. The proposed HST would be a steel-wheel, steel-rail electrically-powered train operating in an exclusive right-of-way. Because there would be no roadway grade crossings, the annoying sounds of the train horn and warning bells would be eliminated. The use of electrical power cars would eliminate the engine rumble associated with diesel-powered locomotives. The above factors allow HST to generate lower noise levels than conventional trains at comparable speeds below 100 mph (161 kph). At higher speeds above 150 mph (241 kph), however, HST noise levels would increase over conventional trains due to aerodynamic effects. A mitigating factor is that high speeds would enable HST noise to occur for a relatively short duration compared with conventional trains (a few seconds at the highest speeds versus 10 to 20 seconds for conventional passenger trains and over 1 minute for freight trains).

For the proposed HST system higher operating speeds of 150 to 220 mph (241 to 354 kph) would be planned for the less constrained areas, in terms of alignment (i.e., flat and straight). In contrast, much lower operating speeds <125 mph (201 kph) would be planned in the more developed areas. Figures 3.4-2 and 3.4-3 illustrate the maximum operating speeds for express service along each of the proposed HST alignment options. Local and semi-express services would not necessarily reach these maximum speeds because they would stop and start for more stations.

Noise from a high-speed train is expressed in terms of a source-path-receiver framework as illustrated in Figure 3.4-4. The source of noise is the train moving on its tracks. The path describes the intervening course between the source and the receptor wherein the noise levels are reduced by distance, topographical and human-made obstacles, atmospheric effects, and other factors. Finally, at each receptor, the noise from all sources combine to make up the noise environment at that location.

The total noise generated by a train is the combination of sounds from 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 3.4-5. These noise sources can be grouped into three categories according to the speed of the train.

For low speeds, below about 40 mph (64 kph), noise emissions are dominated by the propulsion units, cooling fans, and under-car and top-of-car auxiliary equipment such as compressors and air conditioning units. The HST would be electrically powered and considerable quieter at low speeds than conventional trains that are usually diesel powered.

In the speed range from 60 mph to about 150 mph (98 kph to 241 kph), mechanical noise resulting from wheel/rail interactions and structural vibrations dominate the noise emission from trains. In the existing rail corridors within California, conventional trains seldom exceed 79 mph (127 kph), so this speed range, which represents a medium range for HST, is the top end of noise characteristics for trains with which most people are familiar. Speed has a strong influence on noise in the medium speed range.

Above approximately 170 mph (274 kph), aerodynamic noise sources tend to dominate the radiated noise from the HST. Conventional trains are not capable of attaining such speeds. HST noise in the transition speeds between each of the three foregoing ranges is a combination of the sources in each range.

Noise from HST also depends on the type and configuration of its track structure. Typical noise levels are expressed for HST at grade on ballast and tie track, the most commonly found track system. For trains on elevated structure, HST noise is increased, partially due to the loss of sound absorption by the ground and partially due to extra sound radiation from the bridge structure. Moreover, the sound from trains on elevated structures spreads about twice as far as it does from at-grade operations of the same train, due to raising the sound source higher above ground.

Horns are an example of a train noise source that is a dominant noise source at any speed. Audible warnings at grade crossings, including train horns and warning bells, are a common feature of conventional trains and a vital safety component of railroad operations. These noise sources often prove to be a source of annoyance to people living near railroad tracks. In the case of HST, however, horn and warning bell noise at grade crossings are absent except in the case of emergencies because grade crossings are eliminated for reasons of safety. Elimination of horns and bells at existing grade crossings would provide a noise benefit associated with the implementation of HST for alignments along existing rail corridors, but only in locations where grade separations also served the existing rail service, thereby removing the need for grade crossing warnings and train horns.

Vibration of the ground caused by the pass-by of the HST is similar to that caused by conventional steel wheel/steel rail trains. However, vibration levels associated with the HST are relatively lower than conventional passenger and freight trains due to new track construction and smooth track and wheel surfaces resulting from high maintenance standards required for high-speed operation.

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 commonly exposed to vibration levels from outside sources that they can feel. Little concern results when a door is slammed and a wall shakes or something heavy is dropped and the floor shakes momentarily. Concern results, however, when an outside source like a train causes homes to shake. The effects of ground-borne vibration in a building located close to a rail line could at worst 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 daily.

As with noise, ground-borne vibration can be understood as following a source-path-receptor framework, as shown in Figure 3.4-6. The source of vibration is the train wheels rolling on the rails. They create vibration energy that is transmitted through the track support system into the track bed or track structure. The path of vibration involves the ground between the source and a nearby building. The receptor of vibration is the building.

Mode Noise Level Comparisons

Noise levels of typical individual transportation vehicles are compared in Figure 3.4-7 with each other and with other commonly experienced sounds in the environment. Jet aircraft are clearly the noisiest of the transportation sources, followed by train horns and diesel trucks. Noise levels of high-speed trains at speeds of 100 to 150 mph (161 to 241 kph) are similar to that of freight and commuter trains at speeds of 50 to 80 mph (80 to 129 kph). The descriptor for the figure is the L_{max} which represents the highest sound level associated with a single event such as the passage of a train, aircraft, or truck.

As described above, the descriptor used in environmental assessments is the L_{dn}, which represents the cumulative noise exposure during a 24-hour period, rather than the L_{max}. A comparison of noise associated with surface transportation sources at various distances on either side of an unobstructed highway or railway is shown in Figure 3.4-8. This example is based on conventional passenger and freight trains at typical operating speeds compared with high-speed trains at a range of speeds, for a hypothetical situation of one train per hour. The graph shows the relative differences between these types and speeds of trains in terms of cumulative noise exposure. The graph also includes the cumulative noise levels over a 24-hour period of an 8-lane freeway with traffic traveling at 65 mph (105 kph) in relation to the train examples.

The graph in Figure 3.4-9 shows the difference in cumulative noise exposure for the same train types and speeds given typical frequency levels. In this case, since commuter trains and high-speed trains share many of the same noise profile characteristics (frequency, relative speed, and length) commuter trains and high-speed trains are assumed to have much higher frequencies than freight trains based on typical commuter operations and conceptual operating assumptions for HST. For this illustration, HST is assumed to have 118 day and 14 night trains made up of 1 power car and 15 coaches; commuter trains are assumed to have 46 day and 28 night trains made up of 1 locomotive and 5 coaches; and freight trains are assumed to have 10 day and 3 night trains made up of 2 locomotives and 40 freight cars. The 8-lane freeway in this and the preceding plot is assumed to carry 1,885 vehicles/hour/lane with 2% medium trucks and 3% heavy trucks. This example shows that as frequencies and speeds are increased (e.g., the addition of HST trips) the noise exposure is increased relative to the existing conventional rail services. Again, the graph includes the cumulative noise levels of a typical 8-lane freeway with traffic traveling at 65 mph (105 kph) in relation to the train examples. This example also shows how the cumulative noise diminishes with distance from the linear-type surface transportation sources. In the first 300 ft (91 m) from the centerlines, L_{dn} from rail sources tends to diminish more with respect to distance than that from a busy freeway. The freeway constitutes a continuous long source of noise, whereas a rail line has a series of transient noise events with relatively short sources.

Because of its aerial nature, airport noise cannot be represented in the same format used for surface transportation sources. Contours of noise exposure surround the airport in an irregular pattern depending on the orientation of its runways and their use. The frequency of operations (takeoffs and landings) has a direct impact on the noise levels in the vicinity of the airports. The area within each contour grows with the number of operations of aircraft. For example, the area of the L_{dn} 65-dBA airport noise contour used as the impact criterion in FAA's planning guide increases 17% (affecting additional land area) for every 1.5-dB increase in L_{dn} (approximately a 40% increase in number of operations), according to FAA's area equivalent method.

C. NOISE ENVIRONMENTS BY REGION

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. Existing noise along highway and proposed HST corridors has been estimated using data in the noise element from the general plan for cities and counties in the region, along with general methods provided by FHWA, FRA, and FTA for estimating transportation noise. Ambient noise levels are characterized for each region in the sections below. Ambient vibration conditions are very site-specific in nature and are not characterized as part of the program environmental process.

Bay Area to Merced

This region includes central California from the San Francisco Bay Area (San Francisco and Oakland) south to the Santa Clara Valley and east across the Diablo Range to the Central Valley. The ambient noise in the northern portion of the Bay Area to Merced region is dominated by motor vehicle traffic in densely populated areas and along freeways. All the regional freeways considered in the No Project and Modal Alternatives are major contributors to the ambient noise environment. In this region the potential HST alignments would primarily follow or parallel existing rail tracks. Along the proposed HST alignment on the San Francisco Peninsula, the existing Caltrain passenger service is a major contributor to the ambient noise levels, especially at grade crossings where horn noise dominates the noise environment within 0.25 mi (0.40 km) of the intersections. Along the proposed HST alignment in the East Bay, existing Amtrak passenger service and freight rail contribute to the ambient noise levels, with horns at grade crossings being a major factor. In southern San Jose and as far as Gilroy to the south, Caltrain, Amtrak, and freight rail are major contributors to the ambient noise levels.

In the urban areas and suburban areas of the East Bay, San Francisco Peninsula, and San Jose, the ambient noise is estimated to range from L_{dn} 57 to 66 dBA. In many of the residential areas close to the international airports at San Francisco (SFO), Oakland (OAK), and San Jose (SJC), the ambient levels exceed L_{dn} 65 dBA. In the more rural areas of the region to the southeast, the ambient noise ranges from 52 to 57 dBA. Henry Coe State Park is characterized by a low ambient noise environment, approximately L_{eq} 40 dBA, being in a remote location and removed from transportation noise sources, except along SR-152, which is also part of the Modal Alternative.

Sacramento to Bakersfield

This region of central California includes a large portion of the Central Valley (San Joaquin Valley) from Sacramento south to Bakersfield. The proposed HST alignment options in the Sacramento to Bakersfield region primarily follow two major railroad alignments, UPRR and BNSF. Most of the UPRR corridor runs parallel to SR-99. The proposed UPRR alignment generally has more populated land use development than the one following BNSF. The highway improvements included in the Modal Alternative are primarily focused on SR-99 and I-5. These railroad lines and the highways are major contributors to the ambient noise environment.

The land use along the corridor corresponds to a quiet suburban or rural area, changing into a noisy suburban or urban area primarily inside of the city and town limits such as Fresno and Merced, in the middle and at Sacramento and Bakersfield on each end, where typical moderate to high noise levels exist. Due to the proximity of the existing railroad and highway corridors to the proposed alignment/improvement options, the non-developed areas or areas of low population density are also relatively noisy. The non-residential, rural, and quiet suburban areas along the alignment options and existing transportation corridors in this region correspond primarily to agricultural land use where low noise levels predominate. There are some commercial and industrial areas next to the alignments, but only within the boundaries of the towns and cities. Ambient levels are estimated to be between L_{dn} 50 to 58 dBA for rural and quiet suburban, and L_{dn} 60 to 68 dBA for noisy suburban urban areas.

Bakersfield to Los Angeles

This region of southern California encompasses the southern portion of the Central Valley south of Bakersfield, the mountainous areas between the Central Valley and the Los Angeles basin, and the northern portion of the Los Angeles basin from Sylmar to downtown Los Angeles. The ambient noise from Bakersfield to Sylmar is dominated by motor vehicle traffic along the I-5 corridor and by both motor vehicle traffic and freight and passenger trains throughout portions of the Antelope Valley option. From Sylmar to Los Angeles Union Station (LAUS) the ambient noise is dominated by motor vehicle traffic and near rail lines 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 dBA or even higher. In the more rural areas of the region, the ambient noise levels range from L_{dn} 50 to 53 dBA.

Los Angeles to San Diego via Inland Empire

This region of southern California includes the eastern portion of the Los Angeles basin from downtown Los Angeles east to the Riverside and San Bernardino areas and south to San Diego generally along the I-215 and I-15 corridors. Between Los Angeles and Riverside, the ambient noise environment in the study area is dominated by a combination of noise from freeways, major roads, and existing railroads. With close proximity to a freeway or rail line, the transportation noise will typically dominate the local noise environment. Ambient noise in these areas ranges from L_{dn} 58 to 68 dBA.

Along portions of the alternative corridors between Riverside and Escondido, which follow I-15 and I-215, freeway noise is the dominant component of the existing ambient noise. Although this portion of the region is fairly rural, ambient noise near the existing highways is high. The most rural area of this portion is mountainous, where ambient noise ranges from L_{dn} 54 to 65 dBA.

The Escondido to San Diego portion of the Inland Empire region is less urban than the Los Angeles area, but major freeways and existing rail lines have similarly high local noise environments. Ambient noise in the Escondido to San Diego areas along the study corridors ranges from L_{dn} 55 to 68 dBA.

Los Angeles to San Diego via Orange County

This region includes the western portion of the Los Angeles basin between downtown Los Angeles and Los Angeles International Airport (LAX) and the coastal areas of southern California between Los Angeles and San Diego, generally following the existing I-5 highway corridor. The ambient noise in the northern portion of the region is dominated by motor vehicle traffic in densely populated areas and along freeways. Along the connection to LAX, and in particular near freeways, motor vehicle traffic dominates. Closer to the airport, aircraft noise becomes dominant.

Along the conventional rail alignment south from LAUS, existing passenger service (Amtrak, Metrolink, and Coaster) and freight rail contribute to the local noise. Throughout this portion of the region, roadway traffic also contributes to the ambient. Along the HST alignment, freight rail and motor vehicle traffic comprise the sources of ambient noise. Along the coast, local roadway traffic and passenger rail service contribute to the ambient noise conditions, most notably horn blowing at grade crossings. Freeway noise is the dominant noise source in this region.

In the urban areas and suburban areas of Los Angeles and northern Orange Counties, the ambient noise ranges from L_{dn} 63 to 68 dBA depending on the proximity to noise sources such as rail, roadway and airport. In the more suburban areas of the region, the ambient noise ranges from 58 to 63 dBA. Along the coast, the ambient noise environment ranges from L_{dn} 54 to 64 dBA depending on proximity to local noise sources.

3.4.3 Environmental Consequences

A. EXISTING CONDITIONS COMPARED TO NO PROJECT ALTERNATIVE

The No Project Alternative includes programmed and funded transportation improvements that will be implemented and operational by 2020 in addition to the existing conditions. These improvements are not major system-wide capacity improvements (e.g., major new highway construction or widening or additional runways) and will not result in a general improvement of intercity travel conditions across the study area.

