2024 Business Plan
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Ridership and Revenue Forecasting Report to the 2024 Business Plan

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Signature/Approval Sheet

TO: Bill Casey

FROM: Justin Cassarino

SUBJECT: Approval of 2024 Ridership and Revenue Forecasting Report

DESCRIPTION OF ENCLOSED DOCUMENT(S): 2024 Ridership and Revenue Risk Analysis Report

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Disclaimer

The information and model results presented in this technical memorandum are estimates and projections that involve subjective judgments and may differ substantially from the actual future ridership and revenue. This technical memorandum is not intended, nor shall it be construed, to constitute a guarantee, promise, or representation of any particular outcome(s) or result(s). Furthermore, the material presented in this technical memorandum is provided solely for purposes of the CHSRA's 2024 Business Plan and should not be used for any other purpose.

The estimates and assumptions documented in this report are preliminary in nature and subject to further refinement as CHSRA and DB ECO continue to refine model assumptions and service planning for the implementation of the Valley to Valley and Phase 1 scenarios as well as the initial operation of the Central Valley Service. CHSRA continues collaboration and coordination with regional partners and stakeholders regarding connecting rail and bus services. As more detailed information and revised concepts become available, they will be incorporated in future forecasts.

Executive Summary

The California Rail Ridership Model (CRRM) is a travel demand model encompassing the state of California as well as external travel links to reflect travel to and from neighboring states. The model was developed by Steer for the California High-Speed Rail Authority (CHSRA) with the intention to reflect in more detail and with an updated database the effects of an integrated high-speed rail system in California as well as to estimate impacts on connecting rail and transit services in the state. The CRRM differs from the previous 2020 Business Plan Model (BPM-V3) by additional access/egress from the core network and an approach known as the pivot process, in which observed 2018 base year data is used to scale future year forecasts.

The Base Case scenarios developed for Valley to Valley and Phase 1 service for the California High-Speed Rail Authority's 2024 Business Plan show noticeable differences from the corresponding scenarios in the 2020 Business Plan. These include updated service plans for High-Speed Rail services in both scenarios, with Phase 1 having three different service types: express, limited and default. In addition, improvements were applied to the modeling of conventional rail services, connecting Intercity Bus services and incorporation of HSR Bus services. The Base Case scenarios are assumed to have an integrated transportation network, with shorter distances and shorter perceived penalties for transferring between HSR and connecting rail and bus services. These updated assumptions are part of ongoing refinements to service planning and forecasting assumptions. Therefore, the ridership and revenue estimates shown in this document are preliminary in nature and subject to further refinement as assumptions evolve.

A fare sensitivity analysis was conducted for the Valley to Valley and Phase 1 scenarios to develop an updated fare structure. The new fare policy includes fare differentiation by service type in which express, limited and default services were tested using different fare assumptions. The fare elasticities for the overall model indicate variability by market, such that long-distance markets have higher fare elasticity while short-distance markets have lower fare elasticity. The updated fare structure, along with transit network and socioeconomic data assumptions, were input to the CRRM, and the Base Case scenarios were modeled to develop forecasts for future years 2030, 2040 and 2050.

The ridership and revenue forecasts developed for the 2024 Business Plan are lower than the 2020 Business Plan forecasts. The difference in socioeconomic growth assumptions likely account for a significant portion of this reduction, with residual differences between ridership and revenue due to updated modeling assumptions and service plans for connecting rail and bus services. Overall, the HSR ridership and revenue forecasts for the Valley to Valley and Phase 1 scenarios indicate the positive benefits of high-speed rail for all Californians.

The developed forecasts in this technical report are comprehensive in scope but approximate in nature. The modeling output provides estimates and numbers that are appropriate for the two study levels evaluated: Valley to Valley (San Francisco – Bakersfield) and Phase 1 (San Francisco – Anaheim).

1 Introduction

Overview

The California High-Speed Rail Authority (CHSRA) tasked DB E.C.O. North America Inc. (DB ECO) to develop ridership and revenue forecasts for the 2024 Business Plan.

California High-Speed Rail (HSR) will be the United States' first high-speed rail system and will connect California's two largest population centers, the San Francisco Bay Area, and Los Angeles Metropolitan Area, while serving a significant portion of the state's Central Valley region.

The California Rail Ridership Model (CRRM) was used to develop ridership and revenue forecasts for the Valley to Valley and Phase 1 scenarios using the latest transit network, fare structure and socioeconomic data assumptions. The CRRM is a state-of-the-art travel demand model encompassing the entire state of California as well as external travel links to reflect travel to and from neighboring states. The CRRM was developed and calibrated on 2018 base year conditions, with the capability of forecasting travel demand for future years 2030, 2040 and 2050.

The Base Case scenarios for Valley to Valley and Phase 1 were developed by incorporating new future year assumptions including network alignments, service plans, stopping patterns and fare structure for HSR services and connecting HSR Bus services. The new network alignments and service patterns as provided by DB ECO were incorporated into the CRRM to develop the ridership and revenue forecasts.

A detailed fare sensitivity analysis was conducted by Steer in coordination with DB ECO to support the development of an updated fare structure for the Base Case scenarios. The fare sensitivity analysis was requested to adapt the previous fare policy to revised market conditions, an evolving competitive landscape with other modes, and changes in user behavior since the original fare policy was developed in 2008. The new fare structure was provided by DB ECO and focuses on maximizing farebox revenue while adapting fares to capture regional differences and optimize ridership within specific markets. A broader objective of the revised fare structure is to reflect the competitive situation with auto and air modes, such that HSR can be perceived as a viable alternative to air and auto travel between origins and destinations along California HSR corridors.

California Rail Ridership Model (CRRM) Review

The CRRM is a new travel demand model developed using the EMME transportation forecasting software[1] to evaluate long-distance/intercity rail travel in the state of California. The model completed its first round of development in June 2022. At that time, the model was checked at the county-to-county travel patterns by mode, and destinations were matched against observed data.

The CRRM was used to generate HSR ridership and revenue forecasts for future year Base Case scenarios published in the 2024 Business Plan. This is the first time the CRRM has been applied to develop CHSRA business plan ridership and revenue forecasts. In general, the CRRM has predicted lower ridership and revenue than previously utilized models, likely due to updated model parameters compared to previous assessments and lower socioeconomic growth assumptions.

Many modeling assumptions have been updated compared to the initial assumptions outlined during the model development process, with the purpose of further refining the methodology; these changes in assumptions are discussed in the Model Review section. While some of the model updates were made as part of this review process, others were based on new developments and a refined project definition.

Base Case Scenarios

The Steer Ridership Model was used to produce ridership forecasts for two Base Case (or Build) scenarios of the HSR project:

- Valley to Valley with San Francisco to Bakersfield services
- Phase 1 with San Francisco and Merced to Anaheim services

In addition, a Business as Usual (BAU) scenario (or No Build) was developed to model future conditions in the absence of HSR services. Both Base Case and BAU scenarios contain updates to conventional rail and intercity bus networks.

For both the Valley to Valley (V2V) and Phase 1 scenarios, a detailed fare sensitivity analysis was conducted to develop an updated fare policy. The fare sensitivity analysis, including the derivation and review of fare elasticities, is discussed in the Ridership and Revenue Forecasting chapter.

Ridership and Revenue Forecasting

The ridership and revenue forecasting for Base Case scenarios were developed for future years 2030, 2040 and 2050 using transit network, fare structure and socioeconomic data assumptions as inputs to the California Rail Ridership Model (CRRM).

[1] Bentley Systems, EMME Transportation Forecasting Software

2 California Rail Ridership Model (CRRM)

Steer was commissioned in October 2019 by DB ECO on behalf of CHSRA to support in the development of a rail ridership and revenue modeling framework - the California Rail Ridership Model (CRRM) for California. The CRRM is designed to represent intercity travel specifically to forecast demand related to various phases of the California High-Speed Rail (HSR) program as well as for any future intercity rail planning for the State of California. The model also includes a high-level representation of travel to neighboring countries/states of Mexico, Nevada and Arizona.

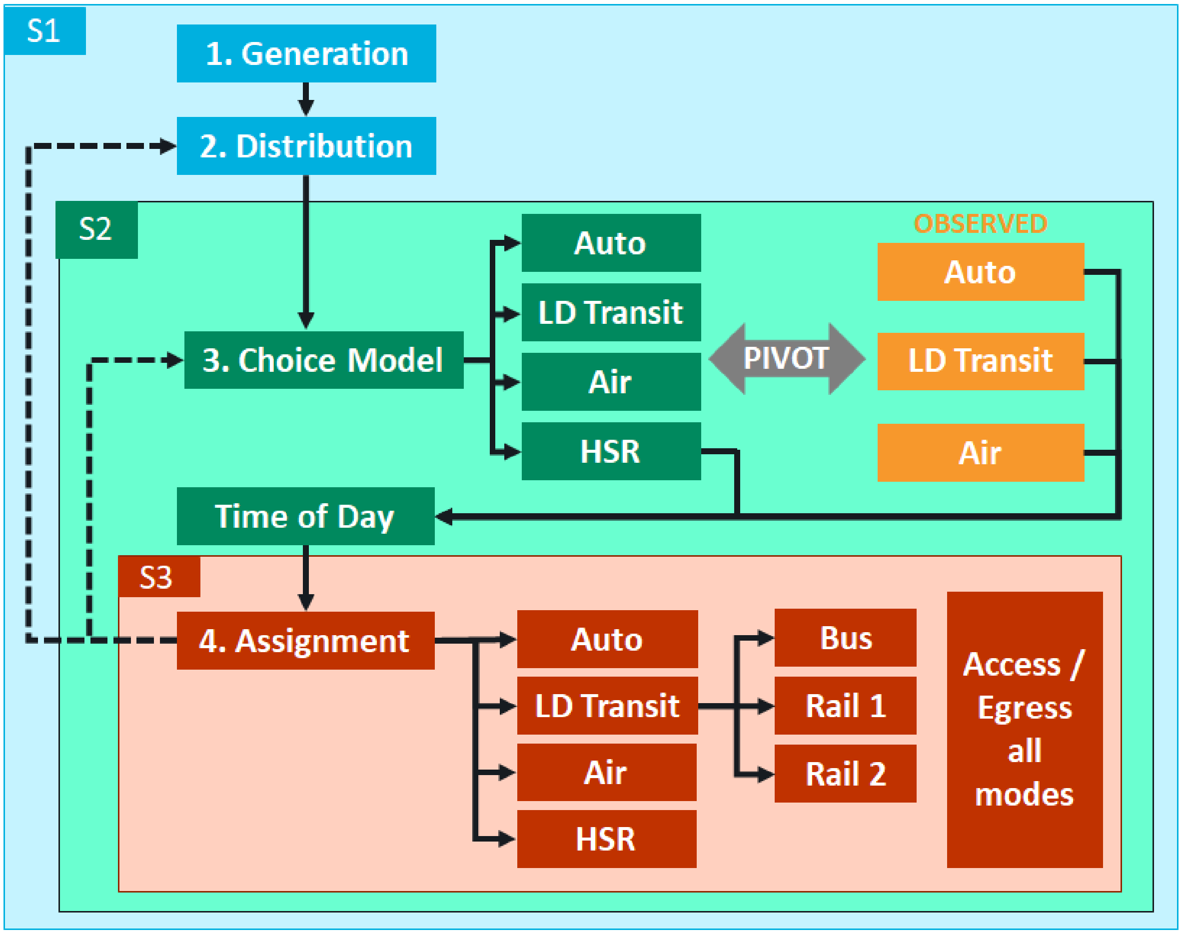
The CRRM considers the wider travel context within California to a greater level of detail. Modes represented within the model include auto, rail and HSR services, long-distance bus and air. The CRRM can be used to forecast the impact of service changes on HSR and non-HSR rail services in the state. The CRRM's parameters and input data were mostly developed from a new original behavioral survey, cell-phone movement-based data. Other data sources include the California Statewide Travel Demand Model (CSTDM) and the travel demand forecasting models maintained by various Metropolitan Planning Organizations (MPOs) across the state. These data were cross-validated and complemented by data from public agencies such as the US Census Bureau, National Household Travel Survey (NHTS) and the Federal Aviation Administration.

Model Structure

The CRRM is a 4-step travel demand modeling framework, which focuses on predicting long-distance trips within California and to and from neighboring states. The model is implemented in the EMME network modeling software package[2]. The model has a feedback loop from the assignment to distribution and thus can model the changes in destination choice, mode choice and station choice in response to changes in the model network and other factors affecting travel behavior, such as fares. To assess the impacts of HSR and variants thereof, the model is coded with the HSR network specification, including the proposed HSR bus connecting services, as well as any associated changes in service patterns of other modes (notably rail) and future-year socioeconomic data. Figure 2.1 shows the model structure in detail.

[2] Bentley Systems, EMME Transportation Forecasting Software

Figure 2.1: CRRM Flow Diagram



Source: Steer CRRM Documentation

The following is a brief description of the modeling steps used in the model.

Trip Generation

The trip generation model estimates the trip ends for the daily in-scope trips by zone in the model. The production (typically the home end of the trip) and attraction (trip destination) models are built based on the observed travel behavior obtained from the National Household Travel Survey (NHTS). The models are then validated based on observed travel information from trip tables. Trip production rates are developed using the cross-classification of household socioeconomic characteristics by trip purpose. The attraction model is developed based on regression analysis using household survey data, employment by occupation and population data. These trip productions and attractions are stratified by trip purpose.

The in-scope trips from the NHTS data under-represented the long-distance trips. The long-distance trip information was refined accordingly by re-weighting the data to observed information from the California State Travel Demand Model (CSTDM), Census Transportation Planning Products Program (CTPP) and other regional models.

Trip Distribution

The Trip Distribution model estimates the number of trips that occur between each origin zone and each destination zone. The trip-distribution model is based on a gravity model structure which uses as inputs the results of the trip generation model (productions and attractions) and the travel costs between the zone pairs (skim matrices) for all modes included in the model network. The model is a deterrence function; hence, the trips between a zone pair are directly proportional to the production and attractions between zones and inversely proportional to the travel cost (including travel times and other perceived costs) between those zone pairs.