For purposes of this analysis, it is assumed that there will be no additional noise and vibration impacts associated with the development of No Project as compared to existing conditions. The potential significant impacts associated with programmed projects would be addressed with mitigation measures in a manner consistent with existing conditions in accordance with the project-level environmental documents and approvals for the projects as prepared by the project sponsors. While the implementation of the No Project Alternative may result in some increases, any estimate of such increases would be speculative.

B. NO PROJECT ALTERNATIVE COMPARED TO MODAL AND HIGH-SPEED TRAIN ALTERNATIVES

The No Project Alternative is used as the basis for comparison. It is assumed that any improvements associated with the proposed Modal and HST Alternatives would be in addition to No Project conditions.

The relative level of potential noise impact for the Modal Alternative is illustrated in Figures 3.4-10 and 3.4-11. The figures show the relative noise impact in terms of high, medium and low categories for all of the potentially improved highway segments included in this alternative. The Modal Alternative has over 200 mi (322 km) of highway segments with potential for high noise impacts. The segments of high potential impact generally result from the high total traffic volumes (existing plus the representative demand) and the capacity improvements associated with the Modal Alternative, which result in increased speeds and wider facility cross sections. The segments with existing noise barriers are assumed to have less than high potential because most improvements would include noise walls.

The noise levels for airports are not categorized as high, medium, and low. The available data indicate that the number of people affected by the aviation component is a small portion of the number affected by the Modal Alternative (see Appendix 3.4-D). Although aircraft and airport improvements contribute less to the Modal Alternative's potential noise impacts than the more extensive highway improvements, it should be acknowledged that noise from aircraft and airport operations can impact relatively large areas of land including large numbers of people surrounding the airport. Noise is one of the most prominent factors for the environmental acceptability of airport improvement or expansion and is often the limiting factor in the approval of such projects. There is typically strong community resistance to airport expansions due to noise issues. Many of the airports in urban areas like Burbank, San Jose, and Orange County all have operating restrictions based on the noise from the aircraft and the airport operations.

The relative level of potential noise impacts for the HST Alternative is illustrated in Figures 3.4-12 and 3.4-13. The figures show the relative noise impacts in terms of high, medium and low categories for all of the HST alignment options. The potential noise impact ratings account for the reduction of horn and bell noise associated with the elimination of grade crossings on existing rail lines, where appropriate.

The relative level of potential noise impact for each alternative is shown in Table 3.4-1 in terms of the total lengths of alignment (highway or HST) in each rating (high-medium-low) category. The sections of alignment options with high, medium, and low potential noise impact ratings for the HST Alternative are compared with the equivalent sections of the Modal Alternative. In addition, the potential impact ratings of HST alignments are shown without mitigation. The impact levels shown for the Modal Alternative assume that sound barriers (walls) are maintained or rebuilt along the segments of each improved highway where they currently exist. The results show the HST Alternative would have less total mileage of high potential for noise impact than the Modal Alternative. A full range of HST alignment options were assessed assuming a statewide system comprising the alignment options with the greatest potential for noise impact (GPI) and those with the least potential for noise impact (LPI).

Based on the percentage of total system-wide length that would experience potential high noise impacts, the HST Alternative is close to the Modal Alternative. For example, 14% of the improvements associated with the Modal Alternative are rated with a high potential for noise impact, whereas the HST Alternative ranges from 3% for LPI to 14% for GPI.

Table 3.4-1
Summary of Noise Impact Ratings for Alternatives

Length (miles) with Potential Noise Impact Ratings[a]									
	Modal[b]			HST (GPI)			HST (LPI)		
REGION	H	M	L	H	M	L	H	M	L
System-wide totals[c]	210	258	1040	107	181	484	21	111	601
System-wide percentage of total[c]	*14*	*17*	*69*	*14*	*23*	*63*	*3*	*15*	*82*
Bay Area to Merced	93	153	131	26	103	70	0	50	103
Sacramento to Bakersfield	26	63	611	11	23	258	5	3	284
Bakersfield to Los Angeles	23	0	199	13	10	88	6	17	114
Los Angeles to San Diego via Inland	68	42	100	57	45	68	10	41	100
LOSSAN	61	43	14	42	65	50	5	65	50

a See Appendix 3.4-B for rating method.
b Assumed with maintenance or replacement of existing highway noise mitigation.
c Totals without LOSSAN.

The potential for direct effects of train noise on wildlife in natural areas is not well documented. Current research suggests that the noise effects of trains traveling at very high-speed could have limited influence on some species close to the tracks. Some research has been performed regarding the reactions of animals to low-flying aircraft, but the specific levels of significance and specific effects related to high-speed trains are not known. Long-term changes in behavior tend to be strongly influenced by factors other than intermittent noise exposure (as would occur with high-speed trains), such as weather, predation, disease and other disturbances to animal populations. Conclusions from research conducted to date provide only preliminary indications of the appropriate noise descriptor, rough estimates of threshold levels for observed animal disturbance, and habituation characteristics of only a few species. Long-term effects continue to be a matter of speculation. Since high-speed trains always will be on the same track and on a schedule, habituation may be likely to occur. Sound levels from train passes are also not as high, nor are onset rates as great as they are from low altitude military aircraft, hence, the observed effects of aircraft may not apply to high-speed trains.

3.4.4 Comparison of Alternatives by Region

A. BAY AREA TO MERCED

<u>Modal Alternative</u>

Under the Modal Alternative, the noise impact ratings for the various highway segments range from high in the urbanized areas to low in the rural areas. Two areas of high impact are the I-880 corridor from I-238 to Fremont/Newark in the East Bay and the US-101 corridor from SFO to Gilroy going south from the Peninsula. In both locations the highway and freeway corridors are adjacent to residential areas. The corridors from San Francisco over the bridge to I-880 and south to SFO have medium noise impact ratings because of less sensitive land uses adjacent to the freeways in those areas. The part of the region from Gilroy to Merced has low population density, which results in a low potential noise impact rating. Noise impacts on wilderness areas would also be relatively low since the highway improvements identified are expansions of existing facilities (noise corridors).

Increases in railroad operations are another potential source of noise impacts for the Modal Alternative. Potential noise impacts in residential areas are caused by increased train operations and by horns and bells at grade crossings. Commuter rail operations by Caltrain on the Peninsula and, to a lesser extent, Amtrak and freight operations on East Bay are major contributors. However, the change in projected commuter/intercity rail operations between Modal and No Project Alternatives is anticipated to be relatively small compared to the significant increases in highway traffic that will have a greater effect on noise.

The Modal Alternative included a new runway for both Oakland and San Jose airports to accommodate intercity traffic in lieu of HST. Adding runways in a dense urban environment would affect large additional areas due to the size of the physical improvement as well as the increased noise level associated with the improvement. In San Jose, an additional runway would impact a large area of residential and commercial land uses. In Oakland, the increased number of operations would impact the noise levels in surrounding areas. Overall, the Modal Alternative would have a greater number of miles with a high impact rating than the HST Alternative, although the total number of people newly impacted would not be as great in this region, primarily due to prior exposure from the existing highway, rail and air noise components.

<u>High-Speed Train Alternative</u>

The existing Caltrain alignment along the San Francisco Peninsula and the East Bay railroad alignments pass through densely populated communities where there is high potential for noise impacts. The potential noise impacts of the proposed HST service through these areas would result primarily from the greater frequency of trains, since the HST service would be operating at reduced speeds and would create similar noise levels to the existing services. The HST system would be expected to result in the elimination of up to 48 grade crossings on the Peninsula and up to 38 grade crossings on the East Bay. Grade separation of existing rail services would result in considerable benefits from the elimination of the warning bells at existing at-grade crossings and the horn blowing of the existing commuter/intercity services along these alignments. Although the HST service would be going through densely populated communities, the Caltrain alignment and the Hayward/Niles/Mulford Line in the East Bay were rated as having a medium level of potential noise impacts because the HST would be traveling at reduced speeds, and the communities would benefit from grade separation improvements for existing services and electrification of the railroad.

Between San Jose and Gilroy, the HST is rated as having medium potential for noise impacts. While the HST system could reach speeds as great as 186 mph (299 kph) through this area, the densities are less than on the Peninsula or the East Bay, and the communities would receive considerable benefit from the elimination of up to 24 grade crossings.

All the options for mountain crossings between the Bay Area and the Central Valley are through sparsely populated areas, but would introduce new noise sources along corridors through wilderness areas where the alignment is at grade or elevated.

<u>High-Speed Train Alignment Option Comparison</u>

Of the two options in the East Bay, the Hayward/I-880 alignment was given a higher ranking for potential impacts than the Hayward/Niles/Mulford Line, since the former would be elevated and would add noise from the already grade-separated freeway corridor. However, the Mulford Line would pass through the Don Edwards Wildlife Refuge and would have more impacts on wildlife than the I-880 freeway option.

Between San Jose and Merced, the Pacheco Pass alignments have higher potential for community impacts than the Diablo Range direct crossing options because of the potential for noise impacts through the urban and suburban areas of south Santa Clara County. For the Pacheco Pass alignment options, the Morgan Hill/Caltrain/Pacheco Pass option would minimize potential noise impacts on Gilroy. The Diablo Range direct alignment through Henry Coe State Park at grade would have more potential impacts on wildlife than the other two Diablo Range options because these options would have about 5 mi (8 km) of additional at-grade track rather than tunnel in the wilderness area.

Serving both the Peninsula and the East Bay would increase the number of alignment miles for Bay Area noise impacts, but reduce the frequency of HST service to either side of the bay.

B. SACRAMENTO TO BAKERSFIELD

Modal Alternative

From Sacramento to Bakersfield the potential noise impacts would be generally low. One area of potentially high impact is the I-5 corridor from the middle of Stockton to I-5 due to the close proximity of residential land along this alignment segment. Two segments with a medium rating are along SR-99 south from Sacramento to Manteca and also south from Bakersfield to I-5. Overall, the Modal Alternative has a greater distance with a high impact rating than the proposed HST Alternative, although the total number of people newly impacted is not as great as other regions, primarily due to existing exposure to highway noise. These highway corridors are heavily used by truck traffic, which generates high noise levels through the evening hours.

Potential improvements at the Sacramento Airport and Fresno Airport would not be extensive in terms of additional land area required (additional runways) and would have low potential noise impacts.

High-Speed Train Alternative

Through the Central Valley most of the alignment options for the HST Alternative are rated as low potential noise impact, due generally to the sparseness of residential land use and the extent of open space along most of the length of the options—even though the proposed HST service would be operating at maximum speeds throughout most of the Central Valley. However, there are a number of locations throughout the San Joaquin Valley where the various alignment options pass through populated areas and have high potential noise impact ratings for short segments. Examples include portions of Sacramento, Fresno, Tulare, and Manteca that could be exposed to high noise levels from HST operations.

Through many of the cities in the Central Valley, the HST is proposed to be on aerial structure, primarily to reduce potential conflicts with freight railroad spur tracks or freight railroad yards. The vertical elevation of the aerial structure would allow potential noise impacts to extend further than they would at grade.

Through several of the urban areas, the HST mainline (express or high-speed) alignment could pass through the city or community or avoid it by passing through surrounding areas (primarily farmlands). A representative typology study of the proposed high-speed loop around Fresno concluded there would only be a 12% to 16% reduction in noise impacts by moving the high-speed mainline (express) tracks outside the urbanized areas. The relatively modest decrease in noise impacts is attributed to three factors: 1) there would be some residential impacts along the new express loop; 2) many of the land uses surrounding the freight line through downtown

Fresno are industrial; 3) the express loop results in noise impacts on two corridors as opposed to one. Figure 3.4-14 shows the mainline alignment through Fresno and the express loop options together with the surrounding land uses.

All alignment options in this region would have a low potential vibration impact rating. A few short segments of populated areas would have medium potential vibration impact ratings.

HST Alignment Option Comparison

Between Sacramento and Bakersfield there are two potential alignment options for the proposed HST Alternative along railroad rights-of-way, UPRR and BNSF, along with some combinations. The UPRR alignment would have a considerably greater potential for noise impacts than the BNSF alignment. The UPRR alignment passes through much more urban area. The UPRR has more freight activity to the Central Valley cities it bisects, which results in more spur lines, service lines, and freight yards in these communities along the freight alignment. The proposed HST line would be grade-separated from these freight railroad facilities, typically on an elevated structure. Therefore, the UPRR passes through more communities, and would require more elevated structures through these communities. The Central California Traction (CCT) alignment option would have fewer potential noise impacts than the UPRR alignment between Sacramento and Stockton because there are fewer residential areas near the alignment. South of Power Inn Road in Sacramento, both CCT and UPRR would be predominately at grade. Along the UPRR, some grade-separation benefits would result from reducing noise from the existing freight services, whereas the CCT is a recently abandoned freight corridor.

Between Stockton and Merced, the UPRR alignment would have much higher potential noise impacts than the BNSF alignment. UPRR goes through much more urban area as it passes through the cities and communities that developed around the railroad line, and is proposed to be on aerial structure through many of these communities. Conceptually, the alignment options along UPRR would have a substantial amount of aerial structure through Manteca, Modesto, Keyes, Turlock, and Atwater, whereas the alignment through Salida, Ceres, Delhi, Livingston, and Merced would be at grade. The alignment options along BNSF would have a substantial amount of aerial structure through Escalon and Riverbank. Through Riverbank, however, the downtown and most of the populated area would be at grade. BNSF would be at grade through the outskirts of Modesto (Briggsmore), Hughson, Denair, Winton, Atwater, and Merced. Much of the potential noise impact of BNSF may be offset by the noise benefits from grade separating the adjacent freight service when operating at grade.

Between Merced and Fresno, the UPRR alignment option would have higher potential noise impacts than the BNSF alignment. UPRR goes through more urban areas, and is proposed to be on aerial structure through these communities. Conceptually, the alignment options along the UPRR corridor have a substantial amount of aerial structure through both Chowchilla and Madera. The BNSF corridor does not go through much developed area between Merced and Fresno. The BNSF alignment options would be at grade through Le Grand and the outskirts of Madera. Much of the potential noise impact of BNSF may be offset by the noise benefits from grade separating the adjacent freight service when operating at grade. Through Fresno, only the UPRR alignment option is being considered for further evaluation. A majority of the UPRR alignment through Fresno is expected to be at grade.

Between Fresno and Bakersfield, the UPRR alignment option would have much higher potential noise impacts than the BNSF alignment option. However, BNSF would have more potential noise impacts through Bakersfield. UPRR goes through many more urban areas and is proposed to be on aerial structure through many of these communities. Conceptually the alignment options along the UPRR corridor would have a substantial amount of aerial structure through Selma, Traver, Goshen, Tulare, Pixley, and Delano, whereas the alignment through Fowler, Kingsburg (on aerial structure south of the Kingsburg urban area), Tipton, Earlimart, and McFarland would be at grade. The alignment options along the BNSF corridor would have a substantial amount of aerial structure through the outskirts of Corcoran, through Hanford, and Shafter, whereas the BNSF would be at grade through Laton. Through Bakersfield, a majority of the UPRR alignment option is at grade and travels through industrial land uses. The BNSF alignment option would include more aerial structure through Bakersfield and impact more residential areas than the UPRR alignment option.

Through Modesto, Merced, Fresno, and Tulare, the high-speed train mainline (express or high-speed) alignment could pass through the city or community or avoid it by passing through surrounding areas (primarily farmlands). As previously noted, the focused study on the high-speed loop around Fresno concluded there would only be a modest (12% to 16%) reduction in noise impacts by moving the high-speed mainline (express) tracks outside the urbanized areas. The Fresno typology is representative of the express loop bypass design options for other Central Valley communities, and it is expected that the express loop design options for Modesto, Merced, and Tulare would yield similar results to the Fresno typology.

C. BAKERSFIELD TO LOS ANGELES

Modal Alternative

From Bakersfield to Los Angeles there would be more potential noise impacts in the urban areas such as Bakersfield and Los Angeles than in the rural areas. As the highway alternative crosses the sparsely populated Tehachapi Mountains potential noise impacts on residents would be minimal; however, there may be noise impacts on sensitive wildlife.

The expansion of the Burbank airport and the associated higher frequency of take offs and landings would have potential noise impacts in the area surrounding the airport. The addition of a runway would impact a large area of residential and commercial land uses and the increased number of operations would impact the noise levels in surrounding areas. Overall, the Modal Alternative's potential noise impacts would be expected to be greater than potential noise impacts from the HST Alternative. Because the highway would be expanded by as much as 6 lanes through the mountain passes and would not use tunneling, it would have substantial noise impacts on wildlife, recreational use of nature trails, and other outdoor recreation activities and uses.

High-Speed Train Alternative

The proposed HST Alternative would have low potential noise impact ratings between Bakersfield and Sylmar due to the sparseness of residential land use and the extent of open space along most of the two routes. Within Bakersfield, where HST express services would achieve maximum speeds, the two alignment options would pass through areas with residential population and have greater potential noise impacts. As the alignments near Los Angeles, the potential for noise impact increases as the population density increases. The alignment segment between Sylmar and Burbank would be expected to reach relatively high speeds as great as 186 mph (299 kph) and has a high potential for impact through Sylmar and a medium potential for impact through Burbank. Elimination of nine grade crossings between Sylmar and Los Angeles would result in noise reduction benefits to people who live near those crossings. South of Glendale, the proposed HST system would operate at reduced speeds. Most of the segment between Sylmar and Los Angeles is considered to have medium potential noise impacts because of the relatively long trench section proposed and the reduction in noise associated with the removal of grade separations over a long portion of this segment.

High-Speed Train Alignment Option Comparison

The HST Alternative has low potential noise impact ratings along both the I-5 and SR-58/Soledad Canyon alignment options due to the sparseness of residential land use and open space along most of these two routes. However, more of the SR-58/Soledad Canyon alignment option passes through populated areas. In addition, the I-5 alignment would require more tunneling through the open space and natural areas, which would result in fewer potential noise impacts on wildlife, hiking trails, and other outdoor recreational uses.

D. LOS ANGELES TO SAN DIEGO VIA INLAND EMPIRE

Modal Alternative

Between Los Angeles and San Diego along the inland routes, freeway traffic is extremely heavy throughout the area. The high population density in close proximity to the freeways between Los Angeles and San Bernardino/Riverside results in high noise impact ratings for that area. South of March Air Reserve Base (ARB) to Mira Mesa, the lower population density along the highway segments is reflected in a low noise impact rating. Potential noise impacts are rated as medium in the stretch from Mira Mesa to San Diego.

The expansion of the Ontario and San Diego airports and the associated higher frequency of takeoffs and landings would have high potential impacts on the noise levels in the areas surrounding the airports. An additional runway at each of these airports would impact large areas of residential and commercial land uses and the increased number of operations will impact the noise levels in surrounding areas. Overall, the number of potential noise impacts associated with the Modal Alternative falls between the HST GPI and with the LPI in this region.

High-Speed Train Alternative

The high population density in Los Angeles and San Bernardino/Riverside results in both medium and high noise impact ratings for the proposed HST Alternative throughout that area. However, compared to the freeway alignments, the rail alignments generally abut less sensitive industrial and commercial land uses that are less vulnerable to noise. There are also considerable stretches of grade-separation improvements that would reduce impacts from existing freight rail services along portions of the alignment. Between Pomona and Riverside, the UPRR Colton alignment is very straight and contains mostly industrial land uses where the HST system would be expected to achieve maximum speeds for this segment. South of March ARB to Mira Mesa, the lower population density along the I-215 and I-15 highway alignments is reflected in a low noise impact rating. South of Escondido, the HST service would largely be reduced to speeds of 125 mph (201 kph) or less because of alignment issues. Potential noise impacts are rated as medium and high in the stretch from Mira Mesa to downtown San Diego via either Miramar Road or Carol Canyon. All alignment options in this region have potential vibration impact ratings of medium or low.

High-Speed Train Alignment Option Comparison

The HST Alternative alignment option along the UPRR Colton Line (northern alignment option) alignment between Los Angeles and East San Gabriel Valley would have a high potential for noise impacts due to the proximity of residential land use along most of this route, whereas the UPRR Riverside/UPRR Colton alignment is largely surrounded by industrial land uses and is ranked as having a medium potential for noise impacts.

The alignment that would most directly serve San Bernardino would have considerably higher potential noise impacts than the UPRR Colton alignment because it would impact more residential areas. Between Ontario Airport and Colton, the UPRR Colton alignment is within a wide, sparsely developed industrial corridor.

From Los Angeles to March ARB, the low potential vibration rating would be along the UPRR Colton Line option, as compared to a medium rating along the UPRR Colton Line to San Bernardino, due to the lower population within the screening distance along the former alignment.

The Miramar Road alignment option from Mira Mesa to San Diego would have a higher potential noise impact rating than the Carol Canyon alignment option, which would traverse less populated areas. Both the Miramar Road and Carol Canyon alignments would have considerably higher potential noise impacts than the option along I-15 to Qualcomm Stadium. The Qualcomm Stadium option would also have a lower potential for vibration impacts.

E. LOS ANGELES TO SAN DIEGO VIA ORANGE COUNTY

Modal Alternative

Under the Modal Alternative, the potential for high noise impacts would occur along the I-5 corridor from downtown Los Angeles to Irvine and also in San Juan Capistrano, Encinitas, and San Diego. These potential noise impacts would be due primarily to the close proximity of residential land along these alignment segments. The coastal area south of Dana Point up to Encinitas would not be as highly impacted due to the relatively open agricultural areas along the freeways. The Modal Alternative would have generally greater impact than the proposed HST options through this region. South of Encinitas along the coastal areas to San Diego and across lagoons with sensitive habitat and numerous birds, the noise impacts of expanded highways would be added to existing noise levels.

High-Speed Train Alternative

The HST Alternative would be expected to have potential impacts that are high along the LAX connection alignment for the proposed HST and the UPRR Santa Ana alignment from Los Angeles to Anaheim. Although the proposed HST speeds along the LAX alignment would be well under 100 mph (161 kph), a new, frequent, passenger service would be introduced into a dense urban area, resulting in a new and significant noise source.

Overall, the LOSSAN alignment would receive benefits from grade crossing eliminations that would be part of the proposed improvements. A major benefit is the elimination of horn noise at the grade crossings. Horn noise dominates the area within 0.25 mi (0.40 km) of a grade crossing, such that its elimination would more than make up for the increased train noise. It is estimated that potential noise impacts can be reduced by approximately 80% at adjacent receptors by eliminating freight and passenger train horns, according to the noise study results.

High-Speed Train Alignment Option Comparison

The LOSSAN rail alignment between Los Angeles and Anaheim has a considerably lower noise impact rating than the UPRR Santa Ana alignment. The communities along the LOSSAN alignment would receive benefits from full grade separation due to the elimination of warning bells and train horn noise from existing services (Amtrak, Metrolink, and freight) along this heavily used rail line. In contrast, UPRR Santa Ana would be introducing a new, frequent, passenger service to a lightly used freight alignment.

Between Anaheim and Irvine, both the HST alignment option (to bring direct service to Irvine), and the high end conventional rail improvements option would result in a fully grade-separated LOSSAN rail alignment. The communities along the LOSSAN alignment (Orange, Santa Ana, and Tustin) would receive benefits from full grade separation due to the elimination of warning bells and train horn noise from existing services (Amtrak, Metrolink, and freight) along this heavily used rail line from these options. In contrast, the low end conventional rail improvements would permit additional frequencies of service, which would have additional noise impacts without the benefits of grade separation.

3.4.5 Design Practices

Because of the high-speed alignment requirements of the HST system, over nearly 10% of the preferred alignments are in a tunnel or trench section. For these segments of the system the potential for noise impacts are mostly eliminated. The tunnel cross sections are designed (per established engineering criteria) to provide sufficient cross sectional area to avoid potential aerodynamic effects at the tunnel portals due to trains operating at maximum speed.

At similar speeds high-speed trains generate significantly less noise than existing commuter and freight trains. This is primarily due to the use of electric power versus diesel engines, higher quality track interface, and smaller, lighter and more aerodynamic trainsets. The use of electric power units would not have the engine rumble associated with diesel-powered locomotives. While wheel/track interface is a significant source of train noise, HST track beds and rails are designed and maintained to very high geometric tolerances and standards which would greatly minimize track noise that is prevalent with existing commuter/freight tracks throughout the study area.

Another reason HST noise impacts are less than commuter or freight trains is that high speeds would result in short duration noise events compared with conventional trains (a few seconds at the highest speeds versus 10 to 20 seconds for conventional passenger trains and well over 1 minute for freight trains).

The HST system would be fully grade separated from all roadways. In the urban areas where potential for noise impacts is typically at the highest levels, the HST system is predominantly in or adjacent to existing rail corridors and the HST Alternative often includes the grade separation of the existing tracks. Grade separations completed with the HST system in corridors such as these would eliminate current horn sounding and bells at existing grade crossings and would result in a noise benefits that would offset much of the HST noise impacts.

3.4.6 CEQA Significance Conclusions and Mitigation Strategies

Based on the analysis above, and considering the CEQA Appendix G thresholds of significance for noise and the FRA guidance manual discussed in section 3.4.1, the HST alternative would have a potentially significant impact on noise when viewed on a system-wide basis. The HST alternative would create construction-related short-term noise impacts. The HST alternative would also create long-term noise impacts from introduction of a new transportation system, including potential vibration impacts. At the same time, the HST alternative would create some long-term noise reduction benefits due to elimination of noise sources with grade separation of existing grade crossings. While the significance of the impacts is dependent on the sensitivity of the landscape and noise receptors, the analysis finds some high impacts on noise-sensitive land uses and populations and these impacts are therefore considered significant. Mitigation strategies, as well as the design practices discussed in section 3.4.5, will be applied to reduce this impact.

General mitigation strategies are discussed in this programmatic review of potential noise impacts associated with proposed alternatives. More detailed mitigation strategies for potential noise and vibration impacts would be developed in the next stage of environmental analysis. Noise and vibration mitigation measures can generally be applied to the source (train and associated structures), the path (area between train and receiver) and/or the receiver (property or building). A new HST system would be designed and developed to meet state-of-the-art technology specifications for noise and vibration, based on the desire to provide the highest-quality train service possible. Trains and tracks would be maintained in accordance with all applicable standards to provide reliable operations.

Treatments such as sound insulation or vibration controls to impacted buildings may be difficult to implement for the potentially numerous properties adjacent to the right-of-way. Such treatments require protracted implementation procedures and separate design considerations. The most feasible and effective mitigation treatments are typically those involving the path. These mitigation measures can often be applied to the path within the right-of-way, either under or adjacent to the tracks. Potential noise impacts can be reduced substantially by the installation of sound barrier walls constructed to shield receivers from train noise. For vibration mitigation, a number of track treatments may be considered for reducing train vibrations. Determining the most appropriate treatment would depend on the site-specific ground conditions found along the corridor. This program-level analysis has identified areas where future analysis should be given to potential HST-induced vibrations.

A. NOISE BARRIERS

Noise barriers are often a practical way to reduce noise impacts from transportation projects including the proposed HST system. The representative typologies considered mitigation with noise barriers for certain areas. In most cases the potential noise impacts could be reduced from the severe impact category to the FRA's impact category, and to the no impact category in some locations, with the application of appropriately dimensioned noise barriers next to the tracks. The design of noise barriers appropriate for the proposed HST right-of-way line would depend on the location and height of noise-sensitive buildings, as well as the speeds of the trains. Noise barriers 8 to 10 ft (2 to 3 m) tall could be installed where speeds are relatively low such that wheel/rail noise dominates. Higher noise barriers of 12 to 16 ft (4 to 5 m) might be used to reduce noise to taller buildings, or where speeds are high in noise-sensitive areas. In many locations noise barriers could be installed on one side of the track only, due to he location and proximity of noise-sensitive areas.

Application of mitigation to the proposed HST system would result in a considerable reduction of potential noise impacts. The estimates obtained from the results of the representative typologies showed noise barriers to be effective in reducing the potential noise impact rating by one category, for example, from high to medium or from medium to low. Consequently, HST segments with high rating would be adjusted down to, at most, a medium rating. With mitigation applied to the HST Alternative, both the GPI and LPI scenarios would represent substantially lower levels of potential impacts as compared to the Modal Alternative.

To estimate the reduction in noise impacts, the percentage reduction in noise for each segment was applied to the total number of people impacted in that segment, assuming the mitigation removed that many people from being impacted. The number of people remaining in the impact category was then summed for each region and system-wide. The lengths of the routes requiring noise barriers were then tabulated to provide an estimate of the mitigation costs.