The output from the trip distribution is validated against the observed trips by comparing the patterns at the county-to-county levels and the trip lengths of the modeled and the observed data. The trip distribution produces trip tables by:

- Trip Purpose - commute, business, leisure, other and non-home based;
- Employment Status – employed, student, retired, homemaker, other; and
- Income Levels – low, medium and high for employed category and all for others.

For future year scenarios where a new HSR service is introduced, the model calculates the impacts of the new service with the following:

- Trips change their destination choice in response to the new service, given the improved accessibility provided.
- New trips (also called induced trips) are created due to the improved transportation network. The CRRM assumes the induced trips are HSR, rail, or combo trips (using two or more main intercity travel modes), as these services are the ones improved by rail improvement.

Mode Choice

The mode choice is at the core of the CRRM, where the trips from the distribution step by purpose, employment status, and income level are further stratified by main transport mode and access/egress mode to and from stations based on the relative travel cost and availability of mode from origin zone to destination zone.

The mode choice model is a multinomial logit model, with all main modes treated equally across the choices of:

- Auto
- Bus
    - Amtrak Intercity
    - Greyhound, Flixbus
- Air
- Rail
    - Intercity Rail: Capitol Corridor, Coachella Valley, Pacific Surfliner, San Joaquins
    - Commuter Rail: ACE, Caltrain, Coaster, Metrolink, SMART
    - Amtrak Interstate
- HSR
    - California HSR

    - Brightline West
- Combo – combinations of Rail, Bus and for future scenarios HSR

Furthermore, access and egress modes are considered as part of the model, the choices being:

- Auto – private vehicle
- Taxi – shared vehicle (Taxi, Uber/Lyft)
- Transit – metro, light rail, local bus
- Walk

The mode and access/egress mode choice decisions are primarily based on the relative travel time and costs of the range of options. The structure of the model was built based on findings from behavioral research, including the stated preference surveys.

Time of Day

The mode-specific trip matrices from mode choice are further divided into time-of-day matrices. This division of the trip matrices is done based on a set of fixed time-of-day factors, which were developed based on the average weekday and weekend period shares. Weekdays are stratified into AM Peak (AM), Midday (MID), PM Peak (PM), and Evening (OFF) periods and Weekend (WKD) is a standalone time period.

The model has period-specific networks; hence, the stratified time-of-day matrices can be assigned to the respective network in the traffic assignment step. This stratification of network and trip matrices in the time of day was done to reflect the variance of service throughout the day and day of the week, as well as the differing temporal profile of demand. Since the trip tables are either weekday or weekend, in order to convert them to average daily, we apply Average Day Factors for each time period as shown in Table 2.1.

Table 2.1: CRRM Time of Day Periods

Period	Code	Hours	Number of Hours	Factor
Weekday AM Peak	AM	06:00 – 10:00	4	1.4
Weekday Midday	MID	10:00 – 15:00	5	1.4
Weekday PM Peak	PM	15:00 – 19:00	4	1.4
Weekday Evening	OFF	19:00 – 00:00	5	1.4
Average Weekend	WKD	06:00 – 00:00	18	3.5

Source: Steer

Pivot Process

Even after a rigorous calibration, it is very common that the actual base year trip-making patterns are not fully replicated by the developed model and its base year input data which is also the case for the CRRM. To account for this, and as a final step, we use the observed matrices as pivots to create the final trip matrices by mode that feed the model's assignment step. The pivot process attempts to ensure that in the 2018 base year, the modeled county-to-county trips replicate the county-to-county observed trips by mode. The pivot process for the base year produces Scalable Quality Value (SQV) factors at the county-to-county level, which are used to then derive a pivot factor for any future year or alternative scenario to represent the difference in the base year. As HSR is a new mode, the pivot process uses a combination factor derived from all existing modes.

The SQV factor is a statistical measure of the goodness of fit, like the GEH statistic used in demand modeling for many years. However, the SQV factor is symmetrical, with values between 0 and 1. It has been used in the CRRM as a proxy hybrid of absolute differences and proportional differences, both of which have challenges in application where there are small values and/or material changes in forecast demand.

Assignment

The assignment step is the final step in the 4-step travel demand model process. The network for the model constitutes a detailed highway and transit network, including main modes and access modes. The transit network includes stations/airports, park and ride lots and access to/from stations. Each main mode and access/egress combination is assigned, building up to provide a complete set of assigned demands to the respective networks, including the access and egress modes. This step allows the allocation of the demand to the respective network sections and rail and bus services.

Socioeconomic Data

The CSTDM model developed synthetic population estimates for California for 2015. These estimates were based on inputs from 2015 Public Use Microdata Sample (PUMS) data and scaled to the 2015 American Community Survey (ACS) data. As a part of CRRM development, the 2015 synthetic population obtained from CSTDM was updated to 2018 by reweighting the data at the county level to match the population estimates from the California Department of Finance. This approach was used to avoid having to replicate the time-intensive step to generate a separate synthetic population estimate within the CRRM.

Data Sources

Population

- 2022 California Department of Finance Population and Housing Estimates with Census Benchmark {2020}, from California Department of Finance Demographic Research Unit.
- 2015 American Community Survey 5-Year Estimates {2011-2015}, from American Factfinder Historical Population Estimates by Decade {2010-2019}.

Employment

- 2022 Caltrans Long-Term Socio-Economic Forecasts by County, from Caltrans Transportation Economics Branch.
- Current Employment Statistics (CES) {2020}, from CEDD/BLS.
- Quarterly Census of Employment and Wages {2019}, from CEDD/BLS.
- Long-Term Occupational Employment Projections {2019}, from CEDD/BLS.

- Longitudinal Employer-Household Dynamics (LEHD LODES) {2002-2017}, from United States Census Bureau Income.
- 2015 American Community Survey 5-Year Estimates {2011-2015}, from American. Factfinder Historical Population Estimates by Decade {2010-2019}.

School Enrollment
Enrolment in California Public School Districts – 1718 {2017-2018}, from CDE's Quick Quest

Base Year

The Base year (2018) socioeconomic data was developed from data sources above. In 2018, the total population of California was 39.1 million, with 35% employed population.

Table 2.2 displays the summary of population, number of households and employment.

Table 2.2: Base Year Socioeconomic Data for California (in millions)

Base Year	Population	Households	Employment
2018	39.10	17.16	13.90

Source: Steer

Model Networks

Zone System

CRRM has 1,186 zones, including 1,169 internal zones covering all of California and 17 external zones covering neighboring states of Nevada, Arizona, Oregon and Mexico as shown in Figure 2.2. The CRRM zone system was created by aggregating the CSTDM zones to a reasonable level while keeping county boundaries and other land use characteristics, natural features and airport/station locations.

Highway Network

The highway network for CRRM was adopted from the CSTDMv2 model, and the network represents the year 2018 highway conditions. Since the model is an intercity model, local streets and minor arterials are not included in the network, but the zone centroid connectors provide reasonable connectivity with the highway network to be able to assign the in-scope trips to the network. Figure 2.3 shows the highway network as the underlying network to the transit system in the model.

Transit Networks

The transit network for the base year was developed based primarily on 2018 GTFS information from transit agencies. This included information on routing, scheduling, stop locations and frequency of the transit routes available in the base year. For the services for which GTFS information was not available, online and printed information was used to model the services into the network. As a part of this project, a complete validation of alignments of the rail system in the network was done for the base year based on 2018 timetables for all the main mode rail services, as shown in Figure 2.3. These services are:

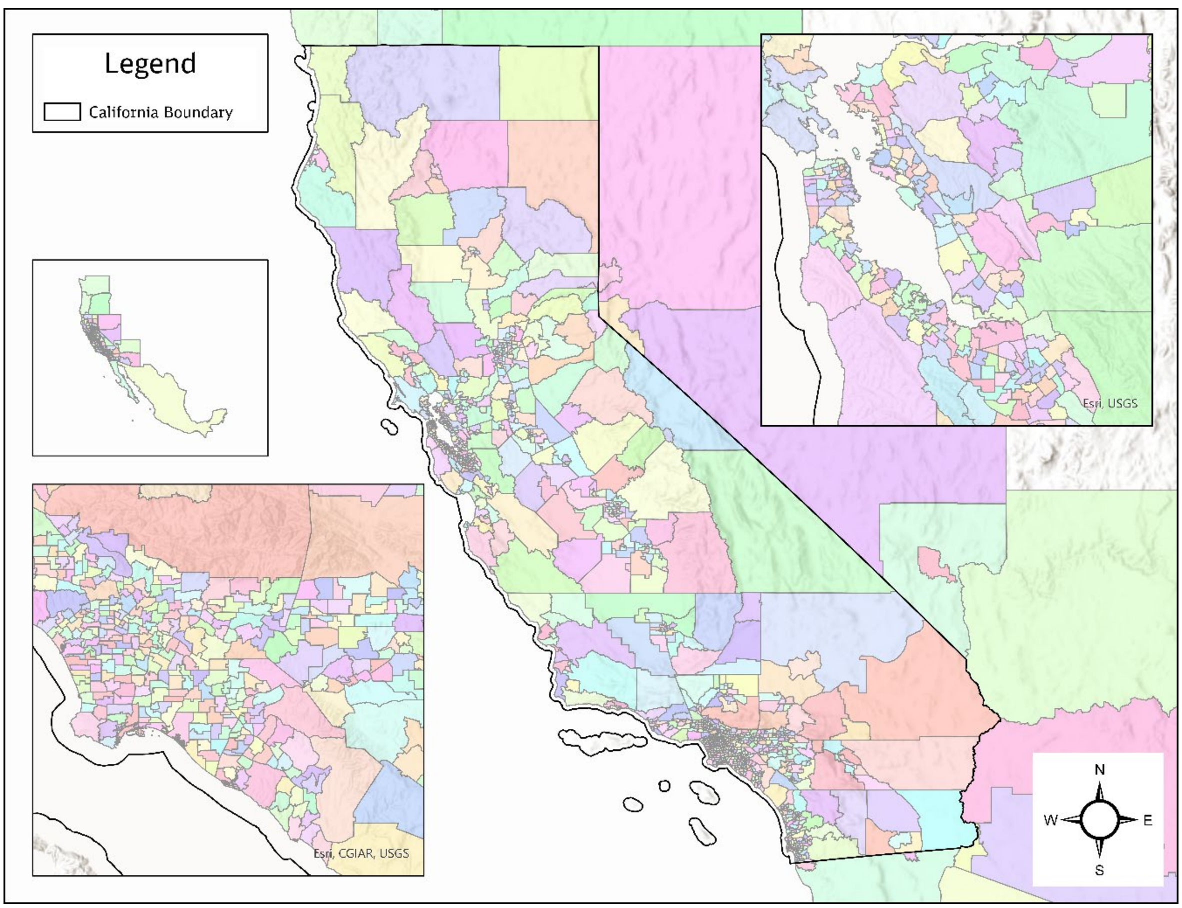
Intercity Rail – Amtrak services

- California Zephyr
- Capitol Corridor
- Coast Starlight
- Pacific Surfliner
- San Joaquins
- Southwest Chief
- Sunset Limited / Texas Eagle

Commuter Rail

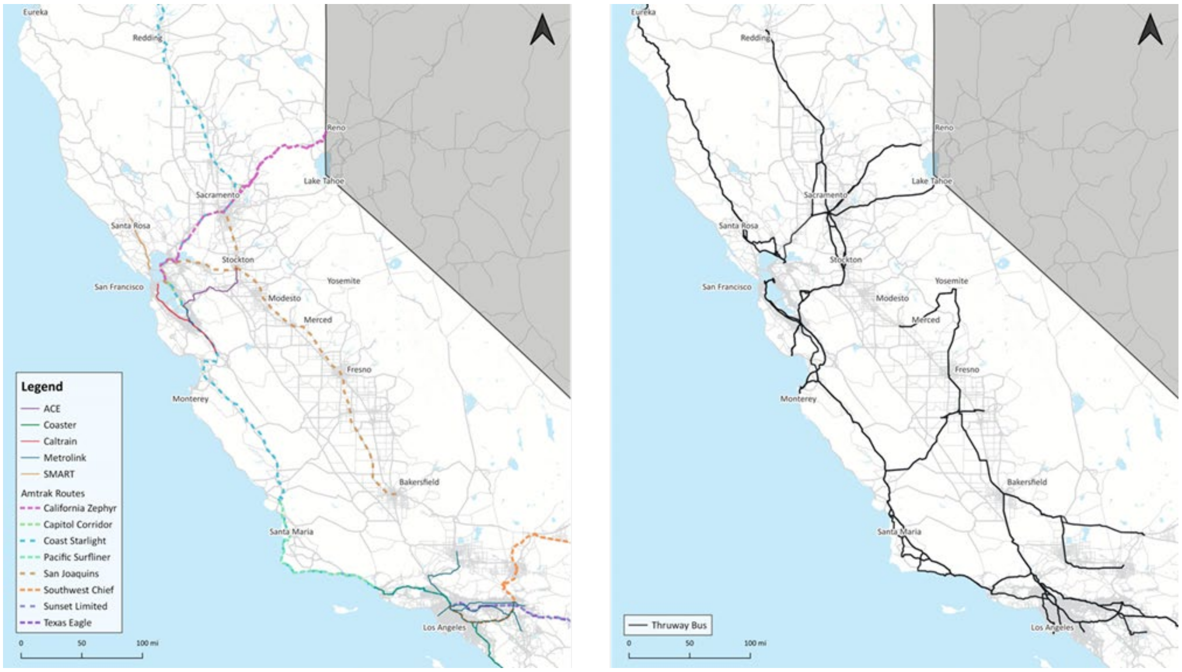
- ACE
- Caltrain
- Coaster
- Metrolink
- SMART