The cost of constructing a noise barrier on one side of a highway or a rail line is estimated at approximately $1 million per mi ($625,000 per km) for a concrete wall of 12 ft (4 m) in height. Conservatively, a unit cost of $1.5 million per mi ($937,500 per km) was applied to the alignment segments in the HST Alternative with high potential noise impact ratings. The procedure was repeated for all segments with a medium rating in addition to those with high rating, thereby reducing all HST noise impact ratings to low. The same costs were applied to the Modal Alternative for comparison using segment lengths with a high noise impact rating. This approach was intended to provide a rough estimate of potential mitigation costs, recognizing that specific mitigation would be developed as a part of project-level review.

The results in Table 3.4-2 show that potential mitigation costs for the HST Alternative, applied to the segments rated at high potential for noise impacts only, would be less than the costs of similar mitigation applied to the Modal Alternative. This analysis included noise mitigation (barrier walls) for 8 of the 731 route miles (13 of the 1,176 route km) of the proposed HST segments with LPI and 133 of the 773 route miles (214 of the 1,244 route km) with GPI. With mitigation applied to both high- and medium-rated segments, the HST potential impacts would be reduced further below the Modal Alternative, including noise mitigation (barrier walls) for 144 and 369 route miles (232 and 594 route km), for the LPI and GPI, respectively.

Table 3.4-2
Potential Length and Cost of Noise Mitigation[a] by Alternative

Alternative	Mitigation length in miles (km)	Noise Barrier Cost (millions)
MODAL—highway component (high level only)	210 (338)	$315
HST mitigating (high levels only)	8–133 (13–214)	$12–$200[b]
HST mitigating (high and medium levels)	144–369[b] (232–594)	$216–$554[b]

[a] Mitigation refers to barrier walls only.
[b] Range for LPI and GPI.

Not included in the costs for the Modal Alternative are noise abatement measures at airports that may involve extensive programs of sound insulation of homes. A typical sound insulation program limits the costs to approximately $30,000 per home. Referring to tables in Appendix 3.4-D where the number of people impacted by aviation noise is shown as approximately 12,000 people, and assuming there are four people to a house, the cost for noise mitigation around airports associated with the Modal Alternative could be an additional $90 million.

B. VIBRATION MITIGATION

Vibration mitigation is less predictable at a program level of analysis due to the site-specific nature of vibration transmission through soil conditions along the alignment. However, an estimate can be made of the length of corridor where special mitigation may need to be considered by totaling the segments with potential vibration impact rating of high. The results are shown in Appendix 3.4-E. The range is 10 to 60 mi (16 to 97 km) to be considered for mitigation depending on which alignment is chosen.

C. CONSTRUCTION MITIGATION

Potential mitigation strategies for construction noise impacts associated with the HST Alternative are listed below.

- Construction noise could be reduced by using enclosures or walls to surround noisy equipment, installing mufflers on engines, substituting quieter equipment or construction methods, minimizing time of operation and locating equipment farther from sensitive receptors.
- Construction operations could be suspended between 7:00 p.m. and 7:00 a.m. or on weekends or holidays in residential areas.
- Contractors could be required to comply with all local sound control and noise level rules, regulations and ordinances.
- Ensure that each internal combustion engine would be equipped with a muffler of a type recommended by the manufacturer.
- Other measures that should be considered include the following:
- Specifying the quietest equipment available would reduce noise by 5 to 10 dBA.
- Turning off construction equipment during prolonged periods of non-use would eliminate noise from construction equipment during those periods.

- Requiring contractors to maintain all equipment and train their equipment operators would reduce noise levels and increase efficiency of operation.
- Locating stationary equipment away from noise sensitive receptors would decrease noise impact from that equipment in proportion to the increased distance.

The above mitigation strategies are expected to reduce the short-term and long-term noise impacts of the HST alternative to a less-than-significant level. Additional environmental assessment will allow a more precise evaluation in the second-tier project-level environmental analyses.

3.4.7 Subsequent Analysis

A. NOISE ANALYSIS

The FRA provides guidance for two levels of analysis in project environmental review, a general assessment method to further quantify the potential noise impacts in locations identified by the screening procedure, and a detailed analysis procedure for evaluating suggested noise mitigation at locations where further studies show there is potential for significant impacts. The process is designed to focus on problem areas as more detail becomes available during project development. Subsequent analysis would proceed along the following lines.

<u>Ambient noise conditions</u>
The existing ambient noise environment is described by assumptions in the screening procedure. However ambient noise values would be estimated at the project-level analysis based on limited measurements in the general assessment and would be thoroughly measured in the detailed analysis. A measurement program involving both long-term and short-term noise monitoring would be performed at selected locations to document the existing noise environment. As it would be impractical to measure everywhere, the monitoring would be supplemented by estimates of noise environments at locations considered to be typical of others. Guidelines for characterizing the existing conditions are provided by the FRA.

<u>Project Noise Conditions</u>
A generic HST is used in the screening procedure, but a specified train type, speed profile and operation plan would be available for more refined projections of noise levels in the next stage of environmental analysis.

<u>Noise Propagation Characteristics</u>
The screening procedure assumes flat terrain with noise emanating from a source unhindered by landforms and human-made structures. The next stage of analysis would incorporate topography as well as consideration of shielding by buildings, vegetation, and other natural features in a particular corridor.

<u>Impact Criteria</u>
The screening procedure accounts for all noise-sensitive land use categories that may be exposed to noise levels exceeding the threshold of impact. In the next stage of analysis, assessments using the full, three-level FRA impact criteria would be performed (U.S. Department of Transportation 1998). This more detailed assessment would more specifically identify locations where potential impacts may occur and locations where potentially high impact may occur and would provide for consideration of specific mitigation measures where appropriate.

<u>Mitigation</u>
Noise abatement is discussed generally in the screening procedure, and areas are identified where more detailed analysis should be focused in the future to integrate a proposed HST system into the existing environment. As more detail becomes available in the general assessment

phase, there may be many areas that were identified as potentially impacted during screening analysis for which further analysis would not be needed, because they would not be impacted. The detailed analysis would provide information useful for the engineering design of mitigation measures. These measures would be considered in the project-level environmental review, and potential visual and shadow impacts of noise barriers would also be considered.

B. VIBRATION ANALYSIS

The steps involved in the more detailed analysis of ground-borne vibration would be similar to those for noise. The major difference would be the need for study of site-specific ground-borne vibration characteristics. Considerable variation of soil conditions may occur along the corridor, resulting in some locations with significant levels of vibration from the HST and other locations at the same distance from the track where vibrations can hardly be perceived. Determining the potential vibration characteristics in the detailed analysis would involve a measurement program performed according to the method described in the FRA guidance manual (U.S. Department of Transportation 1998). This method would allow for the prediction of vibration levels and frequency spectrum information valuable not only in the assessment of impact, but also in the consideration of mitigation measures.

3.5 ENERGY

This analysis provides an overview of the potential operation and construction impacts associated with both the general overall use of energy and the more specific use of electrical energy for the existing conditions and the No Project, Modal, and High-Speed Train (HST) Alternatives.

3.5.1 Regulatory Requirements and Methods of Evaluation

A. REGULATORY REQUIREMENTS

Federal Regulations

Federal Energy Regulatory Commission: The Federal Energy Regulatory Commission (FERC) is an independent agency that regulates the interstate transmission of natural gas, oil, and electricity. FERC also regulates natural gas and hydropower projects. As part of that responsibility, FERC regulates the transmission and sale of natural gas for resale in interstate commerce, the transmission of oil by pipeline in interstate commerce, and the transmission and wholesale sales of electricity in interstate commerce. FERC also licenses and inspects private, municipal, and state hydroelectric projects; approves the siting of and abandonment of interstate natural gas facilities, including pipelines, storage, and liquefied natural gas; oversees environmental matters related to natural gas and hydroelectricity projects and major electricity policy initiatives; and administers accounting and financial reporting regulations and conduct of regulated companies.

Corporate Average Fuel Economy Standards: Corporate Average Fuel Economy (CAFE) standards are federal regulations that are set to reduce energy consumed by on-road motor vehicles. The standards specify minimum fuel consumption efficiency standards for new automobiles sold in the United States. The current standard for passenger cars is 27.5 miles per gallon (mpg) (44.3 kilometers per gallon [kpg]). The 1998 standard for light trucks was 20.7 mpg (33.3 kpg) (Competitive Enterprise Institute 1996). In April 2002, the National Highway Traffic Safety Administration, part of the U.S. Department of Transportation (DOT), issued a final rule for CAFE standards for model-year 2004 light trucks that codified a standard of 20.7 mpg (33.3 kpg); this level is now in effect (U.S. Department of Transportation 2002a).

Transportation Equity Act for the 21st Century: The Transportation Equity Act for the 21st Century (TEA21), passed in 1998, builds on the initiatives established in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), which was the prior authorizing legislation for surface transportation. The ISTEA identified planning factors for use by Metropolitan Planning Organizations (MPOs) in developing transportation plans and programs. Under the ISTEA, MPOs are required to “protect and enhance the environment, promote energy conservation, and improve quality of life” and are required to consider the consistency of transportation planning with federal, state, and local energy goals (U.S. Department of Transportation 2002b).

Section 403(b) of the Power Plant and Industrial Fuel Use Act of 1978 (P.L. 95-620): This section of the Power Plant and Industrial Fuel Use Act encourages conservation of petroleum and natural gas by recipients of federal financial assistance.

Executive Order 12185, Conservation of Petroleum and Natural Gas (December 17, 1979, 44 F.R. § 75093): This executive order encourages additional conservation of petroleum and natural gas by recipients of federal financial assistance.

State Regulations

Public Resources Code Section 21100(b)(3) provides that an EIR shall include a statement setting forth the mitigation measures proposed to minimize the significant effects on the environment, including measures to reduce the wasteful, inefficient, and unnecessary consumption of energy. Appendix F to the California Environmental Quality Act (CEQA) Guidelines addresses energy conservation goals, notes that potentially significant energy implications of a project should be considered in an EIR, and contains general examples of mitigation measures for a project's potentially significant energy impacts.

CEQA Guidelines Section 15126.2 discusses requirements for an EIR to address potentially significant effects, and although it does not include energy specifically, it mentions use of nonrenewable resources. CEQA Guidelines Section 15126.4(a)(1)(C) requires an EIR to discuss energy conservation measures, if relevant.

California Code of Regulations, Title 24, Part 6, Energy Efficiency Standards: Title 24, Part 6 of the California Code of Regulations, Energy Efficiency Standards, promotes efficient energy use in new buildings constructed in California. The standards regulate energy consumed for heating, cooling, ventilation, water heating, and lighting. The standards are enforced through the local building permit process. These standards may apply to any buildings (e.g., stations) constructed as part of or in association with the No Project, Modal, and HST Alternatives.

B. METHOD OF EVALUATION OF IMPACTS

This evaluation of energy supply and demand compares potential energy use for intercity travel of the proposed alternatives. This section explains the methodology used to evaluate the potential energy impacts and benefits attributable to operation (direct energy) and construction (indirect energy) of the alternatives under study. This section also explains the criteria used to determine whether a potential impact on energy consumption would be significant. The evaluation is based on available data and forecasts.

Direct Energy

Analyses were performed as described below to determine the operational impact of the alternatives on overall statewide transportation-related energy supply[1] and statewide electricity supply during peak demand.

Overall Statewide Transportation-Related Energy Supply: Overall direct energy consumption by the alternatives involves potential energy use by the operation of vehicles (automobiles, airplanes, and HSTs) and related infrastructure in the state. The potential direct impacts on overall transportation-related energy supply were evaluated both quantitatively and qualitatively.

The quantitative analysis focused on the direct relationship between projected vehicle miles traveled (VMT) and energy consumption to estimate the potential change in total energy consumption between the No Project, Modal, and HST Alternatives. Only intercity trips that would be served by the HST system, including some long-distance commute trips, were considered when modeling VMT. Local commute and other regional and intercity trips were not considered. The quantitative assessment of direct energy impacts considered the following.

- VMT for automobiles, airplanes, and HST within the study area, as described below in Section 3.5.2 (consistent with the analysis conducted for Section 3.3, Air Quality).
- Variation of fuel consumption rates by vehicle type.

Ridership projections for the HST system varied between 42 million and 68 million passengers (including 10 million long-distance commuters) for 2020, with potential for significantly higher

[1] *Overall energy* refers to the combination of energy derived from petroleum fuels and electrical energy.

ridership beyond 2020. The figures on the lower end of these estimates are considered investment-grade forecasts and are based conservatively on year 2000 costs, travel times, and congestion levels of air and automobile transportation. The figures on the higher end are based on a sensitivity analysis, which assumes the increased costs and congestion associated with air and automobile travel would result in greater potential ridership for the proposed intercity HST. The sensitivity analysis assumed investment-grade ridership forecasts and applied variations in mode characteristics that would tend to increase HST ridership and revenue in order to determine how sensitive HST ridership would be to increases in air and automobile rates of travel, air and automobile travel times, and airfares. This sensitivity analysis produced a higher ridership forecast, which is used in this Program EIR/EIS to estimate or project a maximum impact potential for the Modal and HST Alternatives.

For this Program EIR/EIS, the higher demand forecast of 68 million riders (58 million intercity trips and 10 million commute trips), based on the sensitivity analysis, offers a more reasonable estimate to represent total capacity of the proposed HST system, while serving as a representative worst-case scenario for defining the physical and operational aspects of the alternatives in 2020. This higher forecast is generally used as a basis for defining the Modal and HST Alternatives and is referred to in this report as the representative demand. In some specific analyses, such as this energy analysis, the high-end forecasts result in a benefit because the additional HST riders would make the HST more energy efficient (i.e., it would use less energy per passenger), thus creating a higher energy benefit to the overall intercity transportation system than the low-end (investment-grade) forecasts. In cases where the investment-grade forecasts result in greater impact levels than would result with representative demand, additional analysis is included to address the differences in potential energy impacts between what is expected under each of the ridership scenarios.

Projections of HST ridership and the number of trips that would otherwise use other modes were calculated and reported by Charles Rivers Associates in *Independent Ridership and Passenger Revenue Projections for High Speed Rail Alternatives in California* (California High Speed Rail Authority 2000). These projections were the basis for determining projected statewide VMT for each mode. Projections in the ridership report were based on surveys of current intercity air, conventional rail, and private vehicle travelers, historical and forecast population, income, traffic data, and an airline simulation model. HST trip durations and departure frequencies, fares, station locations, and amenities also affected ridership projections.

This energy analysis applies the higher-end forecasts from the Charles River Associates' sensitivity analysis. Automobile VMT modeling for the proposed HST Alternative was developed as part of this Program EIS/EIR and used to develop VMT values for existing conditions and the No Project and Modal Alternatives.

The VMT fuel consumption method used herein is outlined in the *Technical Guidance*, Section 5309 New Starts Criteria (Federal Transit Authority, Office of Planning 1999). Energy consumption factors for the first two modes identified in Table 3.5-1 were developed by Oak Ridge Laboratory and published in the 2002 *Transportation Energy Book* (Edition 22) (Oak Ridge Laboratory 2002). These results are based on national averages for road, traffic, and weather conditions, and are intended for general comparisons. The energy consumption factor for the HST mode is based on energy used by similarly designed trains, such as the Trains à Grande Vitesse in France and the Intercity Express in Germany (DE Consult 2003). This report assumes a 16-car trainset (engines and cars) with a 1,200-passenger carrying capacity.

Table 3.5-1
Direct Energy Consumption Factors

Mode	Factor
Passenger vehicles (auto, van, light truck)[a]	5,669 Btus/VMT
Airplanes[a]	334,086 Btus/VMT
High-speed trains[b]	924,384 Btus/VMT

Btus = British thermal units

Sources:
[a] Oak Ridge Laboratory 2002; based on nationally averaged conditions and fleet composition.
[b] DE Consult 2003, based on a 16-vehicle trainset.

Overall direct energy, measured in British thermal units (Btus), was converted to equivalent barrels of crude oil to represent potential energy impact and/or savings. (Btus are the standard units used by industry and government literature for such comparisons. Metric units for energy [i.e., Joules] are not used in this report.) Annual direct-energy consumption values for intercity travel were calculated for existing conditions and the No Project, Modal, and HST Alternatives, and compared. The potential change in commuter-derived direct energy consumption from the future No Project condition (in Btus) was calculated for the Modal and HST Alternatives.

The qualitative analysis of overall direct energy consumption considers the estimated or assumed levels of service for each of the alternatives and the effect that each would have on congestion and travel speeds, which would have a substantial impact on fuel efficiency and, therefore, energy use.

In addition to the overall direct energy analysis, average energy consumption per passenger mile was calculated for each of the transportation modes essential to the development of the Modal and HST Alternatives.

Statewide Electricity Supply During Period of Peak Demand: For the HST Alternative, peak-period electricity demand was determined using an energy consumption factor for HSTs obtained from DE Consult Peer Review Report (DE Consult 2000) and the operation plan from the California High Speed Rail Authority's (Authority's) final business plan (Business Plan). The demand was calculated in terms of megawatts and compared to current estimates of peak demand and supply capacity within grid controlled by the California Independent State Operator (Cal-ISO). Peak demand for electricity for the future No Project and Modal Alternatives is discussed qualitatively, as it is not possible to measure at the program level. This approach is reasonable because the possible increase in transportation-related electricity use associated with these alternatives would likely be small and considered insignificant.

Indirect Energy

The indirect energy impacts considered here include two potential construction-related energy consumption factors: construction of proposed alternatives and construction of secondary facilities.

Construction of Alternatives: Projected construction-related energy consumption refers to energy used for the construction of HST trackway and support facilities under the HST Alternative and highway expansion and airport runway improvements under the Modal Alternative, and transportation of materials and equipment to and from the work site. Construction-related energy consumption factors for the proposed HST system cannot be compiled because of the relative dearth of available HST examples from which to draw data. Data gathered for typical heavy rail systems and a heavy rail commuter system, San Francisco Bay Area Rapid Transit District (BART), were used to estimate projected construction-related energy consumption of the proposed HST system. Projected construction-related energy consumption for the Modal and HST Alternatives is presented in Table 3.5-2. These estimates are appropriate for comparison purposes.

The construction energy payback period measures the number of years that would be required to pay back the energy used in construction with operational energy consumption savings. The payback period was calculated for this section by dividing the estimate of each alternative's construction energy by the amount of energy that would later be saved by each of the proposed alternatives compared to the No Project condition. It was assumed that the amount of energy saved in the study year (2020) would remain constant throughout the payback period.

Table 3.5-2
Construction-Related Energy Consumption Factors

Mode	Facility	Rural Compared to Urban[f]	Factor (billions of Btus)
Modal Alternative			
Automobile	Highway (at grade)	Rural[a]	17.07/one-way lane mi
		Urban[b]	26.28/one-way lane mi
	Highway (elevated)	Rural[a]	130.38/one-way lane mi
		Urban[b]	327.31/one-way lane mi
Airplane	Runway	N/A[g]	6,312/runway
	Gate	N/A[g]	78[c]/gate
HST Alternative			
High-Speed Train	At grade	Rural[d]	12.29/one-way guideway mi
		Urban[e]	19.11/one-way guideway mi
	Elevated	Rural[d]	55.46/one-way guideway mi
		Urban[e]	55.63/one-way guideway mi
	Below grade (cut)	Rural[d]	117.07/one-way guideway mi
		Urban[e]	163.14/one-way guideway mi
	Below grade (tunnel)	Rural[d]	117.07/one-way guideway mi
		Urban[e]	328.33/one-way guideway mi
	Station	N/A[g]	78[c]/station

[a] Estimates reflect average roadway construction energy consumption.
[b] Estimates reflect range maximum for roadway construction energy consumption.
[c] Value for construction of freight terminal. Used as proxy for unknown air gate and HST station consumption factors.
[d] Estimates reflect typical rail system construction energy consumption.
[e] Estimates reflect BART system construction energy consumption as surrogate for HST construction through urban area.
[f] Differences between the construction-related energy consumption factors for urban and rural settings reflect differences in construction methods, demolition requirements, utility accommodation, etc.
[g] Discreet (i.e., non-alignment-related facilities) are not differentiated between rural or urban because the data used to develop the respective values were not differentiated as such. Some difference between the actual values might be expected.

Sources: Congressional Budget Office 1977; Congressional Budget Office 1982 Congressional Budget Office in Energy and Transportation Systems, Prepared for the Federal Highway Administration, Sacramento, CA, by California State Department of Transportation (California Department of Transportation 1983); based on construction for air freight services.

Secondary Facilities: A *secondary facility* is a facility that consumes energy in the production of materials related to the project alternatives. For example, a factory that produces construction materials and machinery that would be used in the construction and maintenance of the alternatives' structures and attendant facilities would be a secondary facility. Potential impacts resulting from energy consumption of secondary facilities are discussed qualitatively. Consideration was given to whether nonrenewable resources would be consumed in a wasteful, inefficient, or unnecessary manner, (with special attention given to the efficiency of production of construction materials and machinery and the choices made regarding construction methodology and procedures, including equipment maintenance).

C. CRITERIA FOR DETERMINING SIGNIFICANCE OF IMPACTS

According to Appendix F of the CEQA Guidelines, the means to achieve the goal of conserving energy include 1) decreasing overall per capita energy consumption, 2) decreasing reliance on natural gas and oil, and 3) increasing reliance on renewable energy sources. The significance criteria discussed herein are used to determine whether the alternatives would have a potentially significant effect on energy use, including energy conservation.

The No Project Alternative is the primary basis against which potential impacts of the Modal and HST Alternatives are compared. Significant potential operational energy impacts would occur if the Modal or HST Alternative would result in either substantial demand on statewide and/or regional energy supply, or a significant additional capacity requirement; or significant increase in peak- and base-period electricity demand.

Significant potential construction-related energy impacts would occur if construction of either the Modal or HST Alternative would consume nonrenewable energy resources in a wasteful, inefficient, or unnecessary manner. Implementation of the Modal or HST Alternative would have a significant adverse effect if it, together with regional growth, would contribute to a collectively significant shortage of regional or statewide energy. By contrast, if the implementation of either alternative resulted in energy savings or alleviated demand on energy resources, the alternative would contribute to energy conservation and would have a beneficial effect.

3.5.2 Affected Environment

A. STUDY AREA DEFINED

The areas potentially affected by overall energy use of the alternatives are the regions comprising six of California's 15 air basins. (See Figure 3.3-1 in Section 3.3, *Air Quality*, for a map of the state's 15 air basins.) The following six air basins fall within the study area defined for overall energy use.

- San Francisco Bay Area.
- Sacramento Valley.
- San Joaquin Valley.
- Mojave Desert.
- South Coast.
- San Diego County.

At this program level of analysis, the data needed to model overall energy use are similar to those used to analyze air quality effects, which were also analyzed at the air basin level. (See discussion of air quality in Section 3.3.) The air basins used in this analysis were identified because the majority of intercity trips taken in California occur within them. Nearby air basins could also be affected by the project alternatives, but any impact would likely be minimal compared to impacts on the basins that physically contain the project alternatives.

At this program level of analysis, the area studied to determine the potential effects of the proposed alternatives on electricity generation and transmission was the entire state of California, since most of this infrastructure in the state contributes to the statewide grid. In general, any potential effects on electrical production which may result from the proposed alternatives would affect statewide electricity reserves and, to a lesser degree, transmission capacity. Some general discussion of potential effects on regional electricity production and transmission is included.

B. GENERAL DISCUSSION OF ENERGY RESOURCES

California is the tenth-largest worldwide energy consumer and is ranked second in consumption in the U.S. behind Texas. Of the overall energy consumed in the state, the transportation sector represents the largest proportion at 46%. The industrial sector follows at 31%, residential at 13%, and commercial at 10%. Petroleum satisfies 54% of California's energy demand, natural gas 33%, and electricity 13%. Coal fuel in California accounts for less than 1% of total energy demand. Electric power and natural gas in California are generally consumed by stationary users, whereas petroleum consumption is generally accounted for by transportation-related energy use (California Energy Commission 2000). A description of the existing energy resources and market conditions that could be potentially affected by the proposed alternatives is provided below.

Petroleum

Demand for transportation services (and, therefore, petroleum/gasoline consumption) in California mirrors the growth of the state's population and economic output. Historical trends coupled with current population and economic growth projections indicate that transportation sector use of gasoline and diesel fuels can be expected to increase by approximately 40% over the next 20 years; gasoline demand is projected to increase from 13.9 billion gallons (gal) (52.6 billion liters [L]) in 1999 to 19.9 billion gal (75.3 billion L) by 2020, and diesel from 2.4 billion gal (9.1 billion L) to 4.8 billion gal (18.2 billion L) over the same period. The California Energy Commission (CEC) projects that in-state oil refining capacity will lag behind this forecasted growth if major changes to the in-state oil refining industry are not made, which could contribute to long-term volatility in the price of both gasoline and diesel fuel (California Energy Commission 2000). Foreign petroleum imports account for approximately 29% of the state's petroleum supply, a percentage that would be expected to increase as in-state and Alaskan oil production declines (California Energy Commission 2002c).

The combination of the strong growth in gasoline demand, recently phased-out fuel additive methyl tertiary butyl ether (MTBE), significantly expanded use of ethanol necessitated by the federal minimum oxygen requirement, and transition to Phase 3 reformulated gasoline (RFG) could negatively affect the balance between supply of and demand for transportation fuels in California and impair the ability of refiners to supply consistent volumes of gasoline to meet California's demand. MTBE is a gasoline-blending component that was used as a gasoline oxygenate to help control carbon monoxide emissions before being phased out of gasoline sold in California (December 31, 2002). Phase 3 RFG prohibits use of MTBE and directs use of only ethanol as an oxygenate. Revisions of state and federal regulations to further tighten specifications for diesel fuel have been adopted to reduce environmental impacts. Together, these efforts to improve the environmental performance of petroleum fuels pose challenges for producing fuel volumes required to satisfy California's growing transportation-related fuel consumption. According to CEC staff, it would be difficult for the state to rely solely on petroleum-based fuels in the future, assuming a stable transportation fuel market is the desired outcome. (California Energy Commission 2000.)

Electricity

Electric energy is given consideration in this analysis because of the projected use of electric energy to power the proposed HST.

Existing State Electricity Supply and Demand: In-state electricity generation, which accounted for 85% of the 2001 total electrical supply, is fueled by natural gas (42.7%); nuclear sources (12.6%); coal[2] (10.4%); large hydroelectric resources (8.0%); petroleum (0.5%); and renewable resources, including wind, solar, and geothermal (10.5%). Electricity imports in 2001 were 15% of total production. Imports from the Pacific Northwest accounted for 2.6%, and 12.8% came from the Southwest. (California Energy Commission 2003.)

According to the CEC, total statewide electricity consumption grew from 166,979 gigawatt-hours (GWh) in 1980 to 228,038 GWh in 1990, at an estimated annual growth rate of 3.2%.[3] The 1990s saw a slowdown in demand growth because of the recession that lasted through the early and middle parts of the decade. The statewide electricity consumption in 1998 was 244,599 GWh, reflecting an annual growth rate of 0.9% between 1990 and 1998 (California Energy Commission 2002a). In 2001, statewide consumption was about 250,000 GWh (California Energy Commission 2002b).

Peak electricity demand, expressed in megawatts (MW), measures the largest electric power requirement during a specified period, usually integrated over one hour. A single MW is enough power to meet the expected electricity needs of 1,000 typical California homes (California Energy Commission 2003b). For comparison, one GW would be enough power for 1,000,000 typical homes. Peak demand is important in evaluating system reliability, determining congestion points on the electrical grid, and identifying potential areas where additional transmission, distribution, and generation facilities might be needed. California's peak demand typically occurs in August between 3 p.m. and 5 p.m. High temperatures lead to increased use of air conditioning, which, in combination with industrial loads, commercial lighting, office equipment, and residential refrigeration, comprise the major consumers of electricity consumption in the peak-demand period in California (California Energy Commission 2000). In 2003, according to CEC, peak electricity demand for California is predicted to be about 52,150 MW.[4] Peak-generating capacity for the state was expected to be about 59,696 MW[5] in 2003 (California Energy Commission 2003c).

Cal-ISO controls the electrical grid that distributes about 82% of the electricity consumed in the state, with the remainder being distributed by municipal utilities. A potential HST system would likely draw most of its electricity from the Cal-ISO-controlled grid, illustrated in Figure 3.5-1.

Electricity Supply and Demand Outlook

The CEC has conducted studies to predict the short- and long-term outlooks for electricity supply and demand balance in California. According to its 2003 staff report, *California's Electricity Supply and Demand Balance over the Next Five Years*, the CEC believes that the near-term

[2] Intermontane and Mohave coal plants are considered to be in-state facilities because they are in Cal-ISO-controlled areas.

[3] Electric energy is measured in watts (W): 1,000 watts is a kilowatt (kW); 1,000 kilowatts is a megawatt (MW); 1,000 megawatts is a gigawatt (GW). Electric consumption over time is measured in kilowatt-hours (kWh), megawatt-hours (MWh), and gigawatt-hours (GWh).