Figure 2.2: CRRM Travel Analysis Zone Map



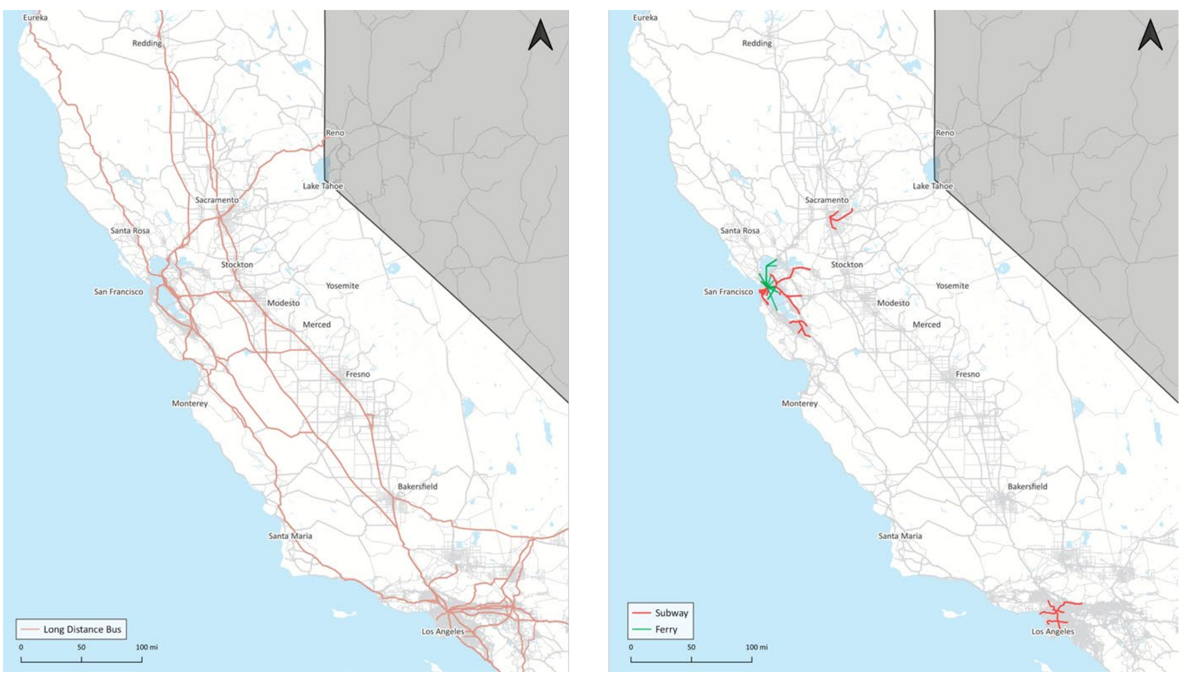
Source: DB ECO

Figure 2.3: Base Year Rail and Intercity Bus Network



Source: Steer

Figure 2.4: Base Year Long-Distance Bus and Access/Egress Transit Modes – Subway and Ferry



Source: Steer

Costs and Fares

The base year fares were developed for each mode based on fare and revenue data by each mode:

Transit Fares

Rail fares were computed based on Amtrak and thruway bus total demand by route, revenue per route and passenger miles traveled (PMT) per route.

Long-distance bus fares were developed from the observed fares from Greyhound, Megabus and Flixbus.

Airfares were derived from the DB1B database.

Auto Costs

Auto fuel prices are derived from historic data on pump prices and typical fleet fuel efficiency rates. The Energy Information Administration (EIA) reports historic, current and forecast values for both fuel prices and fleet efficiency assumptions, which include important effects such as the impact of the shift towards electric vehicles and this was used to derive forecast fuel prices for use in the model. Further, the EIA provides California-specific data in some publications, allowing us to ensure relevance to the local market.

The “hidden” costs of vehicle ownership and maintenance are sourced from data and analysis produced by the American Automobile Association (AAA).

Parking costs in urban areas are obtained from the MPO models; outside of these areas, a simple and reasonable approach was to assume no parking costs. Airport parking costs are obtained from online data (for both on-site and off-site operators).

Auto tolls are included in the CRRM for select Bay Area bridges and toll roads in Orange County and incorporated into the model using travel time penalties.

Table 2.3 provides a summary of fare rates for non-HSR main modes and access/egress modes.

Table 2.3: Summary of Fare Rates by Main Mode (2018$)

Mode	Auto	Taxi	Transit	Air	Rail	Bus (Public Intercity/ Local)	Bus (Private Long-Distance)
Boarding Fare ($)	—	—	$2.38	—	—	—	—
Per Mile Fare ($/mile)	$0.23	$2.98	—	$0.16-1.81 (Varies by Region)	$0.15-0.24 (Varies by Region)	$0.15-0.24 (Varies by Region)	$0.14
Fare Cap	—	—	—	—	No max fare	No max fare	—

Source: DB ECO

Behavioral Assumptions

Many of the assumptions built into the base year model are based on behavioral surveys conducted by Steer in 2019. Some of the key assumptions are listed below:

Perceived Transfer Penalty for 2018 Base Year

- Inter-main mode without schedule and network integration: 94 minutes;
- Intra-main mode: 47 minutes;
- Intra-access/egress transit modes: 5 minutes; and
- Transfers between main mode and transit access/egress: 5 minutes.

External trips tables (from/to outside California) were developed from the data from Visit California

Perception factor of 0.25 was used to maximize the use of the main mode instead of having trips using too many transfers.

Assumptions for logical mode and route choice during the assignment step (First-order out-of-scope rules):

- If the sum of the access and egress legs for a non-auto mode is longer than simply going from O to D direct, then it is out-of-scope.
- If both the access distance and the egress distance individually are longer than the main mode distance for a non-auto mode, then it is out-of-scope.
- If the total distance traveled for a non-auto mode is more than double the auto distance, then it is out-of-scope.
- If the total transfer distance is greater than 1 mile, this mode is out-of-scope.
- If access or egress for long-distance bus is greater than 10 miles, this mode is out-of-scope.

Assumptions to avoid double counting between modes:

- If an attractive rail option exists (based on both the access and egress legs being relatively short), then the combo mode is not a viable option that people would consider (given people’s aversion to transferring modes, especially if an attractive direct option is available to them).
- If an attractive rail option does not exist (based on one or more of the access/egress legs being long) but an attractive combo mode option does exist (based on both the access and egress legs being relatively short), then the combo mode is a viable option, but the rail mode is not.
- If an attractive option does not exist for either rail or the combo mode (based on one or more of the access/egress legs being long in each case), then neither is likely to be a viable option for most people (and this should be shown in the outputs from the choice model). Given rail is already in-scope, however, we remove the unattractive combo mode option to remove any risk of double-counting.

Additional assumptions:

- No long-distance bus for demand segments with employed or homemaker trip purposes;
- For all segments, do not allow main auto as an egress mode; and
- For segments with commuter or other trip purposes, only allow auto or transit access modes and only allow transit egress modes.

Model Review

The CRRM model is calibrated for Year 2018 network and travel conditions. In the current phase of work, we focused on calibrating the transit assignment at the service levels. The model was refined to replicate the assigned trips on the transit network, most importantly on the rail. This section discusses the latest calibration approach and discusses the observed vs. modeled trips at a granular level.

Review Data Inputs

The following data sets were compiled and used in conjunction with each other to review data for the model. Here is a list of datasets used:

National Household Travel Survey (NHTS) (with California Add-On): The NHTS data is the main source of development of the various parts of the model. The NHTS data is one of the most detailed data sources used to develop travel models. The data has information on the daily trip diaries of around 5-7% of the sample population, which is reweighted to the state population. Many pieces of information about trip-making behavior like trip purpose, income levels, time of the day of travel, number of trips daily made by individuals, mode of travel, household size and household vehicles are obtained from the NHTS. Hence, it is a very important source of information for travel model development.

CSTDM Model: The California Statewide Travel Model (CSTDM) had been the starting point for CRRM model development, with the highway networks and many characteristics of the trips extracted from the CSTDM model.

Streetlight Data: This Location Based Service (LBS) data on origin-to-destination travel movements provided important insights to validate the travel patterns in the region.

Ridership Data from Individual Operators: This data was used to build the Base Demand matrices, which are used for the pivot process in the model.

Traffic Counts: Such counts on California Highways are useful for highway calibration and used to validate the base demand matrices obtained from CSTDM.

California Tourist database: This data from Visit California was used for visitor travel information.

Census Transportation Planning Products Program (CTPP): This was used to validate the journey to work travel in the model.

Data from *Individual Train/Bus Operators*: The following sets of data are used as calibration targets for the assignment of transit trips in the network.

- Station-to-station volumes
- Boarding and alighting counts
- On-board survey data

Bureau of Transportation Statistics for Air Trips: This data was extracted to develop air travel calibration targets.

Review Process

During the previous phase of work, the CRRM was checked up until the mode choice level replicating county-to-county trips by mode. In the current phase of work, additional detailed review work was carried out to replicate trips at service levels and boardings and alightings at the station level.

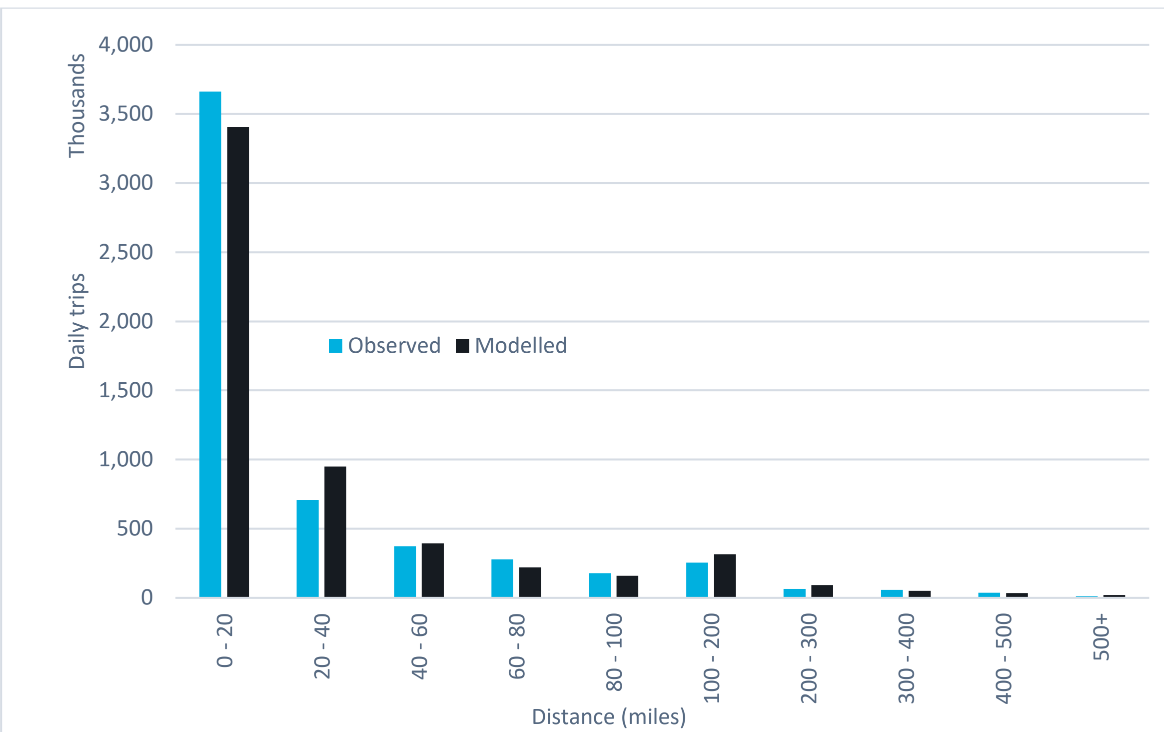
Trip Generation Model Review

The NHTS data with a California add-on was used to extract the in-scope trips (excluding very short-distance trips) for **Trip Generation**. The NHTS under-represented the long-distance trips in the region. Hence, the data was reweighted based on the information from the CSTDM model, CTPP and other regional models. The distribution of trips by origin and destination location, purpose, income, household size and employment status was generated from the reweighted NHTS data, and the **Trip Production** and **Attraction** model was estimated based on this observed information.

Trip Distribution Model Review

The **Trip Distribution** model deterrence function is checked to match the observed trip length frequency distribution from the NHTS data. The synthetic matrices were calibrated to match as closely as possible the trip patterns in the observed demand matrices. The observed demand for distribution adjustment was obtained from Streetlight data for autos and transit operator ridership information. Figure 2.5 shows the trip length frequency comparison between modeled and observed OD trip data from trip distribution step of the model.

Figure 2.5: Trip Length Frequency Distribution – Modeled vs Observed



Source: Steer

Time of the Day

In the CRRM Model, the time of the day distribution of trips was based on the distribution of the observed auto trips. The time of the day factors were reevaluated. These factors were applied to assign the daily trips to different time periods (AM, MID, PM, OFF, WKD). Based on the new time of day factors, the distribution of trips by time periods in the current model is shown in Table 2.4.

Table 2.4: Time of Day Distribution of Trips

Time Period	Percentage of Trips
AM	38%
MID	22%
PM	13%
OFF	9%
WKD	18%

Source: Steer

Mode Choice Model Review

The **Mode Choice** model was estimated based on the behavioral surveys conducted as a part of the model development. To ensure the robustness of the outputs of the mode choice model, costs sensitivity tests were conducted, and demand elasticities were computed to check the model's response to the change in fares/costs of the model. Table 2.5 show the current performance of the mode choice model before the county-to-county level pivot process is applied.

Table 2.5: Mode Choice Validation – Pre-Pivot – Observed vs. Modeled Daily Trips by Mode

Trips	Observed	Modeled	Difference	% Difference
Rail	106,151	110,090	3,939	3.7%
Auto	6,004,387	5,977,487	-26,900	-0.4%
Bus	8,944	17,419	8,475	94.8%
Flight	88,759	114,149	25,390	28.6%
Combo	2,661	871	-1,790	-67.3%
Total	6,210,902	6,220,016	9,114	0.1%

Source: Steer

Trip Table Pivot

The trip tables from the mode choice steps are subject to further adjustment at the county level based on the observed county level trip tables by mode. Scalable Quality Value (SQV) factors are created by comparing the observed and modeled county-to-county trips, and these are converted to pivot factors applied to base year and future year trip tables from the mode choice model. While the mode level trip tables have the zonal trip distribution from the model, the overall county-to-county trips are adjusted to observed information. Table 2.6 show rail trip table values at major market levels compared against observed trips.