[4] Figure does not include 7% operating reserve.

[5] Figure includes net dependable generating additions of about 3,600 MW, as of July 2003, and forced and planned outages of 3,750 MW. Does not include spot market imports of 3,721 MW.

outlook for supply adequacy is promising. A 16% operating margin[6] is estimated for summer 2003 (assuming a 1-in-2-year peak temperature condition) in the Cal-ISO-controlled grid where supply is expected to outpace demand by approximately 6,000 MW[7] (California Energy Commission 2003c). According to CEC staff, a statewide planning reserve margin[8] of 8.8% is projected as far out as August 2008, when statewide supply capacity is anticipated to be 64,669 MW, outpacing a statewide projected demand of 59,459 MW[9] (California Energy Commission 2003c). The apparent decline in margins between the summers of 2003 and 2008 is due to the fact that the planning horizon for electric power resource additions is usually only two to three years out and does not necessarily indicate a downward trend in generating capacity.

This short planning horizon interjects uncertainty into the assessment of supply and reserve margin in 2020, the study year for the No Project, Modal, and HST Alternatives. However, the state has added substantial generating capacity in the last two years and it is reasonable to assume it will continue to add capacity. Between 2000 and February 2003, California licensed and added 18 new power plants which have contributed 4,980 MW to the statewide generating capacity. Power plants representing an additional 3,106 MW of generating capacity were anticipated to come online between February 2003 and August 2003 (California Energy Commission 2003d). Statewide demand in 2012 would most likely be around 64,845 MW, assuming normal summer temperatures (California Energy Commission 2002b). Using the growth trend that fits CEC demand predictions through 2012, published in the *2002–2012 Electricity Outlook* (California Energy Commission 2002b), demand for electricity in 2020 can be estimated to be on the order of 77,000 MW.[10] The Cal-ISO estimates that net additions of domestic electricity generation capacity and electricity imports of 1,000 to 1,500 MW/year will be necessary to maintain current operating margins (California Independent State Operator 2002b).

Electricity Transmission Capacity Outlook: Electricity transmission capacity refers to the maximum amount of power that can be carried from the generating source to the utility provider and is a key component in the electrical power delivery system. In the years since the start of the electricity crisis in the summer of 2000, the transmission capabilities of some portions of the state's electrical grid have occasionally been inadequate to transmit electricity at a rate that would satisfy demand. This phenomenon is known as transmission bottlenecks. An example of one such current bottleneck occurs through what is known as Path 15, a major transmission line between northern and southern California through the Central Valley. According to the Western Area Power Administration (WAPA), the Pacific Gas and Electric Company (PG&E) plans to increase the rating of Path 15 from 3,900 MW to 5,400 MW. This process is expected to be completed by 2004 (Western Area Power Administration 2002). Improvements to other transmission paths are also planned, for example the link between California and the Southwest (Palo Verde-Devers Path) and the interconnect with the Tehachapi wind resource area (Consumer Power and Conservation Financing Authority, Energy Resources Conservation and Development Commission, and California Public Utilities Commission 2003).

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6 *Operating margin* means the percentage by which supply outpaces demand; figure includes a 7% operating reserve in calculation (California Energy Commission 2003b).

7 Figure includes operating reserve of 5,707 MW.

8 *Planning reserve margin* differs from operating margin because it does not including the 7% operating reserve in calculation and does not account for forced outages or include spot market purchases. It is used in extended planning horizons (California Energy Commission 2003c).

9 Demand projection assumes a normal summer. A hot summer increases projected demand to 62,914 MW, which corresponds to a 3.0% planning reserve margin.

10 Projection to 2020 assumes an average annual growth rate of about 2.0%, with a range from between 1.5% and 3.9%. This projection is for comparison purposes only.

Natural Gas

California is the second largest consumer of natural gas in the nation, with consumption at more than 5.5 billion cubic feet (Bcf) (0.2 billion cubic meters [Bcm]) per day in 1997. Approximately 33% of this total daily consumption was for electricity generation. Residential consumption accounts for 25%, followed by industrial, resource extraction, and commercial. CEC's gas demand forecast projects continued growth at 1.3% annually, with volumes exceeding 7 Bcf (0.2 Bcm) daily by 2019. Natural gas supplies to California will remain plentiful for the next several decades. The total resource base (gas recoverable with today's technology) for the lower 48 states is estimated to be about 975 trillion cubic feet (Tcf) (28 trillion cubic meters [Tcm]), enough to continue current production levels for more than 50 years. Technology enhancements will continue to enlarge this resource base; however, increases to production capacity are less certain (California Energy Commission 1999). Production in the continental U.S. is expected to increase from 19.36 Tcf (0.55 Tcm) in 2001 base year to 32.14 Tcf (0.91 Tcm) in 2020 (U.S. Department of Energy 2003). As of 2001, in-state natural gas production accounted for 15% of total consumption. Out-of-state production areas include the Southwest (50%), the Rocky Mountains (10%), and Canada (25%) (California Energy Commission 2003a).

California's Natural Gas Market: Although California's natural gas market is affected by nationwide price conditions, it has taken steps to insulate itself from the full magnitude of the price swing amplitudes. Starting in 2000 to 2001, during the last major price elevation, the state's natural gas utilities obtained additional interstate pipeline capacity rights on the El Paso Interstate Pipeline in the fall of 2002. This addition allowed the state to maintain adequate inflow rates and reduce harm from price swings. During the recent price spike, pipelines serving California were running at 50% to 70% of capacity, indicating that excess capacity was available if it had been needed. The trend toward more pipeline capacity is being continued in California by projects such as the Kern River Expansion pipeline project, which became operational on May 1, 2003. Utilities in California have also invested in underground storage capacity, an effective mechanism for controlling annual costs that will allow them to dampen the effect of future severe price increases by drawing on stored gas instead of buying high-priced natural gas on the open market. Storage capacity was added in 1999 and in 2002 with the construction of Wild Goose Storage, located in Butte County, which can accommodate 14 Bcf (0.4 Bcm) (with the further expansion of 15 Bcf [0.4 Bcm] expected in 2004) and Lodi Gas, which can accommodate 12 Bcf (0.3 Bcm).

The State of California has also provided utilities with the flexibility and tools to manage gas costs by purchasing natural gas supplies under different contract lengths and pricing terms, and from a variety of supply sources. In addition, California is in the process of increasing its supplies of electricity from renewable power sources such as wind, geothermal, and solar energy. California legislation enacted in 2002 (Senate Bill 1078) created the Renewable Portfolio Standard (RPS) Program which will require retail sellers of electricity to increase their purchases of electricity generated by renewable sources, and establishes a goal of having 20% of California's electricity generated by renewable sources by 2017. Increasing California's renewable supplies will diminish the state's heavy dependence on natural gas as a fuel for electric power generation (California Energy Commission/California Public Utilities Commission 2003).

Relationship between Natural Gas and Electricity Resources in California

Increases in gas prices directly affect the price of electricity because of the large role that natural gas plays in electricity production throughout the Southwest—and in California in particular, where natural gas fueled 42.7% of electricity production in 2001. This percentage is likely to grow as the trend toward building natural gas power plants continues. During the spot-market price spike of February 2003, regional electricity prices rose 45% between early February 2003 and February 24, 2003, and an additional 150% between February 24 and February 26, 2003.

Since late February, natural gas prices have steadily fallen, and prices for electricity have followed suit (California Energy Commission/California Public Utilities Commission 2003).

Notwithstanding the relationship between conditions in the natural gas market and electricity prices, the functioning of the natural gas market, as well as the consequences of price changes in the natural gas market, are fundamentally different from the electricity market. Unlike electricity, natural gas has the property of storability, which gives natural gas an advantage as a commodity over electricity. Because electricity is not storable, a true long-term futures market cannot function as it does for durable commodities, and rates are determined almost solely by electricity spot markets. The lack of a futures market makes electricity rates susceptible to the effects of extreme swings in supply and demand. Conversely, the storability of natural gas provides the advantages that a fairly well-functioning futures market[11] offers with regard to upward pressure that risk puts on prices, and it allows utilities to buy natural gas when prices are low and store it until prices rise. In short, natural gas acts as any other durable commodity in the marketplace, including oil. Short-term shortages are mitigated by the above-stated mechanisms. Long-term price increases are corrected by increases in production capacity, the expectation of which, in turn, acts to bring prices down. Since the projected national in-the-ground natural gas reserves are expected to last for at least the next 50 years, actual supplies are not considered to be limiting, and short- and long-term prices are mostly a function of market conditions, assuming the trend toward improvements in production and transmission capacity continues (California Energy Commission/California Public Utilities Commission 2003).

Transportation Energy Consumption

Transportation accounts for a large portion of the California energy budget, with approximately 46% of the state's energy consumption resulting from the transport of goods and people. Between 1997 and 2020, according to the State Department of Finance, the state is forecasted to grow by about 11 million people, or approximately 30% (California Department of Finance 1998). During this same period, intercity travel is projected to grow by almost 40% to almost 215 million trips per year (California High Speed Rail Authority 2000). Although the average fuel economy of vehicles in the state has improved, the fuel savings achieved are overshadowed by the increased number of miles traveled and the marked shift in personal vehicle preference, from the standard passenger automobile (sedan) toward larger vehicles such as sport utility vehicles (SUVs) and pick-up trucks. Currently, California's 24 million automobiles consume more than 17 billion gal (64 billion L) of petroleum, most of which is consumed in southern California. The state is the third-largest consumer of petroleum fuel in the world. Only the United States as a whole and the former Soviet Union exceed this volume. Because of this dependence on petroleum fuels, events in the international petroleum market can immediately and adversely affect the price and adequacy of California's fuel supply (California Energy Commission 1999).

There are currently four options for intercity travel among the major urban areas of California: automobiles on interstate and state highways, commercial airlines, conventional passenger trains (Amtrak) on freight and/or commuter rail tracks, and long-distance commercial bus transit. These four modes of intercity travel represent a wide range of service characteristics, such as travel time and frequency. Automobiles and airplanes are the predominant modes of intercity trips longer than 150 mi (241 km).

The effects of transportation congestion on energy consumption and air emissions can be major. Automobiles are most efficient when operating at steady speeds of 35 mph to 45 mph (56 kph to 72 kph) with no stops (Oak Ridge National Laboratory 2002). Fuel consumption increases by about 30% when average speeds drop from 30 mph to 20 mph (48 kph to 32 kph), while a drop

[11] The quality of data available to market analysts has been a source of some concern recently, although steps are currently being taken on the national level to remedy this situation.

from 30 mph to 10 mph (48 kph to 16 kph) results in a 100% increase in fuel use. Studies estimate that approximately 10% of all on-road fuel consumed is a result of congestion (California Energy Commission 1990).

The analysis of transportation energy focuses on the overall energy consumption differences between the No Project, Modal, and HST Alternatives. This approach captures the two major transportation fuel inputs, petroleum oil and natural gas (a large component of electricity production). Electricity consumption as a specific item will also be analyzed because of the special nature of electricity, specifically its non-storability and its lack of suitability for trading in futures markets. It is reasonable that the analysis of energy consumed by the HST system is confined to electricity and does not include specific reference to natural gas. The price of natural gas is just one variable in the overall ability of the state's electricity-generating infrastructure to deliver adequate power to users. Moreover, it is not the total reserves of in-the-ground natural gas that is uncertain; it is the market conditions and production capacity trends that affect this commodity, just as is the case for the other major transportation fuel, petroleum oil.

3.5.3 Environmental Consequences

A. EXISTING CONDITIONS COMPARED TO NO PROJECT ALTERNATIVE

In 1997, the number of intercity passenger trips taken between regions of California that would be served by the proposed HST system was about 154 million (Charles River Associates 2000). Of these trips, 98% are attributable to automobiles or airplanes, and only 2% were taken via intercity conventional rail and bus. This result corresponds to 14,237 VMT (22,912 million vehicle kilometers traveled [VKT]) and 62 million airplane VMT (100 million VKT).

In 2020, under the No Project Alternative, the number of intercity passenger trips estimated to be taken in California is projected to be about 215 million (Charles River Associates 2000). This corresponds to about 18,866 million automobile VMT (30,362 million VKT) and 102 million airplane VMT (164 million VKT). The increase in intercity passenger trips is reflective of population growth expected over the same period, which is estimated by the California Department of Finance to be on the order of an additional 11 million people (California Department of Finance 1998).

<u>Operational (Direct) Energy</u>
As indicated in Table 3.5-3, the existing (1997 figures) energy used to power the estimated 154 million intercity passenger trips was 101,525,630 million Btus (MMBtus), or 17.5 million barrels of oil. The 215 million passenger trips estimated under the No Project Alternative would consume the equivalent of about 141,023,720 MMBtus, or 24.3 million barrels of oil. This increase of 39% from existing to No Project conditions would be caused primarily by a population increase of 11 million people. This is a conservative estimate because, as noted in Section 3.5.1, automobile fuel efficiency decreases considerably as travel speed decreases below 30 mph (48 kph) and stop-and-go traffic increases. Since congestion levels under the No Project Alternative would likely be higher than they are under existing conditions, the increase in direct energy used in 2020 would be higher than the projected 39% increase. To illustrate, if the direct energy consumption factor for automobiles under a congested No Project scenario increased by 5%, from 5,669 Btus/VMT to 5,952 Btus/VMT, the total direct energy consumption under the No Project Alternative would increase from 141,023,720 MMBtus to 146,371,202 MMBtus, which would represent a 44% increase over existing levels, compared to the 39% increase in direct energy consumption with the assumption of similar levels of service.

The No Project Alternative would potentially place additional demand on statewide energy supplies compared to existing conditions as a result of increased passenger trips, higher levels of congestion, and slower speeds on intercity highways.

Table 3.5-3
Annual Intercity Operational Energy Consumption in the Study Area

	1997 Existing	2020 No Project Alternative[f]
Annual VMT[b,c,g] (mi [km]) (millions)		
Auto	14,237 (22,912)	18,866 (30,362)
Airplane	62 (100)	102 (164)
HST	0	0
Annual Energy Consumption (Btus) (millions)		
Auto	80,711,153	106,949,635
Airplane	20,814,476	34,074,085
HST	0	0
Total Energy Consumption (MMBtus[a])	101,525,630	141,023,719
Change in Total Energy from Existing (MMBtus[a])		39,498,090
Total Energy Consumption (Barrels of Oil[e]) (millions)	17.5	24.3
Change in Total Energy from Existing (Barrels of Oil[e]) (millions)		6.8

[a] One British thermal unit (Btu) is the quantity of energy necessary to raise 1 pound of water 1 degree Fahrenheit.
[b] VMT based on average number of passengers per vehicle, by mode, as follows:
- Intercity auto: 2.4 passengers/automobile
- Airplane: 101.25 passengers/airplane (70% load factor per Business Plan)

HST VMT based on Business Plan (California High Speed Rail Authority 2000)
[c] Intercity travel only; long distance commute travel not included
[d] Rounded.
[e] One barrel of crude oil is equal to 5.8 MMBtus.
[f] Fuel consumption for No Project would increase beyond the figures presented here as speeds drop below 30 mph (48 kph) on congested highways.