Table 2.6: Regional Rail Demand – Post-Pivot – Observed vs Modeled | Daily Trips

Movement	Observed	Modeled	Difference	% Difference
SCAG–SCAG	32,510	23,989	-8,521	-26%
MTC–MTC	53,748	55,545	1,797	+3%
SCAG–SANDAG	5,347	6,960	1,613	+30%
SANDAG–SANDAG	4,247	3,582	-665	-16%
Central Valley–MTC	4,122	3,773	-348	-8%

Source: Steer

Assignment Model Review

During **traffic assignment,** the model assigns the OD travel demand on a transportation network. Thus, an individual trip is assigned a route of travel from its origin to its destination. The CRRM model is calibrated to replicate the observed rail demand, which is based on the data extracted from service operators. The rail trips are calibrated at the most detailed level, given the model is an inter-city rail model, while the flight and bus trips were checked at an aggregated level. For the inter-city rail travel, the modeled data was calibrated with observed data at the following levels:

Rail Service Level: Rail demand for each service in the network was calibrated with the observed base demand for individual lines for each service (or operator). Table 2.7 shows the calibration of the model at these service levels. The services where the model shows the larger deviations are generally those that are part of the Metrolink network, although overall, Metrolink has a good fit. The Amtrak routes are reasonable, with the exception of the Sunset Limited and Texas Eagle, long-distance Amtrak routes that only operate tri-weekly with erratic service performance and thus have notably low observed volumes. Overall, the line validation is reasonable.

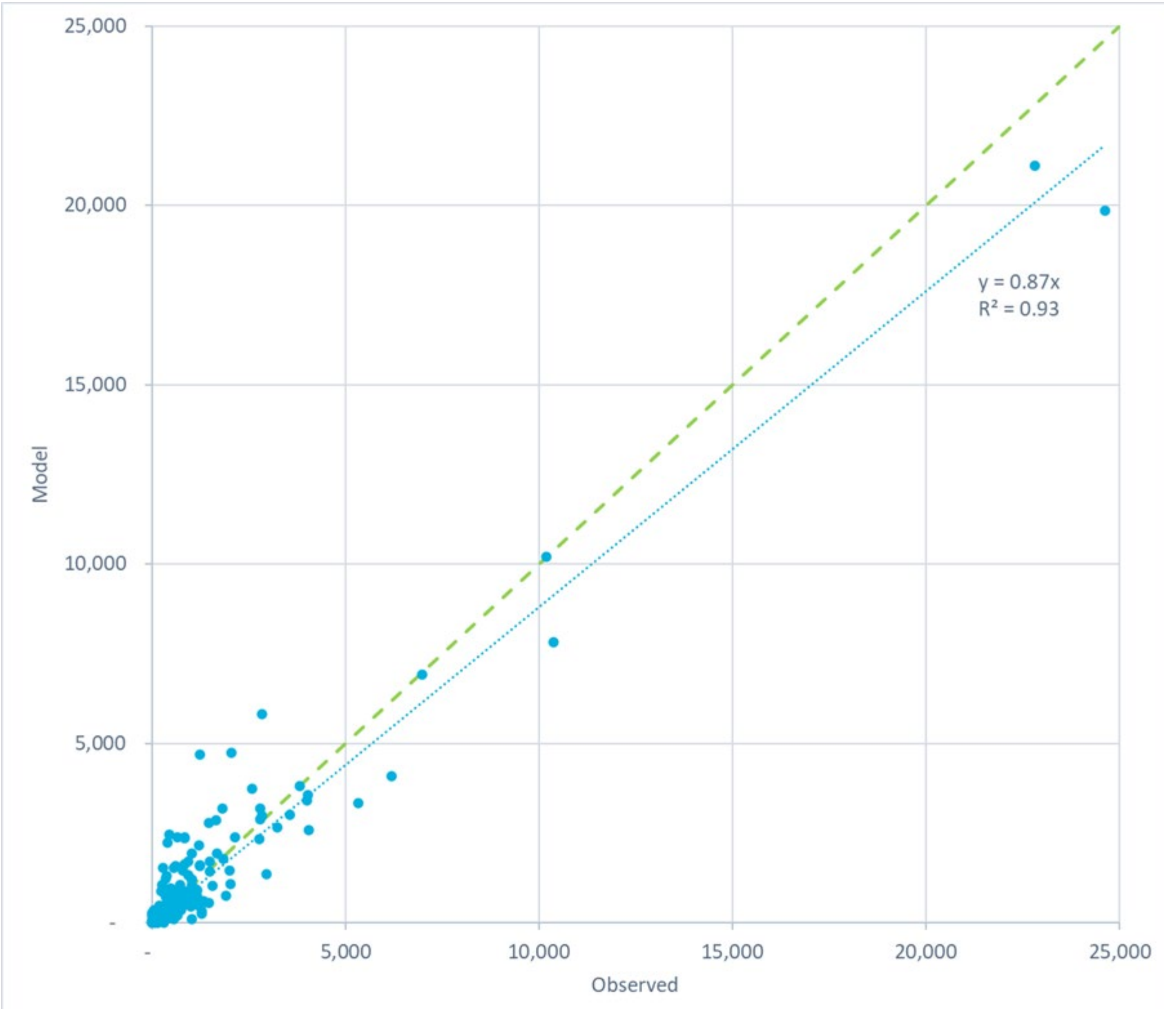
Table 2.7: Rail Service Level – Observed vs Modeled

Service	Route	Observed	Modeled	Difference	% Difference
ACE	Altamont Corridor Express	3,833	3678	-155	-4%
SMART	Main Line	1,686	2,004	318	19%
Caltrain	Caltrain	54,301	51,264	-3,037	-6%
NCTD	COASTER	3,836	3,380	-456	-12%
Amtrak	California Zephyr	396	305	-91	-23%
Amtrak	Southwest Chief	384	448	64	17%
Amtrak	Coast Starlight	833	697	-136	-16%
Amtrak	Pacific Surfliner	8,628	9,962	1,334	15%
Amtrak	Capitol Corridor	4,703	5,394	691	15%
Amtrak	Sunset Limited / Texas Eagle	180	299	119	66%
Amtrak	San Joaquin	2,961	2,596	-365	-12%
Amtrak Total		*17,689*	*19,396*	*1,707*	*10%*
Metrolink	San Bernardino Line	7,627	8,851	1,224	16%
Metrolink	Ventura County Line	2,544	3,739	1,195	47%
Metrolink	Antelope Valley Line	4,907	5,448	541	11%
Metrolink	Riverside Line	3,211	2,049	-1,162	-36%
Metrolink	Orange County Line	6,119	6,595	476	8%
Metrolink	Inland Empire	3,354	2,627	-727	-22%
Metrolink	91/Perris Valley Line	2,373	2,097	-276	-12%
Metrolink		*30,135*	*31,406*	*1,271*	*4%*

Source: Steer

Rail Station Level: The station boardings and alighting are reviewed against the observed station boardings and alighting's for year 2018. The station level observed data is developed from the detailed ticketing data obtained from the service providers. Station level demand (total boardings and alightings) is illustrated in Figure 2.6. The two stations with the highest demand are Los Angeles Union station and San Francisco 4th & King, with the other stations having half or less the demand. For the stations with lower demand (in the range of a few thousand a day), the model fit becomes more variable, reflecting the use of the model zone level patterns by rail noted above. In addition, there are lines where station spacings are very short (e.g. within a mile or two – around San Jose for example and the Metrolink network), making a better fit more challenging.

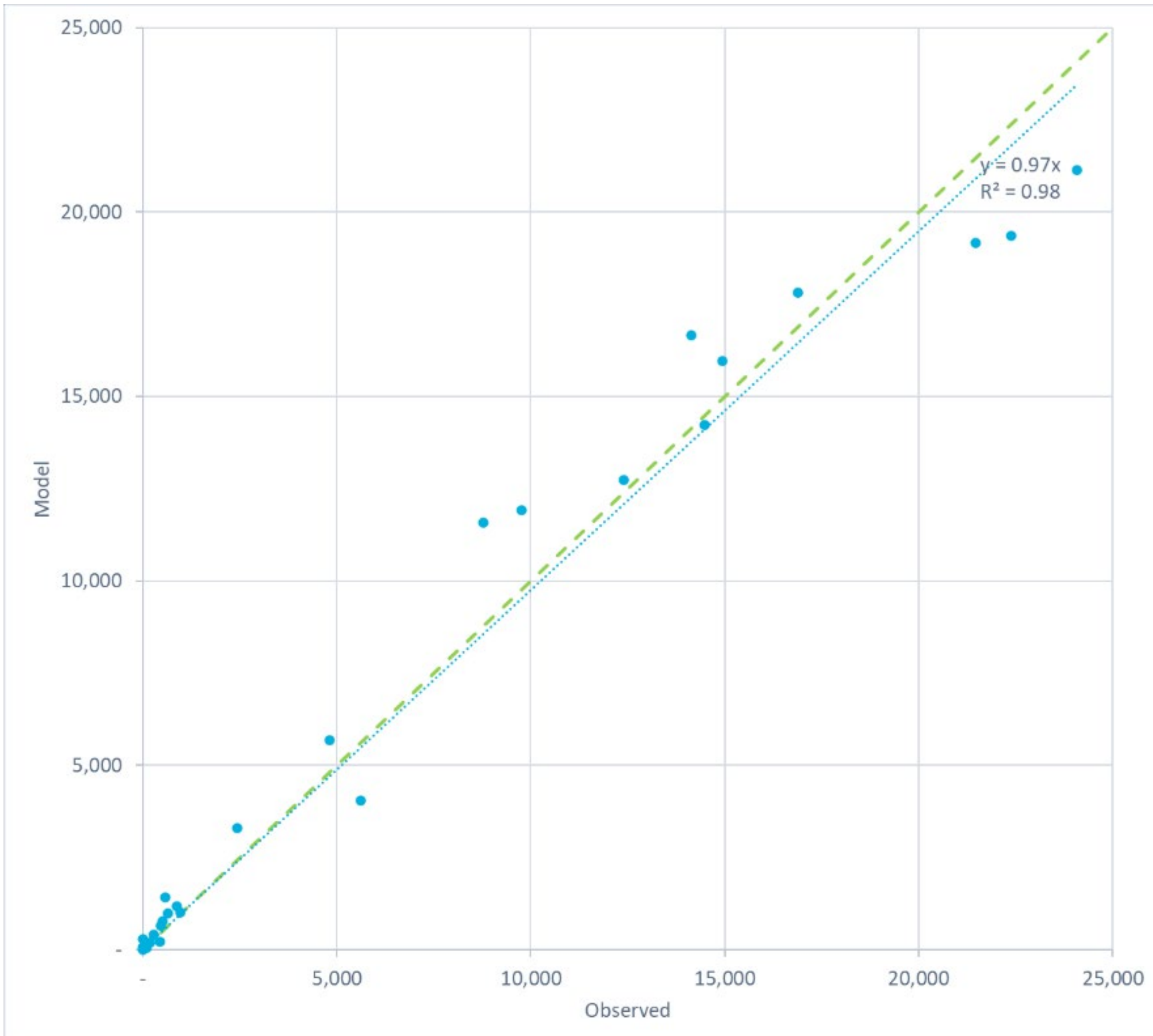
Figure 2.6: Rail Station Daily Demand – Observed Versus Modeled



Source: Steer

Airport demand: Airport demand (total boardings and alightings) compared with the observed data are shown in Figure 2.7. Overall, this demonstrates a good fit with observed data, with only minor variance resulting from the airport pair choices that exist out of the State.

Figure 2.7: Airport Daily Demand – Observed Versus Modeled



Source: Steer

This model was used to develop the Ridership and Revenue estimated for the Base Case scenarios for Valley to Valley and Phase 1 as discussed in the next section.

3 Ridership and Revenue Forecasting

Overview

DB ECO in conjunction with CHSRA developed the Base Case alignment of HSR scenarios for the 2024 Business Plan. The project began with an assessment of service plans for the Valley to Valley scenario and Phase 1 HSR scenario. After the initial assessment of scenarios, the Valley to Valley and Phase 1 service plans were chosen as alternatives for further assessment. Both the Valley to Valley and Phase 1 service plans were refined compared to the 2020 Business Plan assumptions by DB ECO for use in the ridership modeling process.

We conducted a detailed fare sensitivity analysis for these scenarios. This showed that the model was reasonably sensitive to changes in fares. Through the revenue and ridership optimization exercise, the new fare structure was developed by DB ECO and implemented for the two HSR scenarios. The new proposed fare structure policy focused on maximizing farebox revenue while adapting the fare structure to regional differences and changes in user behavior and optimizing ridership along the service corridors. A broader objective of the proposed fare structure policy is to reflect the competitive landscape of auto and air modes so that high-speed rail can be perceived as an alternative to air and auto travel between origins and destinations along the HSR the major cities corridors in California.

As a part of HSR network updates, CHSRA, along with rail partners and CalSTA/Caltrans, are looking at systemwide improvements to rail and bus connectivity in the state. Along with developing the HSR services, updates to other services are also included in the Build scenarios. These updates are applied to ACE, San Joaquins and connecting Intercity Bus services to stations.

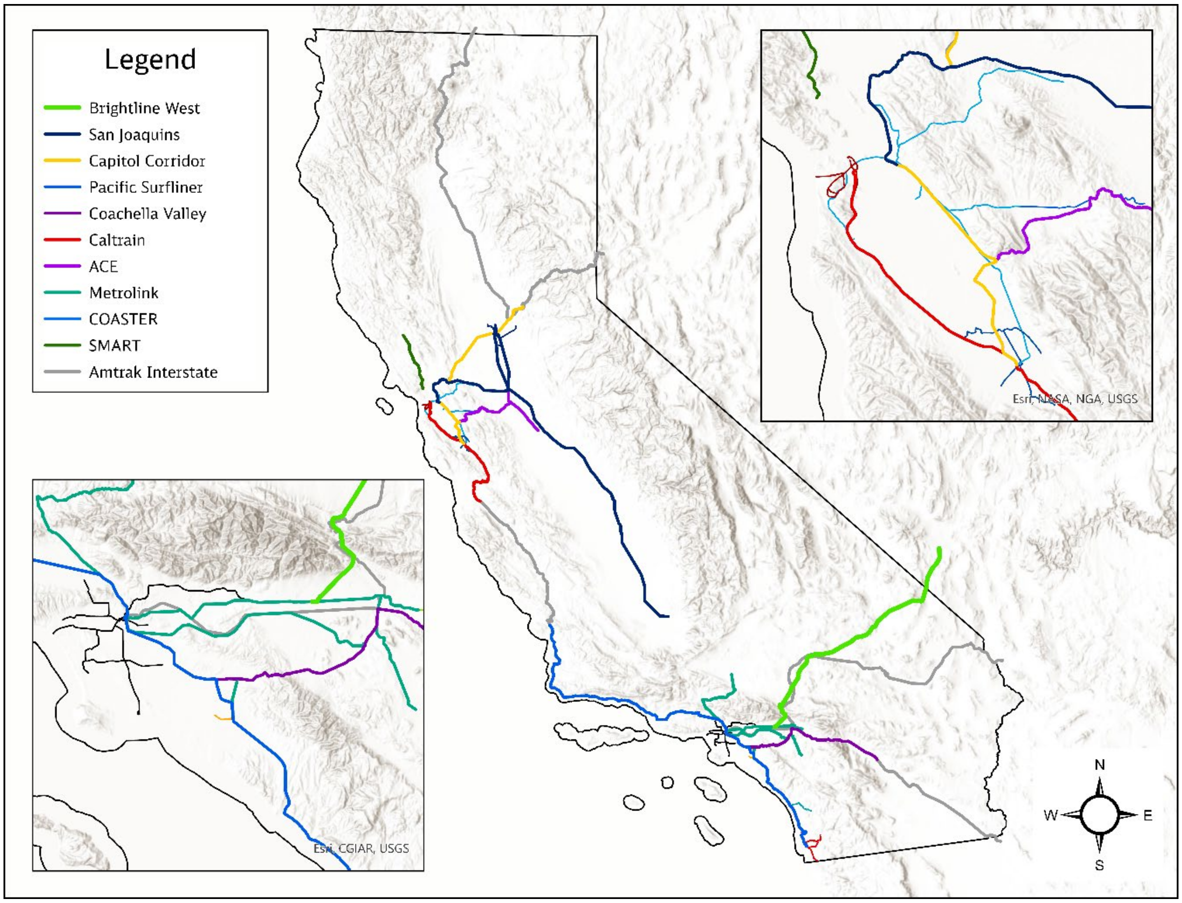
The subsequent sections will set out the network updates for conventional rail and connecting intercity buses, HSR service plans, fare structure and related assumptions. The ridership and revenue forecasts for base case Valley to Valley and Phase 1 scenarios are discussed thereafter.

Service Plan Assumptions

Future No Build Scenario

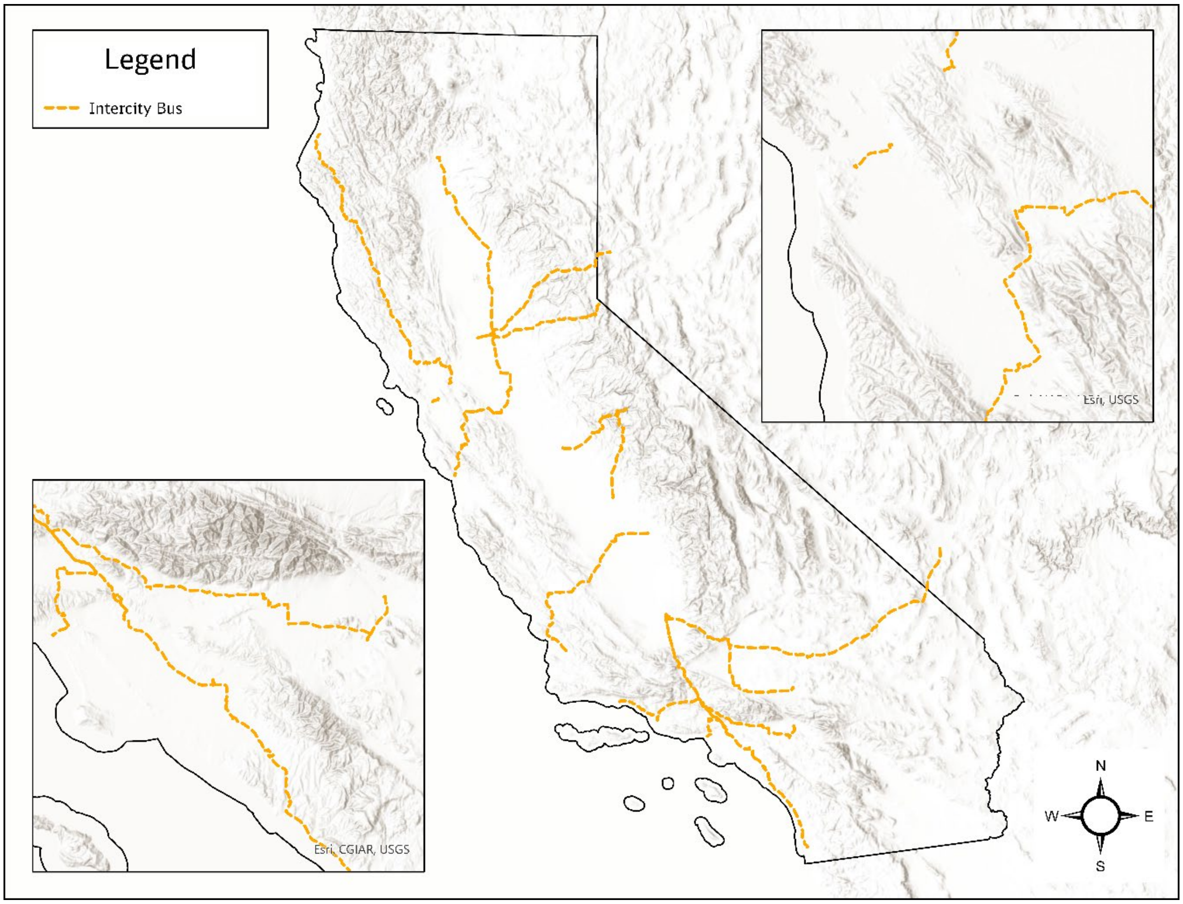
The Business as Usual (BAU) scenario is the future No Build scenario expected in the absence of the HSR project. The BAU scenario is important as it provides a baseline against which any HSR scenario can be compared for ridership, revenue and cost generation. The BAU network includes changes in network route and service frequencies for conventional rail and connecting intercity buses compared to the base network. Figure 3.1 illustrates the modified rail and network for the BAU scenario and Figure 3.2 illustrates the modified bus network for the BAU scenario.

Figure 3.1: Statewide Service Plan Map – Business as Usual – Rail Network



Source: DB ECO

Figure 3.2: Statewide Service Plan Map – Business as Usual – Bus Network



Source: DB ECO

The following sets out the major updates to the network in the BAU scenario:

Altamont Corridor Express (ACE): The ACE provides commuter rail service from Stockton to San Jose. In the BAU, major changes are applied to the ACE service:

- ACE service extended north to Sacramento (Natomas);
- ACE service extended south to Turlock; and
- Modifications to headways for current ACE service.

San Joaquins (SJ): The SJ service operated by Amtrak has two major services, Sacramento–Bakersfield and Oakland–Bakersfield. In the BAU, major changes are applied to SJ service:

- SJ service added between Sacramento (Natomas)–Fresno; and
- Modifications to headways for current SJ service.

Intercity Bus: Figure 3.2 shows the Intercity Bus network in the BAU scenario. In the BAU, minor changes are applied to Intercity Bus service and many headways were modified.

Table 3.1: Statewide Transit Lines – Business as Usual – Rail Network

Service	Route
San Joaquins	Sacramento (SAC) – Bakersfield
San Joaquins	Oakland – Bakersfield
San Joaquins	Natomas – Fresno
Capitol Corridor	San Jose – Auburn [1]
Pacific Surfliner	San Luis Obispo – San Diego [1]
Coachella Valley	Los Angeles – Coachella
Caltrain	San Francisco (4TH) – Salinas [1]
ACE	Natomas – San Jose [1]
ACE	Natomas – Turlock
ACE	Natomas – Stockton (SKN)
ACE	San Jose – Turlock
Metrolink	Ventura – Oceanside [1]
Metrolink	Lancaster – Perris [1]
Metrolink	San Bernardino – Oceanside
Metrolink	Los Angeles – Redlands [1]
Metrolink	Los Angeles – Riverside
COASTER	Oceanside – San Diego
SMART	Sonoma Airport – San Rafael

[1] Route includes short runs that do not operate to terminal stations
Source: DB ECO

Table 3.2: Statewide Transit Lines – Business as Usual – Bus Network

Service	Route
Intercity Bus	San Francisco – Emeryville
Intercity Bus	Eureka – Martinez [1]
Intercity Bus	Redding – Stockton [1]
Intercity Bus	Sacramento – Reno (NV)
Intercity Bus	Sacramento – Stateline (NV)
Intercity Bus	Stockton – San Jose
Intercity Bus	San Jose – Santa Cruz
Intercity Bus	Merced – Yosemite
Intercity Bus	Fresno – Yosemite
Intercity Bus	Santa Maria – Visalia
Intercity Bus	Bakersfield – San Diego [1]
Intercity Bus	Bakersfield – Santa Monica
Intercity Bus	Bakersfield – San Bernardino [1]
Intercity Bus	Bakersfield – Santa Barbara
Intercity Bus	Bakersfield – Victorville
Intercity Bus	Bakersfield – Las Vegas (NV)

[1] Route includes short runs that do not operate to terminal stations
Source: DB ECO

Table 3.3: Statewide Transit Lines – Business as Usual – Other HSR Network

Service	Route
Brightline West	Las Vegas – Rancho Cucamonga

Source: DB ECO

Future Build Scenarios

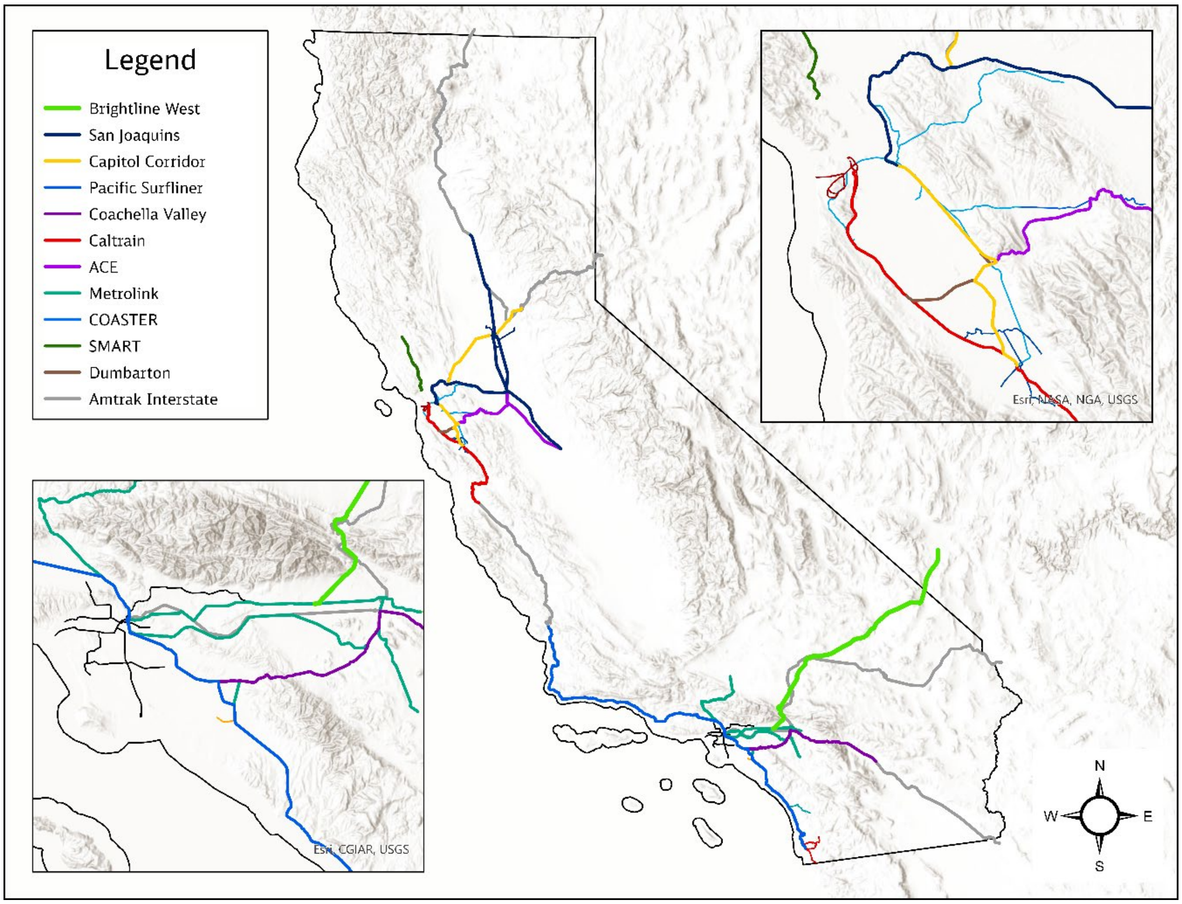
The Base Case assumptions for HSR include two Build scenarios – Valley to Valley and Phase 1, with ridership and revenue estimates provided for future years 2030, 2040 and 2050. Given the southern extension in Phase 1, these scenarios have very different network connectivity to Southern California. While the Valley to Valley scenario will only be able to provide connection to the Los Angeles metropolitan area via HSR Bus and Intercity Bus, the Phase 1 scenario will provide direct HSR connectivity from the San Francisco Bay Area to the Los Angeles Basin.

Conventional Rail and Connecting Bus Network

While the HSR and HSR Bus network for Valley to Valley and Phase 1 will vary, the conventional rail and connecting bus networks are the same for both Build scenarios. Figure 3.3 illustrates conventional rail services and other HSR services in the Build scenarios, and Figure 3.4 illustrates connecting bus services in the Build scenarios.