Sources: [g] Charles River Associates 2002, Paul Taylor (Kaku Associates) pers. comm.

Peak-Period Electricity Demand

The No Project Alternative electricity consumption would increase slightly over existing conditions related to the programmed and funded airport expansion under the No Project Alternative. The possible future electrification of Caltrain, commuter rail systems, and/or Amtrak, which, though not part of the current No-Project Alternative, are being considered, would also increase electricity use. While these projects would be regionally significant, they are small in scale compared to overall electricity usage and would be captured by routine electricity consumption forecasts by CEC, allowing electricity generation and transmission planning to account for and accommodate their additions.

Potential electricity demand under the No Project Alternative would be satisfied by expected expansion in generating capacity. No significant potential impacts on electricity generating capacity have been identified.

Construction (Indirect) Energy
The No Project Alternative is based on the assumption that projects currently included in existing plans and programs, including local, state, and interstate transportation system improvements, would be implemented. It is assumed that construction of the projects included in the No Project Alternative would not result in the consumption of energy resources in a wasteful, inefficient, or unnecessary manner.

3.5.4 Comparison of Alternatives by Region

B. NO PROJECT ALTERNATIVE COMPARED TO MODAL AND HST ALTERNATIVES (with sensitivity analysis ridership forecasts)

Operational (Direct) Energy
The 39% increase in energy use of the No Project Alternative over existing conditions is similar to the potential increase that would be expected with implementation of the proposed Modal Alternative, which would increase direct energy consumption by 40% over existing conditions, as summarized in Table 3.5-4. By contrast, the proposed HST Alternative would increase direct energy consumption by 10% over existing conditions, a much slower rate than the Modal or No Project Alternatives.

Statewide: As indicated by the VMT-based analysis, energy requirements for intercity transportation would be greater under the Modal Alternative than under the No Project Alternative because of induced demand for automobile travel related to extra highway capacity. Table 3.5-4 shows that, although the number of airplane VMT would remain the same under Modal and No Project Alternatives,[12] the number of automobile intercity trips taken would increase statewide by 1.1% over the No Project Alternative,[13] which would increase the number of annual VMT by 208 million (335 million VKMT) to 19,073 million (30,695 million VKMT). These additional VMT translate into an additional energy use of 1,176,446 MMBtus, which is the equivalent of 0.2 million barrels of oil. However, as indicated in Section 3.5.1, automobile fuel efficiency decreases considerably as travel speeds decrease and stop-and-go traffic increases. This means that the higher energy consumption resulting from more VMT would be offset by the Modal Alternative's lower level of congestion in rural highway segments. For example, if the direct energy consumption factor for automobiles increased by 5% because of congestion under the No Project Alternative, from 5,669 Btus/VMT to 5,952 Btus/VMT, the total energy consumption under No Project would increase from 141,023,720 MMBtus to 146,371,202 BTUs. In this scenario, the Modal Alternative would consume 3% less direct energy than No Project. This compares to a 1% increase in direct energy consumption when comparing the Modal Alternative to a more congested No Project Alternative.

By comparison, the HST Alternative would potentially decrease intercity automobile VMT from 18,865 million (30,360 million VKT) under the No Project Alternative scenario to 15,816 million (25,453 million VKT), decrease airplane VMT from 102 million (164 million VKT) to 1 million (2 million VKT), and increase HST VMT attributable to intercity trips from 0 to 22 million (35 million VKT). Under the HST Alternative, commuter automobile VMT (based on 1.0 passenger per automobile) would also potentially decrease by 509 million VMT (819 million VKT) compared to the No Project Alternative, although HST VMT attributable to commuter trips would increase from 0 to 2 million (3 million VKT). Where the HST system would use 20,304,566 MMBtus for trips related to intercity travel, the overall direct energy for intercity

[12] It is assumed that an increase in the level of service for air travel under the Modal Alternative compared to the No Project Alternative would not increase the number of trips, but instead would meet peak travel demand. This could also be thought of as satisfying rush hour demand.

[13] Trips that would be induced (also called latent demand) as a result of the improved level of service.

travel would be 30,717,124 MMBtus, or the equivalent of 5.2 million barrels of oil, less per year than the 2020 No Project Alternative. This potential reduction represents a 22% energy savings for intercity trips over the No Project Alternative and a 9% increase over direct energy consumption under existing conditions (1997). Proposed HST operations related to commuter travel would use 1,630,199 MMBtus. However, the 10 million commute-related passenger trips that could be diverted from automobiles to the proposed HST system would result in a potential decrease in energy use by automobiles of 2,886,699 MMBtus. This would result in a net reduction in commute-related direct energy consumption of 1,256,500 MMBtus, compared to the No Project Alternative.

Table 3.5-4
Annual Intercity Operational Energy Consumption in Study Area

	1997	2020		
	Existing	No Project Alternative	Modal Alternative	HST Alternative
Annual VMT[b, c, g] (mi [km]) (millions)				
Auto	14,237 (22,912)	18,866 (30,362)	19,073 (30,695)	15,816 (25,453)
Airplane[d]	62 (100)	102 (164)	102 (164)	1 (2)
HST	0	0	0	22 (35)
Annual Energy Consumption (MMBtus[a])				
Auto	80,711,153	106,949,635	108,126,081	89,661,289
Airplane	20,814,476	34,074,085	34,074,085	340,741
HST	0	0	0	20,304,566
Total Energy Consumption (MMBtus)	101,525,630	141,023,720	142,200,166	110,306,596
Change in Total Energy from Existing (MMBtus)		39,498,090	40,674,536	8,780,967
Change in Total Energy from No Project (MMBtus)			1,176,446	-30,717,124
Total Energy Consumption (Barrels of Oil[f]) (millions)	17.5	24.3	24.5	19.1
Change in Total Energy from Existing (Barrels of Oil[f]) (millions)		6.8	7.0	1.5
Change in Total Energy from No Project (Barrels of Oil[f]) (millions)			0.2	-5.2

[a] One British thermal unit (Btu) is the quantity of energy necessary to raise 1 pound of water 1 degree Fahrenheit.

[b] VMT based on average number of passengers per vehicle, by mode, as follows:
- Intercity auto: 2.4 passengers/automobile
- Airplane: 101.25 passengers/airplane (70% load factor)

HST VMT based on Business Plan (California High Speed Rail Authority 2000)

[c] Intercity travel only; long-distance commute travel not included.

[d] Does not include airplane VMT resulting from passengers making connections to other flights to continue or complete their journey because these are a minor portion of the HST-served market.

[e] Rounded.

[f] One barrel of crude oil is equal to 5.8 MMBtus.

[g] Fuel consumption for the No Project Alternative would increase beyond the figures presented here as speeds drop below 30 mph on congested highways.

Sources: [h] Charles River Associates 2002; Paul Taylor (Kaku Associates) pers. comm.

The VMT-based energy calculations above do not account for congestion levels. As congestion levels decrease, so does vehicular energy use for transportation. Therefore, the 22% energy consumption reduction projected under the HST Alternative is probably conservative because intercity route congestion levels would be expected to lessen in rural areas if it is implemented. Using the example of a 5% increase in the energy consumption factor for automobiles due to congestion, explained above under Modal Alternative, a congested No Project Alternative could hypothetically result in direct energy consumption of 146,371,202 MMBtus, compared to the 141,023,720 MMBtus anticipated in a less-congested No Project scenario. The congested scenario would result in additional intercity potential direct energy savings with the proposed HST Alternative of about 5,347,482 MMBtus, which would represent a potential 17% increase in the amount of energy saved. Thus, the total energy savings with the proposed HST Alternative and high-end ridership could be as great as 25% over the No Project Alternative.

An energy intensity analysis of the alternatives was also calculated using passenger miles traveled (PMT) for each of the modes. This is useful for anticipating how each of the alternatives would affect energy use. Table 3.5-5 lists the energy consumption factors of each of the modes. HST service offers a sharp reduction in energy consumption per passenger mile compared to other modes.

Table 3.5-5
Energy Consumption Based on Passenger Miles Traveled (PMT)

Mode	Energy Consumption[e]
Intercity Passenger Vehicles (Auto, Van, Light Truck) [a]	2,400 Btus/PMT
Commute Passenger Vehicles (Auto, Van, Light Truck) [b]	5,700 Btus/PMT
Airplanes[c]	3,300 Btus/PMT
High-Speed Trains[d]	1,200 Btus/PMT

[a] Based on 2.4 passengers per vehicle.
[b] Based on 1.0 passenger per vehicle.
[c] Based on 101.25 passengers per vehicle (70% load factor).
[d] Based on 761 passengers per 16-car trainset (63% load factor, which accommodates projected 2020 sensitivity case high-end demand for HST service within the existing Business Plan).
[e] Rounded.

Regional: In addition to the statewide direct automobile VMT savings that would result from travelers choosing HST travel, the proposed HST Alternative would potentially provide additional regional VMT reductions, compared to the No Project Alternative conditions. Proposed HST station-stops would be more numerous than airports, which would result in a lessening of the average distances required for passengers to travel from their points of origin to the mode transfer point (and vice versa) because of the likelihood that one or more of the stations would be closer to their point of origin than would their respective regional airport.

Implementation of the HST Alternative would also potentially decrease regional transportation-related energy consumption through proposed improvements to rail corridors in the Bay Area to Merced and Los Angeles to San Diego via Orange County (LOSSAN) regions. Grade separations are proposed for Caltrain and the LOSSAN corridor as part of the proposed HST system, which would increase traffic flow in the affected areas, thereby increasing fuel efficiency and decreasing energy consumption.

The comparison of the Modal and HST Alternatives to the No Project Alternative shows that only the proposed HST Alternative would potentially decrease energy use statewide. Compared to the Modal Alternative, the HST Alternative would save 31,893,570 MMBtus, or about 5.5 million barrels of oil annually, which equates to an approximate 22% savings. Regional analysis indicates that regional efficiencies, which would be precipitated by implementing the proposed HST Alternative, would increase these projected savings.

The Modal Alternative would have no potential impact because it would likely consume about the same, if not slightly less, energy than the No Project Alternative because of reduced congestion.

Peak-Period Electricity Demand

The small projected increase in electricity demand over existing conditions with the No Project Alternative would be somewhat smaller than what would be expected with implementation of the Modal Alternative. Conversely, the proposed HST Alternative would increase electricity demands on the state's generation and transmission infrastructure, increasing peak demand on the order of 480 MW[14].

Statewide: Compared to the No Project Alternative, there would be some increase in electricity demand in the peak period under the Modal Alternative due to new/expanded airport facilities. It would be small, and it would be covered by CEC projections of electricity demand and supply capacity.

By comparison, electrical power demanded by the HST system would increase the load on the statewide system on the order of 480 MW during peak electricity demand in 2020. Electricity supply and demand projections are not available for 2020. Such a long-time horizon has uncertainty, especially on the supply side, where capacity additions are difficult to predict more than two to three years into the future. However, it is useful to compare the expected HST-related operational electricity demand to surplus projections through 2008, the year that is farthest into the future for which electricity production capacity projections are available. CEC estimates that statewide electricity surplus generating capacity[15] in 2008 will be 5,210 MW, based on a total generating capacity of 64,669 MW and a demand of 59,459 MW (California Energy Commission 2003c). If the system were to become operational in 2008, the additional load (i.e., demand) placed on the system by the HST Alternative would be about 10% of the state's anticipated electricity surplus. Prediction horizons for demand estimates are longer than for capacity additions. The additional 480-MW load that would be placed on statewide electricity generating resources by the HST Alternative would represent approximately 0.7% of the CEC-predicted 2012 statewide electricity demand of 64,845 MW. Projecting the demand horizon to the study year of 2020, the HST Alternative-generated load would represent 0.6% of an estimated 77,000 MW statewide demand.[16] Though the HST Alternative could cause potentially considerable impacts on the state's electricity grid if the generation and transmission capacity were not equipped to handle the additional load, the short-term electricity generation outlook is favorable, and the medium- to long-term demand scenarios indicate that the proposed HST Alternative would represent a very small portion of statewide demand.

[14] Figure based on an average electricity use of 74.2 kW/train mi, which equates to an average electricity use rate of about 12 MW per trainset when integrated over 1 hour. These are averages and do not reflect acceleration or changes in grade; they are for planning purposes only.

[15] This assumes a normal summer and including existing generation, retirements, high-probability California additions, net firm imports, and spot-market imports.

[16] Calculation based on CEC demand projections from 2002 to 2012 for normal temperature years, published in *2002–2012 Electricity Outlook* (California Energy Commission 2002b). Projection to 2020 assumes an average annual growth rate of about 2.0% with a range from between 1.5% and 3.9%. This projection is for comparison purposes only.

The demand growth extrapolation based on CEC demand predictions assumes an average annual electricity demand growth in California on the order of 1,400 MW through 2020, about three times the 480-megawatt load that the HST operations are expected to place on the statewide system. The HST Alternative would be built and become operational in stages, which indicates that, instead of placing an additional 480-MW load on the state's production and transmission resources abruptly, the system would gradually increase its electricity consumption rate to 480 MW. A first segment from Los Angeles to San Francisco, for example, would place an additional load on electricity resources on the order of 350 MW,[17] which is about 72% of the load anticipated for the entire system. This gradual increase would allow the in-state and out-of-state electricity generation and transmission industries and planners to anticipate and respond to the effects of the proposed HST Alternative on generating and transmitting resources.

Regional: Regional impacts on the electricity grid could occur if the proposed HST Alternative contributed to electricity transmission deficiencies, or bottlenecks, which were described in Section 3.5.2. If bottlenecks were to be aggravated by the HST Alternative, a potential adverse impact could result. However, through careful HST electrification design (i.e., design system so that it draws power from the electricity grid at several places throughout the state), it would be possible to minimize or eliminate such potential problems. Also, bottlenecks in the current grid system are being addressed by such projects as the Path 15 upgrade (see Section 3.5.2). If planning transmission line capacity continues to grow to anticipate statewide needs, the HST Alternative would not have the potential to cause a significant impact on transmission. The Modal Alternative is not expected to cause substantial electricity demand increases in any of the regions.