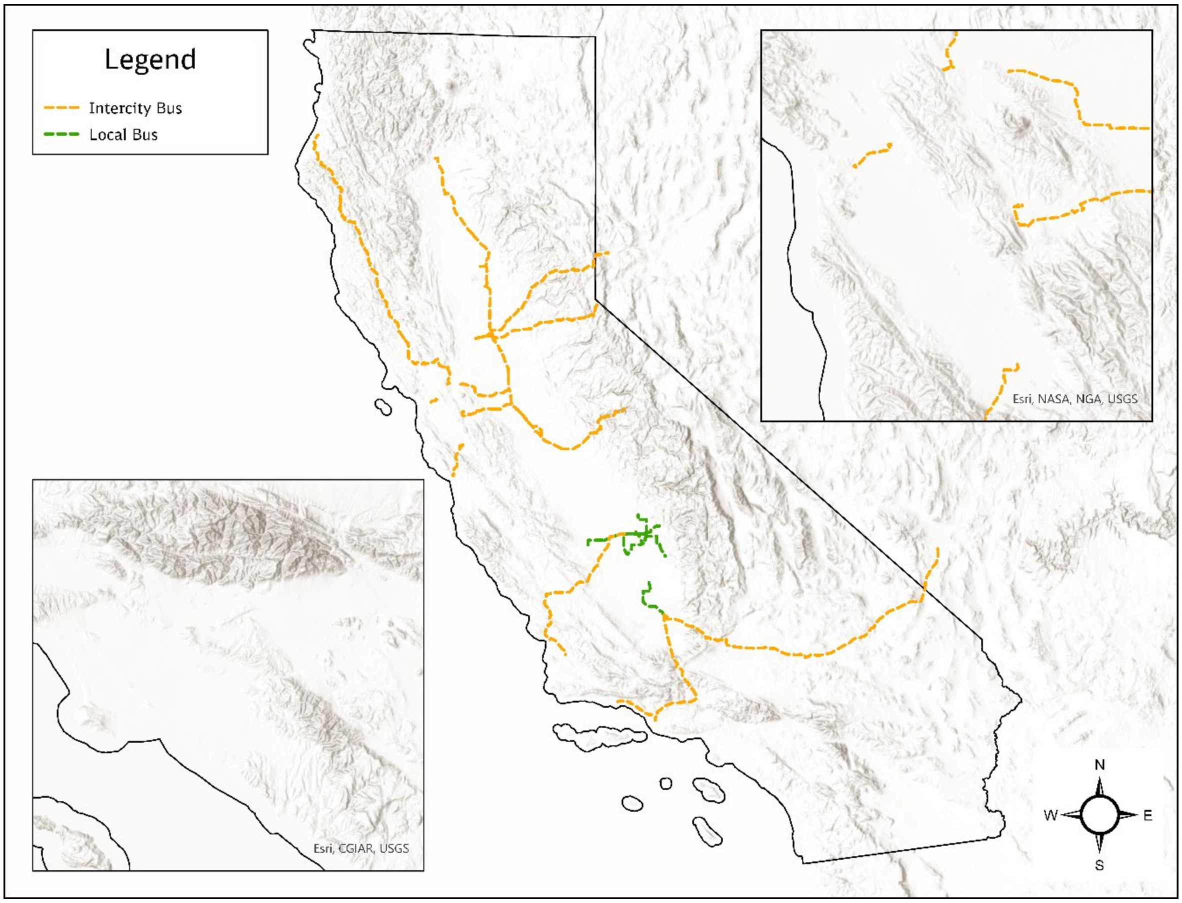
The conventional rail and connecting bus network in the Build scenario combined with the HSR network aim to provide greater connectivity throughout the state of California and a variety of transit options for travelers. These services provide better access and shorter overall travel times.

Figure 3.3: Statewide Service Plan Map – Build Scenario – Rail Network



Source: DB ECO

Figure 3.4: Statewide Service Plan Map – Build Scenario – Bus Network



Source: DB ECO

The principal changes to conventional rail and connecting buses in the Build Scenarios are:

- Altamont Corridor Express (ACE):
    - ACE service extended south to Merced to connect with HSR
    - ACE service extended north to Chico
    - ACE service extended west to Union City
    - Modifications to headways and route/stops for ACE service
- San Joaquins (SJ):
    - SJ service truncated at Merced in the south
    - SJ service extended north to Chico
    - Modifications to headways and route/stops for SJ service
- Intercity Bus:
    - Following new Intercity Bus routes are included in the Build scenarios:
        - Yuba City – Marysville
        - Gridley – Oroville
    - Modifications to headways and route/stops for Intercity Bus service
- Local Bus:
    - New Local Bus services around Kings/Tulare are included in the Build scenarios

Table 3.4: Statewide Transit Lines – Build Scenario – Rail Network

Service	Route
San Joaquins	Sacramento (SAC) – Merced
San Joaquins	Oakland – Merced
San Joaquins	Chico – Merced [1]
Capitol Corridor	San Jose – Auburn [1]
Pacific Surfliner	San Luis Obispo – San Diego [1]
Coachella Valley	Los Angeles – Coachella
Caltrain	San Francisco (4TH) – Salinas [1]
ACE	Natomas – San Jose [1]
ACE	Chico – Merced [1]
ACE	Chico – Stockton (SKN)
ACE	Chico – Union City
ACE	San Jose – Merced
ACE	Union City – Merced
Metrolink	Ventura – Oceanside [1]
Metrolink	Lancaster – Perris [1]
Metrolink	San Bernardino – Oceanside
Metrolink	Los Angeles – Redlands [1]
Metrolink	Los Angeles – Riverside
COASTER	Oceanside – San Diego
SMART	Sonoma Airport – San Rafael
Dumbarton Rail	Redwood City – Union City

[1] Route includes short runs that do not operate to terminal stations
Source: DB ECO

Table 3.5: Statewide Transit Lines – Build Scenario – Bus Network

Service	Route
Intercity Bus	San Francisco – Emeryville
Intercity Bus	Eureka – Martinez [1]
Intercity Bus	Redding – Stockton [1]
Intercity Bus	Yuba City – Marysville
Intercity Bus	Gridley – Oroville
Intercity Bus	Sacramento – Reno (NV)
Intercity Bus	Sacramento – Stateline (NV)
Intercity Bus	Stockton – Pittsburg
Intercity Bus	Merced – Dublin/Pleasanton
Intercity Bus	San Jose – Santa Cruz
Intercity Bus	Merced – Yosemite
Intercity Bus	Santa Maria – Kings/Tulare
Intercity Bus	Bakersfield – Santa Monica [2]
Intercity Bus	Bakersfield – Pasadena [2]
Intercity Bus	Bakersfield – Santa Barbara
Intercity Bus	Bakersfield – Victor Valley [2]
Intercity Bus	Bakersfield – Las Vegas (NV)
Local Bus	Kings/Tulare – Kings/Tulare
Local Bus	Huron – Porterville
Local Bus	Visalia – Tulare
Local Bus	Visalia – Goshen Junction
Local Bus	Visalia – Dinuba
Local Bus	Visalia – Woodlake
Local Bus	Bakersfield – Delano

[1] Route includes short runs that do not operate to terminal stations
[2] Route operates in V2V scenario only and is eliminated for Phase 1
Source: DB ECO

Table 3.6: Statewide Transit Lines – Build Scenario – Other HSR Network

Service	Route
Brightline West	Las Vegas – Rancho Cucamonga

Source: DB ECO

Valley to Valley

The Valley to Valley scenario of the HSR network consists of a core alignment from San Francisco (4th & King) to Bakersfield. San Francisco to Bakersfield has two service types: an all-stop hourly service that goes in and out of Merced and a limited-stop bi-hourly service that excludes Merced.

The HSR network is connected to regions south of Bakersfield by HSR Bus, extending the reach of the core HSR network. These HSR Buses are low-cost bus alternatives to supplement existing long-distance buses and provide seamless connections to markets along the Phase 1 corridor. The HSR Bus services in the V2V scenario include stops at Burbank Airport and Los Angeles Union Station.

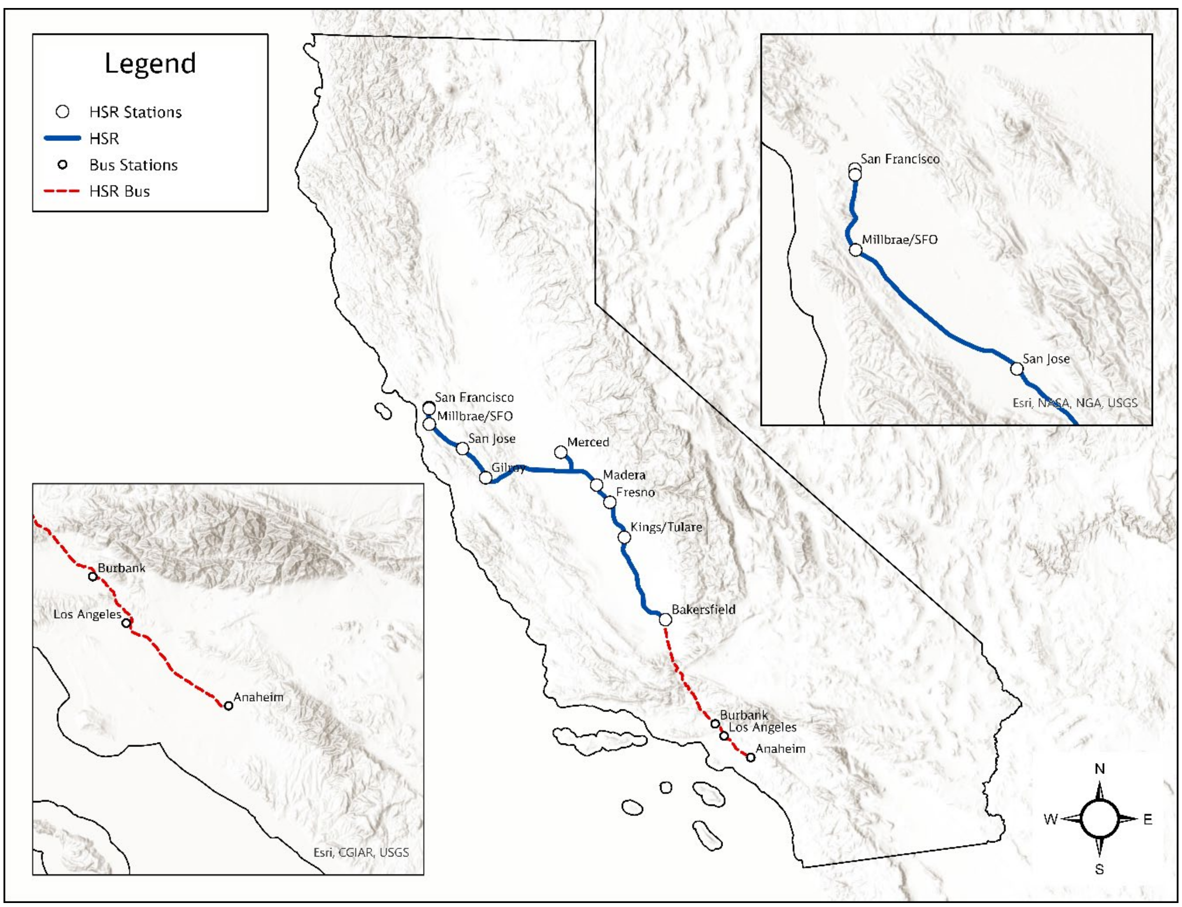
Table 3.7: HSR Bus Transit Lines – Valley to Valley

Service	Route
HSR Bus	Bakersfield – Anaheim

Source: DB ECO

Figure 3.5 illustrates the HSR, HSR Bus, Rail and Bus network for the Valley to Valley scenario. The major transfer stations in the HSR network can be seen in the figure.

Figure 3.5: Statewide Service Plan Map – Valley to Valley – High-Speed Rail Network



Source: DB ECO

A wider improvement to statewide conventional rail and connecting bus services is included in the Valley to Valley scenario. These improvements to conventional rail, most importantly ACE and San Joaquin connections in Merced, aim to provide integrated network connectivity, enhanced scheduling and transfer opportunities, and remove redundancy in the network.

Table 3.8: Service Frequencies by Time of Day – Valley to Valley – HSR and HSR Bus

Service	Route	AM Headway	MID Headway	PM Headway	OFF Headway	WKD Headway
V2V Default	San Francisco – Bakersfield (via Merced)	60	60	60	100	68
V2V Default	Bakersfield – San Francisco (via Merced)	60	60	60	100	68
V2V Limited	San Francisco - Bakersfield	120	100	120	150	120
V2V Limited	Bakersfield – San Francisco	120	100	120	150	120
HSR Bus	Bakersfield – Anaheim	40	38	40	60	44
HSR Bus	Anaheim – Bakersfield	40	38	40	60	44

Source: DB ECO

In order to account for integrated connections with HSR, a maximum transfer penalty of 47 mins was applied to HSR Bus connections at Bakersfield and SJ and ACE connections at Merced. In addition, assuming new HSR stations will have more direct access options available to connecting services such as HSR Bus, a nominal short transfer distance was applied.

The following tables show the travel times for the HSR and HSR Bus services.

Table 3.9: Travel Times in Minutes – Valley to Valley – High-Speed Rail Service

Pattern #	V2V Default	V2V Limited
Frequency	60	120
San Francisco	0	0
Millbrae	13	13
San Jose	49	49
Gilroy	73	72
Merced	106	|
Madera	146	106
Fresno	157	116
Kings/Tulare	175	131
Bakersfield	206	159

Source: DB ECO

Table 3.10 below reveals that HSR Buses are somewhat slower alternatives to long-distances buses in the region, however they will provide seamless timed transfers to HSR services. These buses can only be used to connect at HSR stations (e.g., for trips to Bakersfield, alightings are only allowed at Bakersfield and for trips from Bakersfield, boardings are only allowed at Bakersfield).

Table 3.10: Travel Times in Minutes– Valley to Valley – HSR Bus Service

Pattern #	HSR Bus
Frequency	30/60
Bakersfield	0
Burbank	115
Los Angeles	160
Anaheim	225

Source: DB ECO

Phase 1

The Phase 1 scenario of HSR encompasses complete HSR service between the San Francisco Bay Area and the Los Angeles Basin. Phase 1 has three different service types – Express, Limited and Default service.

- Express: San Francisco – Los Angeles non-stop service running twice a day with a total travel time of around 3 hr 5 mins
- Limited: San Francisco – Los Angeles multiple limited stop services running every 30 mins to an hour with a total travel time of around 3 hr 30 mins
- Default: San Francisco – Anaheim all-stop service running every hour, with a total travel time around 4 hr 30 mins
- Default: San Francisco/San Jose – Merced all-stop service running every hour with a total travel time of around 1 hr 50 min
- Default: Merced – Anaheim all-stop service running every hour with a total travel time of around 2 hr 55 min

The travel time between San Francisco and Los Angeles varies from 3 hr 5 mins for express service to around 4 hr 30 mins for default service. While there are only 2 express HSR services running per day, there are multiple limited or default services per day.

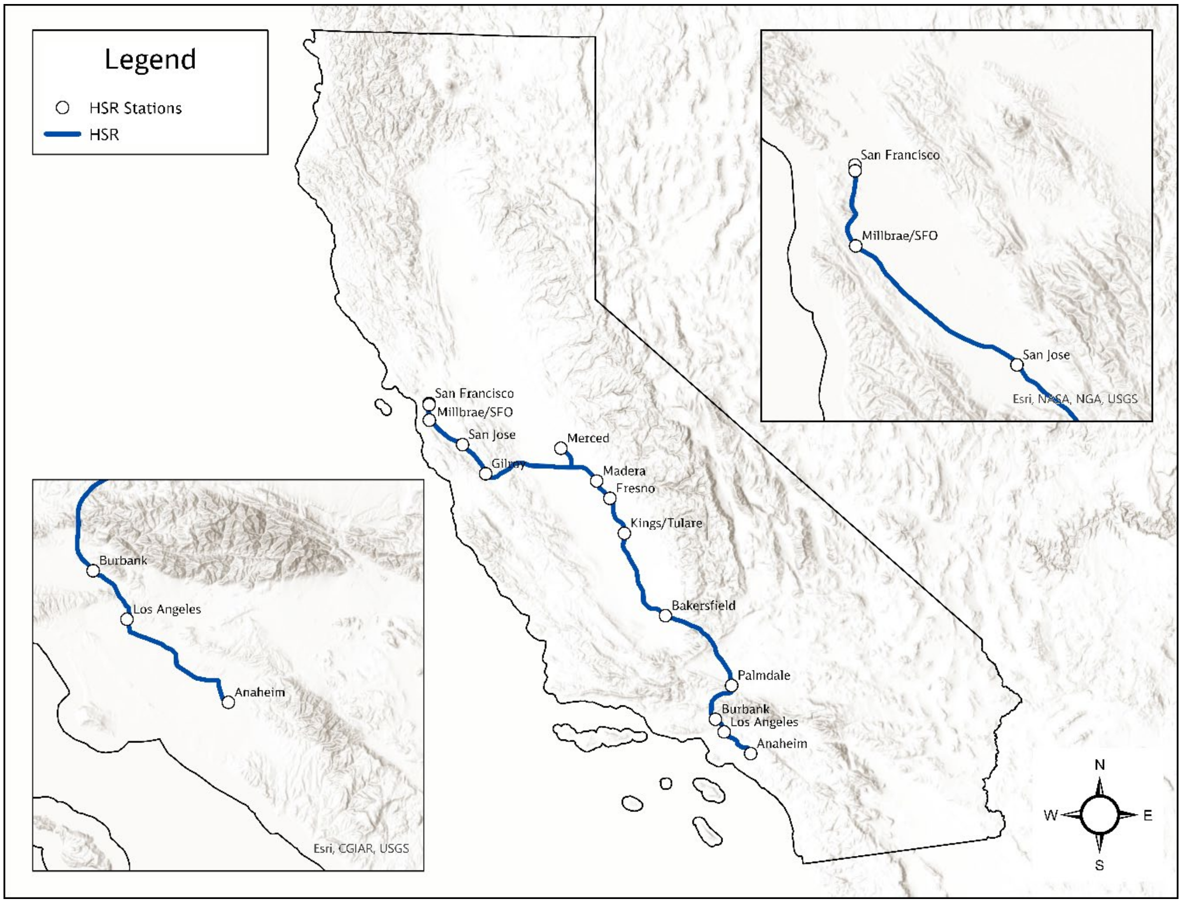
Table 3.11: Travel Times in Minutes – Phase 1 – High-Speed Rail Service

Pattern #	PH1-01 [1] Express	PH1-02 Limited	PH1-03 [2] Limited	PH1-04 [3] Default	PH1-06 Default	PH1-07 Default	PH1-05 [4] Default
Frequency	1080	30	60	60	60	60	60
San Francisco (STC)	0	0	0	0		0	
San Francisco (4TH)	|	|	4	4		|	
Millbrae/SFO	|	16	19	19		16	
San Jose	|	52	55	55	0	51	
Gilroy	|	|	|	79	21	78	
Merced	|	|	|	|	54	111	0
Madera	|	|	|	113			17
Fresno	|	|	114	126			27
Kings/Tulare	|	|	|	141			42
Bakersfield	|	|	152	170			71
Palmdale	|	|	|	202			103
Burbank	|	187	201	221			126
Los Angeles	185	203	217	237			142
Anaheim				271			176

[1] Two runs each direction per day
[2] Morning/evening one train begins/terminates in Fresno
[3] Morning/evening one train begins/terminates in Bakersfield and one train begins/terminates in Los Angeles
[4] Morning/evening one train begins/terminates in Los Angeles
Source: DB ECO

Figure 3.6 illustrates HSR services in the Phase 1 scenario, including default, limited and express services. Note that Phase 1 does not have any HSR Bus connections due to complete HSR service between the San Francisco Bay Area and the Los Angeles Basin.

Figure 3.6: Statewide Service Plan Map – Phase 1 – High-Speed Rail Network



Source: DB ECO

Table 3.12: Service Frequencies by Time of Day – Phase 1 – High-Speed Rail

Service	Route	AM Headway	MID Headway	PM Headway	OFF Headway	WKD Headway
PH1-01	San Francisco - Los Angeles	240	-	-	300	540
PH1-01	Los Angeles - San Francisco	240	-	-	300	540
PH1-02	San Francisco - Los Angeles	30	-	30	-	-
PH1-02	Los Angeles - San Francisco	30	-	30	-	-
PH1-03	San Francisco - Los Angeles	60	60	60	75	64
PH1-03	Los Angeles - San Francisco	80	60	60	60	64
PH1-03	San Francisco - Fresno	-	-	-	300	900
PH1-03	Fresno - San Francisco	240	-	-	-	900
PH1-04	San Francisco - Anaheim	60	60	60	100	68
PH1-04	Anaheim - San Francisco	120	60	60	60	68
PH1-04	San Francisco - Los Angeles	-	-	-	300	900
PH1-04	Los Angeles - San Francisco	240	-	-	-	900
PH1-04	San Francisco - Bakersfield	-	-	-	300	900
PH1-04	Bakersfield - San Francisco	240	-	-	-	900
PH1-06	San Jose - Merced	60	300	80	300	-
PH1-06	Merced - San Jose	60	300	80	300	-
PH1-07	San Francisco - Merced	-	60	-	100	64
PH1-07	Merced - San Francisco	-	75	240	100	64
PH1-05	Merced - Anaheim	60	60	60	75	64
PH1-05	Anaheim - Merced	80	60	60	60	64
PH1-05	Merced - Los Angeles	-	-	-	300	900
PH1-05	Los Angeles - Merced	240	-	-	-	900

Source: DB ECO

Socioeconomic Growth Assumptions

The future year socioeconomic data, including population, households and employment, have been forecasted based on estimates from the California Department of Finance Demographic Research Unit and Caltrans Transportation Economics Branch (2022 datasets). Table 3.13 displays the predicted population, households and employment by county in California for 2030, 2040 and 2050. State socioeconomic growth is expected to be very modest over the period to 2050.

Table 3.13: Summary of Socioeconomic Data

County	Population				Households				Employment			
	2018	2030	2040	2050	2018	2030	2040	2050	2018	2030	2040	2050
Alameda	1,596,130	1,670,455	1,795,198	1,898,488	585,990	621,433	672,826	718,556	830,893	871,743	899,954	916,246
Alpine	3,369	1,200	1,187	1,201	1,461	521	516	541	423	791	810	831
Amador	37,634	41,584	40,621	38,929	16,169	17,849	17,339	16,683	11,868	13,340	14,040	14,510
Butte	211,127	211,002	224,028	242,078	86,829	86,838	92,070	100,717	81,508	87,605	89,146	91,392
Calaveras	42,997	43,735	40,752	37,686	18,642	19,036	17,552	16,321	9,204	10,520	10,430	10,430
Colusa	21,818	22,135	21,532	20,406	7,439	7,667	7,512	7,175	8,429	10,200	10,160	10,200
Contra Costa	1,184,957	1,171,945	1,274,708	1,361,137	429,151	429,892	467,934	503,818	362,821	389,962	399,929	409,267
Del Norte	27,423	24,738	23,347	21,836	11,527	10,533	9,975	9,421	8,392	8,120	7,970	7,850
El Dorado	186,885	185,434	179,456	168,423	75,531	75,542	72,280	68,313	46,995	64,647	67,053	69,087
Fresno	963,206	1,047,382	1,083,901	1,098,206	316,891	347,675	361,522	370,250	377,351	453,247	474,262	488,680
Glenn	26,194	29,182	28,513	26,584	9,590	10,828	10,645	10,033	9,030	9,920	10,000	10,070
Humboldt	135,532	131,729	126,479	121,539	58,917	58,302	57,065	55,841	48,446	51,997	51,970	52,012
Imperial	184,406	184,997	189,972	192,294	59,216	60,191	61,994	63,245	41,751	67,938	69,203	75,466
Inyo	10,815	18,887	18,552	18,093	5,278	9,367	9,255	9,106	7,290	7,630	7,670	7,650
Kern	850,789	940,257	966,310	969,968	277,463	308,815	317,512	321,524	325,123	373,223	387,175	397,088
Kings	140,830	157,531	161,190	160,446	45,810	51,789	53,355	53,520	53,706	53,523	56,301	58,571
Lake	64,775	68,446	67,564	67,065	27,384	28,965	28,385	28,120	16,043	18,370	19,010	19,730
Lassen	32,096	25,708	21,772	17,983	13,986	11,446	9,762	8,194	7,141	8,610	8,980	8,610
Los Angeles	10,067,183	9,566,663	9,306,759	8,877,939	3,542,900	3,457,683	3,428,661	3,344,049	4,696,616	4,741,504	4,844,201	4,918,527

County	Population				Households				Employment			
Madera	152,427	161,980	163,345	161,937	48,962	52,414	52,849	52,644	72,446	58,171	62,393	64,845
Marin	276,295	244,319	245,498	243,295	116,577	107,274	109,130	109,964	113,873	127,772	133,914	137,214
Mariposa	17,858	17,017	16,588	16,372	7,909	7,594	7,329	7,167	4,640	5,440	5,290	5,200
Mendocino	90,500	88,789	89,200	89,697	37,868	37,569	38,037	38,607	30,936	34,924	35,057	35,073
Merced	280,028	311,578	329,168	336,170	87,275	96,571	101,475	104,142	77,159	91,804	93,622	95,589
Modoc	9,248	8,346	7,463	6,464	4,222	3,841	3,388	2,940	2,343	2,880	2,890	2,870
Mono	21,353	12,987	12,068	10,881	10,381	6,391	6,017	5,495	2,684	8,240	8,220	8,260
Monterey	438,913	434,506	436,307	430,706	142,056	143,089	145,719	146,171	179,296	208,438	213,639	217,996
Napa	152,976	132,087	131,600	128,515	57,746	50,944	50,994	50,643	74,896	82,875	85,857	88,160
Nevada	88,270	97,464	94,444	89,649	39,040	43,245	41,499	39,411	30,930	35,395	35,773	35,965
Orange	3,141,992	3,201,361	3,283,811	3,307,387	1,078,185	1,124,328	1,168,774	1,196,457	1,608,654	1,758,299	1,783,555	1,796,951
Placer	391,217	443,936	474,905	490,667	153,335	174,574	184,749	191,615	160,753	202,468	208,375	214,099
Plumas	18,460	17,530	15,319	13,712	8,581	8,197	7,110	6,441	5,818	6,740	6,410	6,100
Riverside	2,408,962	2,540,559	2,637,463	2,670,068	798,257	851,792	889,154	913,435	701,382	899,463	948,171	972,532
Sacramento	1,500,992	1,611,309	1,708,461	1,782,519	559,286	605,994	644,964	676,798	674,370	749,989	779,615	802,687
San Benito	47,705	71,265	75,452	76,959	14,882	22,362	23,688	24,382	13,365	19,439	19,836	20,269
San Bernardino	2,104,994	2,257,518	2,302,286	2,287,280	670,580	724,620	740,484	742,337	795,651	943,601	1,004,816	1,060,036
San Diego	3,290,379	3,373,792	3,416,779	3,394,592	1,211,368	1,267,872	1,303,671	1,319,161	1,508,363	1,621,686	1,663,295	1,702,140
San Francisco	870,037	837,021	845,589	848,071	384,214	377,001	383,957	386,357	759,701	864,799	905,910	944,639
San Joaquin	721,097	831,956	896,033	942,102	236,047	272,591	293,112	310,861	259,362	312,086	327,842	336,253
San Luis Obispo	288,265	286,547	287,621	279,398	118,568	119,585	120,918	120,483	95,991	129,941	131,335	132,181