The HST Alternative could cause potentially considerable impacts on the state's electricity grid if the generation and transmission capacity were not equipped to handle the additional load. However, the short-term electricity generation outlook is favorable, and the medium- to long-term demand scenarios indicate that the proposed HST Alternative would represent a very small portion of statewide demand. If current trends continue as expected, electricity generation and transmission capacity would satisfy the underlying growth in demand, estimated to average about 2% per year. The HST Alternative would represent a small percentage of generating and transmission capacity required to satisfy projected overall demand. Staging of the completion of construction and the start of major operations would make the load additions by each of the HST Alternatives less abrupt than would be the case if the start of the full planned operations were to occur simultaneously.

Construction (Indirect) Energy

Construction of the programmed and funded transportation improvements under the No Project Alternative would require less energy than construction of either the Modal or HST Alternative.

Project Construction: The Modal Alternative construction-related energy consumption would result in the one-time, non-recoverable energy costs associated with construction of new/expanded airport runways, airport facilities, roadways—an estimated 2,970 lane-mi (4,780 km) statewide—interchanges, ramps, and other support facilities (e.g., rest areas, maintenance facilities). The HST Alternative construction-related energy consumption would also result in a one-time, non-recoverable energy cost, which would occur during construction of on-the-ground, underground and aerial facilities such as trackwork, guideways, structures, maintenance yards, stations, and support facilities. Details regarding energy conservation practices have not been specified for the HST Alternative, which has not been designed in detail,

[17] Figure determined by using the proportion of train-miles programmed into the operating plan between Los Angeles and San Francisco to the total number of train-miles for the entire completed project. Assumes that the rest of the operating plan (i.e., peak frequency) would remain the same.

nor have construction methods and staging been planned at this time. Given the scope and scale of the improvements proposed as part of the HST Alternative, however, it is anticipated that the construction-related energy requirement would be substantial. Table 3.5-6 shows estimates of potential construction-related indirect energy consumption for both the Modal and HST Alternatives.

Table 3.5-6
Non-Recoverable Construction-Related Energy Consumption

Alternative	Structure	Rural vs. Urban[a]	Facility Quantity[b]	Energy Consumption[c] (MMBtus)
Modal	Highway (at grade)	Rural	1,476 one-way lane mi (2,375 km)[d]	25,187,000
		Urban	795 one-way lane mi (1,279 km)[d]	20,879,000
	Highway (elevated)	Rural	455 one-way lane mi (732 km)[d]	59,323,000
		Urban	245 one-way lane mi (394 km)[d]	80,191,000
	Subtotal			185,580,000
	Airport (runway)	N/A	6 runways	37,872,000
	Airport (gates)	N/A	91 gates	7,098,000
	Subtotal			44,970,000
	Modal Alternative total			230,550,000
HST	HST guideway (at grade)	Rural	2,263 guideway mi (3,642 km)	27,807,000
		Urban	640 (1,030 km)	12,224,000
	HST guideway (elevated)	Rural	333 guideway mi (536 km)	18,442,000
		Urban	161 (259 km)	8,972,000
	HST guideway (below grade, cut)	Rural	19 guideway mi (31 km)	2,239,000
		Urban	30 (48 km)	4,868,000
	HST guideway (below grade, tunnel)	Rural	242 guideway mi (389 km)	28,322,000
		Urban	146 (235 km)	47,958,000
	HST station	N/A	20 stations	1,560,000
	HST Alternative total			152,390,000

[a] Assumes the HST and Modal Alternatives would be constructed in rural and urban areas at the following proportions:
- Bay Area to Merced: Rural (70%), Urban (30%)
- Sacramento to Bakersfield: Rural (95%), Urban (5%)
- Bakersfield to Los Angeles: Rural (70%), Urban (30%)
- LOSSAN: Rural (30%), Urban (70%)
- Los Angeles to San Diego via Inland Empire: Rural (60%), Urban (40%)

[b] Measured in guideway miles for non-discrete structures (e.g., highways and HST guideways), and in structure quantities for discrete structures (e.g., airport runways and terminals, and HST stations).

[c] Rounded.

[d] Based on 2,970 mi (4,780 km) of highway lane additions; distribution between at-grade (65%) and elevated (35%) estimated for comparison purposes. True values are not known at current level of planning.

[f] Differences between the construction-related energy consumption for urban and rural settings reflect differences in construction methods, demolition requirements, utility accommodation, etc.

As shown in the table, the construction of the proposed HST Alternative would consume 34% less energy during construction than the Modal Alternative. Assuming that the 2020 energy savings for each of the system alternatives remain constant, and assuming an un-congested No Project scenario, the Modal Alternative would not repay the construction energy estimated to be consumed as a result of its implementation because more operational energy would be consumed by the Modal Alternative than by the No Project Alternative. If a 5% increase in the No Project Alternative automobile operational energy is assumed, the Modal Alternative would consume less energy than this congested No Project Alternative and would result in a construction energy payback period of 55 years. Energy savings projected for the proposed HST Alternative would repay the construction energy consumption in 5 years with an uncongested No Project scenario and would have a 4-year payback period if a 5% automobile congestion energy consumption penalty is assumed.

Secondary Facilities: It is reasonable to assume that secondary facilities, such as those used in the production of cement, steel, etc., would employ all reasonable energy conservation practices in the interest of minimizing the cost of doing business. Industry in California reduced electricity usage (which is mostly generated by natural gas, a nonrenewable fuel) from 54.7 million MWh in 2000 to 52.2 million MWh in 2001, a 4.6% reduction, even as the state's population increased by 513,352, or 1.5% (California Energy Commission 2002d). Therefore, it can reasonably be assumed that construction-related energy consumption by secondary facilities would not consume nonrenewable energy resources in a wasteful, inefficient, or unnecessary manner under either the Modal or HST Alternative.

Construction of either the Modal or HST Alternative is anticipated to take about 10 years, beginning in 2005 and finishing in 2016. Construction would occur in stages, and some segments would be open for operation while others are still under construction. Given the scope and scale of the Modal and HST Alternatives, it is anticipated that secondary construction-related energy requirements would be substantial.

Due to the scope and scale of the improvements proposed as part of the Modal and HST Alternatives, construction-related energy impacts, both project and secondary, would be potentially significant. Though the construction energy consumption factors presented in Table 3.5-6 indicate that the HST Alternative would consume less energy during construction than the Modal Alternative, how much less is unknown because limited data is available. Construction of the Modal and HST Alternatives would potentially represent a significant use of nonrenewable resources.

C. NO PROJECT ALTERNATIVE COMPARED TO MODAL AND HST ALTERNATIVES (with investment-grade ridership forecasts)

Operational (Direct) Energy

Statewide: Based solely on VMT, the HST Alternative with the investment-grade ridership forecast would potentially reduce overall direct energy use for intercity travel in 2020 by 11,749,680 MMBtus, or the equivalent of 2.0 million barrels of oil compared to the No Project Alternative, as shown in Table 3.5-7. This reduction represents an 8% energy savings for intercity trips over the No Project Alternative, and a 27% increase over direct energy consumption under existing conditions (1997). This compares to a 22% reduction over the No Project Alternative and a 9% increase over existing conditions (1997) with the high-end sensitivity analysis ridership forecast. Using the example of a 5% increase in the energy consumption factor for automobiles under congested No Project conditions, intercity direct energy savings with the HST Alternative would be 17,097,162 MMBtus with the assumption of investment-grade ridership projections, compared to a savings of 36,064,605 million Btus with the high-end ridership forecast. Commuter diversion to HST would not change with the investment-grade forecast.

Table 3.5-7
Annual Intercity Operational Energy Consumption in Study Area
(Assuming Investment-Grade Ridership Forecasts)

	1997	2020		
	Existing	No Project Alternative[g]	Modal Alternative[e]	HST Alternative[e]
Annual VMT[b,c,h] (mi [km]) (millions)				
Auto	14,237 (22,912)	18,866 (30,362)	19,073 (30,695)	17,367 (27,949)
Airplane[d]	62 (100)	102 (164)	102 (164)	41 (66)
HST	0	0	0	22 (35)
Annual Energy Consumption (MMBtus)				
Auto	80,711,153	106,949,635	108,126,081	98,458,799
Airplane	20,814,476	34,074,085	34,074,085	13,556,367
HST	0	0	0	17,258,873
Total Energy Consumption (MMBtus[a])	101,525,630	141,023,720	142,200,166	129,274,040
Change in Total Energy from Existing (MMBtus[a])		39,498,090	40,674,536	27,748,410
Change in Total Energy from No Project (MMBtus[a])			1,176,446	-11,749,680
Total Energy Consumption (Barrels of Oil[f]) (millions)	17.5	24.3	24.5	22.3
Change in Total Energy from Existing (Barrels of Oil[f]) (millions)		6.8	7.0	4.8
Change in Total Energy from No Project (Barrels of Oil[f]) (millions)			0.2	-2.0

[a] One British thermal unit (Btu) is the quantity of energy necessary to raise 1 pound of water 1 degree Fahrenheit.
[b] VMT based on average number of passengers per vehicle, by mode, as follows:
- Intercity auto: 2.4 passengers/automobile
- Airplane: 101.25 passengers/airplane (70% load factor)

HST VMT based on Business Plan (California High Speed Rail Authority 2000).
[c] Intercity travel only; long-distance commute travel not included.
[d] Does not include airplane VMT resulting from passengers making connections to other flights to continue or complete their journey, because they are a minor portion of the market served by HST.
[e] Rounded.
[f] One barrel of crude oil is equal to 5.8 MMBtus.
[g] Fuel consumption for the No Project Alternative would increase beyond the figures presented here as speeds drop below 30 mph (48 kph) on congested highways.

Sources: [h] Charles River Associates 2002, Paul Taylor (Kaku Associates) pers. comm.

With the investment-grade HST ridership projections, the energy consumption per passenger mile traveled on the HST would be about 1,800 Btus, compared to about 1,200 Btus when the high-end ridership forecast is assumed.

Regional: Regional energy savings with investment-grade ridership projections for the HST Alternative compared to the No Project Alternative would not be qualitatively different from those expected with the sensitivity analysis variations in the ridership forecast.

Peak-Period Electricity Demand
Whereas the proposed HST system would consume electricity at the rate of 480MW when fully operational with the sensitivity analysis variations in the ridership forecast, which would generally require 16-car trainsets to accommodate the expected passenger demand, the HST system would consume electricity at the reduced rate of 410MW[18] with the investment-grade ridership forecast, which would generally require 12-car trainsets to accommodate passenger demand.

Construction (Indirect) Energy
The HST Alternative would have a payback period of 12 years with the investment-grade ridership projections, compared to 5 years with the sensitivity analysis variations in the ridership forecast. Assuming a 5% increase in No Project automobile energy consumption due to congestion, the HST Alternative would have a payback period of 9 years with the investment-grade ridership projections, compared to 4 years with the sensitivity analysis variations in the ridership forecast.

3.5.5 Design Practices

The proposed electrically powered HST technology is energy efficient, requiring substantially less energy than other modes of intercity travel. Implementation of the HST Alternative is anticipated to reduce energy use over the No Project or Modal Alternatives.

3.5.6 CEQA Significance Conclusions and Mitigation Strategies

Based on the analysis above, and considering the discussion in CEQA Appendix F on Energy Conservation, the HST alternative would have a potentially significant effect related to long term electric power consumption when viewed on a system-wide basis. It is calculated that the HST alternative would contribute to statewide electricity demand by adding demand which is about 0.6% of projected statewide electricity demand in 2020. While this is an increase, the HST alternative represents a more energy efficient mode of transportation than travel by aircraft or car, such that the HST alternative would result in an overall reduction in total energy consumption (combined electric power demand and oil consumption). Mitigation strategies, as well as the design practices discussed in section 3.5.5, will be applied to reduce this impact.

This is a broad program-level analysis reviewing potential statewide energy use and impacts related to the proposed HST system and other alternatives. If the proposed HST Alternative were implemented, the HST system would be designed to minimize electricity consumption. The design particulars would be developed at the project-level of analysis, but would they include the following.

- Use regenerative braking to reduce energy consumption of the system.
- Minimize grade changes in steep terrain areas to reduce the use of electricity during peak periods.
- Use energy-saving equipment and facilities to reduce electricity demand.
- Maximize intermodal transit connections to reduce automobile VMT related to the HST system.
- Develop and implement a construction energy conservation plan.

[18] Based on an average electricity use of 63.07 kW/train mi, which equates to an average electricity use rate of the order of 10 MW per trainset when integrated over 1 hour. The rate of electricity use by a 12-car trainset was assumed to be 85% of the rate used by a 16-car trainset. These are averages and do not reflect acceleration or changes in grade; they are for planning purposes only.

- Develop potential measures to reduce energy consumption during operation and maintenance activities.

It is important to note that the proposed HST system is anticipated to reduce energy consumption overall. Any localized energy impacts would be avoided through proper planning and design of power distribution systems and their relationship with the overall power grid. The following measures could further reduce HST alternative energy consumption.

- Locate HST maintenance and storage facilities within close proximity to major stations/terminals.
- Locate construction material production facilities on-site or within close proximity to the project site.
- Use of newer, more energy efficient construction vehicles.
- Implementation of a program to encourage construction workers to carpool or use public transportation for travel to and from the construction site.

The above mitigation strategies are expected to reduce the short-term and long-term electric power consumption impacts of the HST alternative to a less-than-significant level. Additional environmental assessment will allow a more precise evaluation in the second-tier, project-level environmental analyses.

3.5.7 Subsequent Analysis

Subsequent analysis would be required in project-level environmental documentation for the proposed HST Alternative, if selected. Detailed analysis of base and peak-period electricity requirements and transmission infrastructure would be required to more precisely assess the adequacy of electricity generation and transmission capacity relative to demand for each segment to be pursued. Comprehensive traffic analysis for future conditions would be required to assess regional energy impacts in more detail for each segment.

Subsequent energy analysis at the project level would follow the methodology applied in this evaluation, but would employ the more detailed traffic and electrical input data for the energy consumption analysis. Energy consumption factors would be updated using the latest available published information. Detailed construction staging, sequencing, methods, and practices would be necessary to support a quantitative analysis of construction energy consumption.