County	Population				Households				Employment			
San Mateo	750,613	721,006	728,934	726,771	275,112	272,120	279,660	281,902	411,344	443,543	451,754	457,690
Santa Barbara	431,369	459,727	475,401	486,994	150,530	162,093	169,647	178,888	170,756	231,192	234,786	237,977
Santa Clara	1,973,286	1,900,159	2,009,127	2,075,768	688,267	675,903	716,945	744,545	1,111,857	1,190,517	1,215,461	1,240,316
Santa Cruz	264,909	268,734	269,540	266,117	99,682	102,986	104,320	105,667	86,247	115,175	118,275	120,773
Shasta	175,025	178,722	180,245	181,492	72,145	74,258	74,599	75,540	63,998	72,963	73,227	73,098
Sierra	3,051	3,132	2,944	2,844	1,570	1,655	1,542	1,479	468	626	564	527
Siskiyou	43,013	43,068	41,085	39,107	19,415	19,611	18,546	17,810	13,184	13,880	13,370	12,980
Solano	423,809	451,280	476,163	494,487	152,938	163,720	172,822	180,668	153,039	150,504	155,944	158,777
Sonoma	484,610	475,831	459,445	434,406	193,086	194,090	189,702	182,854	205,019	223,418	228,989	233,813
Stanislaus	530,603	558,565	577,523	593,396	178,546	189,083	195,857	203,030	198,813	211,373	216,468	221,046
Sutter	96,640	104,005	105,803	104,604	33,148	36,110	36,797	36,806	28,414	35,189	36,821	37,943
Tehama	84,698	65,151	64,900	64,129	33,804	26,172	26,007	25,854	18,126	22,440	23,320	23,840
Trinity	12,840	16,042	15,727	15,442	6,025	7,564	7,343	7,142	2,334	2,750	2,750	2,770
Tulare	505,901	487,378	487,888	472,966	157,481	153,105	154,190	151,600	147,315	180,237	185,163	189,344
Tuolumne	54,137	50,082	48,956	48,542	23,649	21,973	21,595	21,875	16,523	17,870	17,510	17,030
Ventura	881,412	805,456	789,877	758,161	302,671	283,215	281,103	274,187	313,479	346,210	366,197	382,302
Yolo	212,092	230,484	240,261	243,409	77,418	84,223	88,032	90,990	82,216	127,714	131,586	134,333
Yuba	75,767	87,172	91,389	94,142	26,655	30,677	32,294	33,871	16,962	21,400	22,700	23,850

Source: DB ECO

The population forecasts vary when we examine growth rates by county. Los Angeles County, in particular, is expected to have negative growth beyond 2030, while counties in the Central Valley are expected to grow at a rate higher than average. San Francisco County is projected to experience a decline in population through the decade of the 2020s compared to the base year but has positive growth beyond 2023. The three regions mentioned previously are all in the catchment area of the HSR system.

The growth rates for non-resident and external trips use a different and simpler approach. These use the 'global' growth factor of the resident population total, with the exception of the Las Vegas/Clark County external zones, which use the Nevada population forecasts. The non-resident and external growth rates are summarized in Table 3.14 below.

Table 3.14: Non-Resident and External Growth Factors

Year	Non-Resident and External	Clark County
2018	1.0000	1.0000
2030	1.0084	1.1811
2040	1.0256	1.2892
2050	1.0242	1.3551

Source: DB ECO

Overall, given updated socioeconomic growth rates, travel demand in future years will be lower than in previous forecasts when socioeconomic growth was predicted to be considerably higher.

Fare Policy and Fare Sensitivity Analysis

An initial fare sensitivity assessment was conducted using the 2020 Business Plan (2020 BP) HSR Fares (Table 3.15) converted from 2019 $ to 2018 $ for modeling purposes. Fare sensitivity analysis was conducted for Base Case scenarios using two approaches, a statewide fare policy approach in which overall HSR fares were changed by the same percentage and a regional fare policy approach in which differential fares are applied to different markets.

Table 3.15: 2020 Business Plan HSR Fares (2018 $)

Region	Boarding Fare ($)	Per Mile Fare ($/mile)	Fare Cap
MTC – MTC	$16.94	$0.146	$100.00
SCAG – SCAG	$26.16	$0.182	$100.00
Inter-region	$35.25	$0.218	$100.00

Source: CHSRA 2020 BP

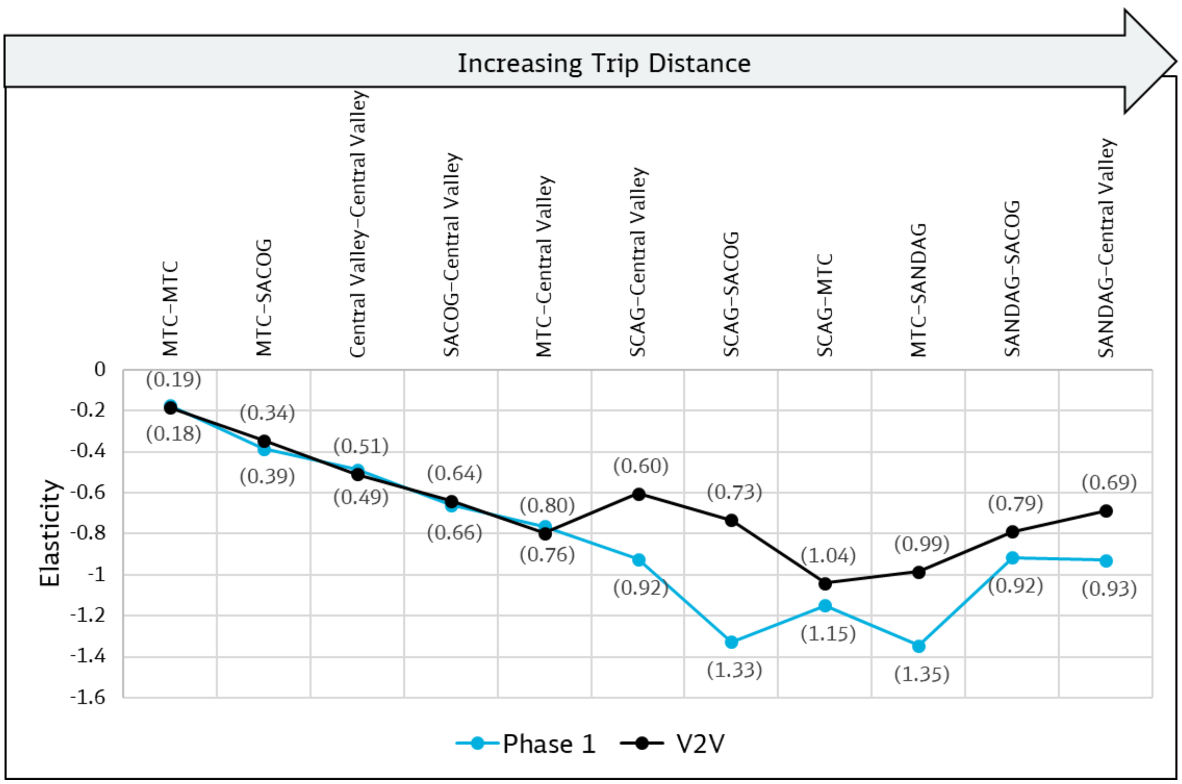
Fare Sensitivity Curves

Fare Elasticities

To develop a fare policy for HSR Base Case scenarios, we conducted a fare sensitivity analysis with +/-60%, +/-40%, and +/-20% to 2020 BP fares. For these analyses, we did not apply an upper fare cap to prices charged for any travel on the HSR system.

The fare elasticities look reasonable overall (on average around -0.7), with variations by market, reflecting the competitive position of HSR between those markets. In general, elasticity values increase with distance, corresponding well with benchmarks and information previously provided as part of earlier model development work. Figure 3.7 depicts average elasticities by market, sorted by overall region-to-region distance, for Valley to Valley and Phase 1 scenarios. In general, the Phase 1 elasticities are higher than Valley to Valley for the movements, including areas south of Bakersfield, where Valley to Valley does not have a direct HSR connection and alternate modes are utilized for travel.

Figure 3.7: Fare Elasticity with 20% Fare Change – Phase 1 and Valley to Valley – Region-to-Region



Source: Steer

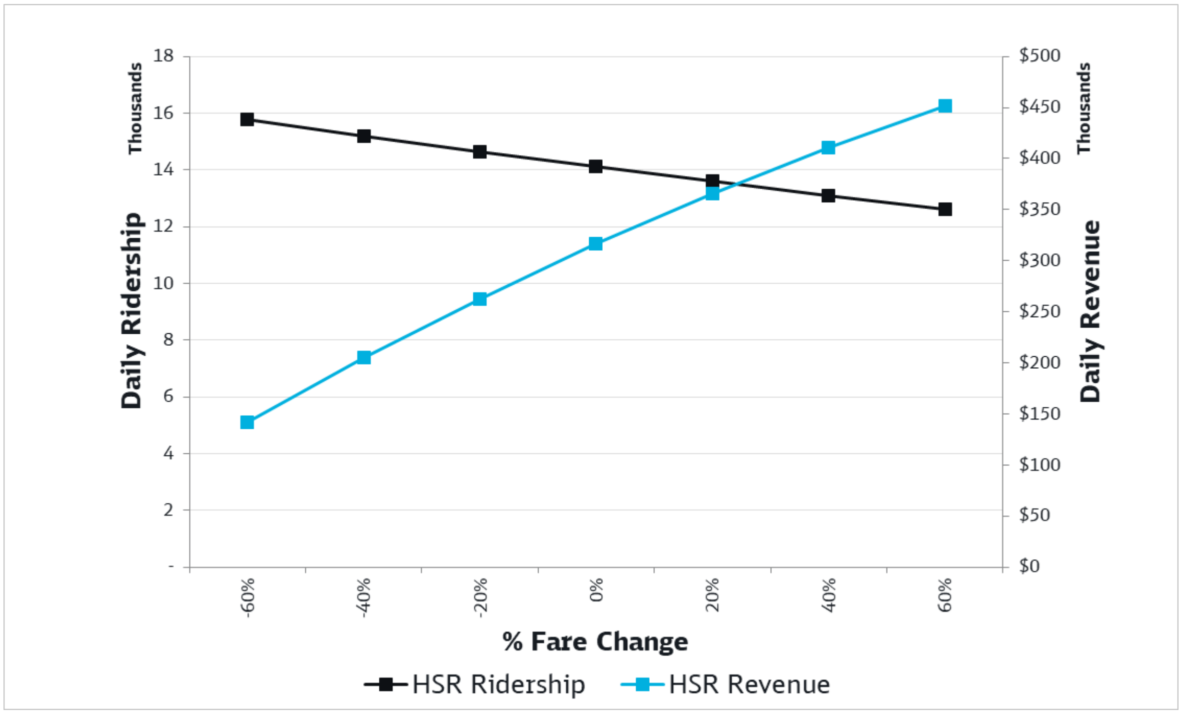
Valley to Valley Curves

The Valley to Valley fare sensitivity analysis indicates that most sub-markets have the potential for higher revenues with fare increases. The largest HSR ridership markets, MTC–MTC and MTC–Central Valley, have maximum revenue of around +60% and +20%, respectively, over the base fares.

This is due to the decreased role that fares play in the overall utility. For example, for MTC–SCAG trips relative to Phase 1, Valley to Valley has a longer trip time, addition of a transfer penalty, a less favorable mode constant (given part of the trip is now via bus), and a lower fare (given bus fares are lower). As such, changing the HSR fare has a lower impact on the overall utility, thereby resulting in a lower output elasticity.

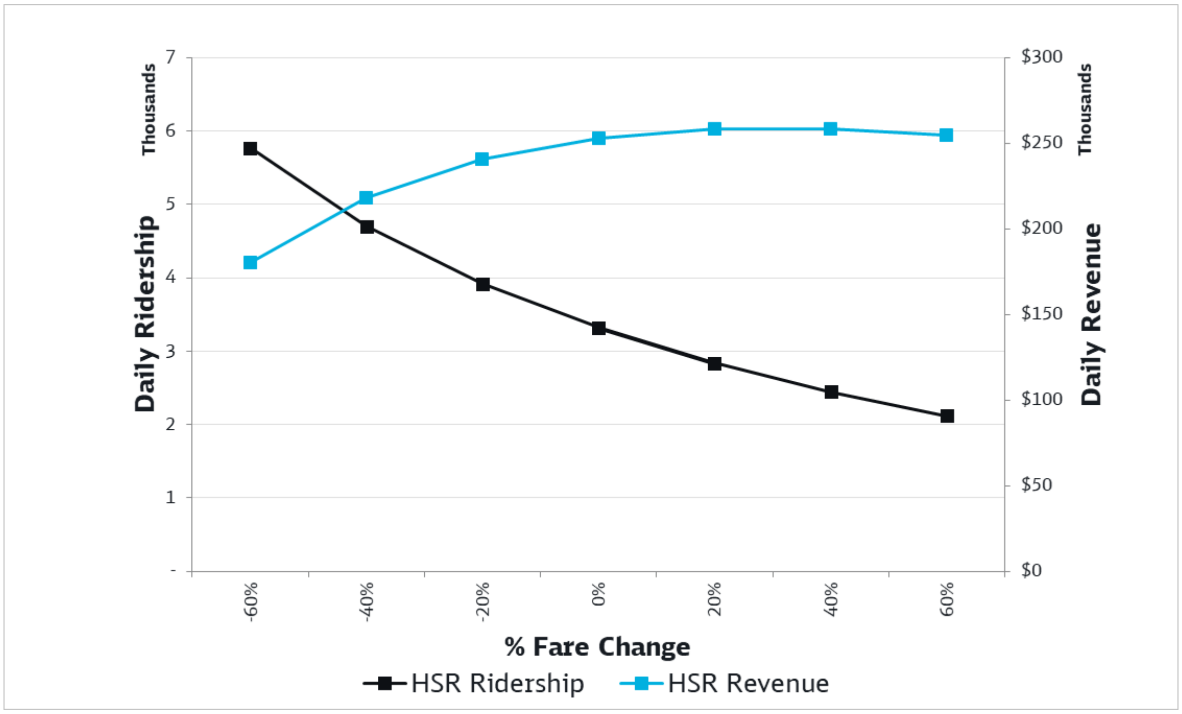
However, in general, it is unlikely that higher fares are recommended for the Valley to Valley scenario compared to the Phase 1 scenario, given the reduced high-speed rail service offering. Therefore, both scenarios are considered in parallel when determining fare policy.

Figure 3.8: Valley to Valley Fare Sensitivity Curves – MTC-MTC Trips



Source: Steer

Figure 3.9: Valley to Valley Fare Sensitivity Curves – MTC-Central Valley Trips



Source: Steer

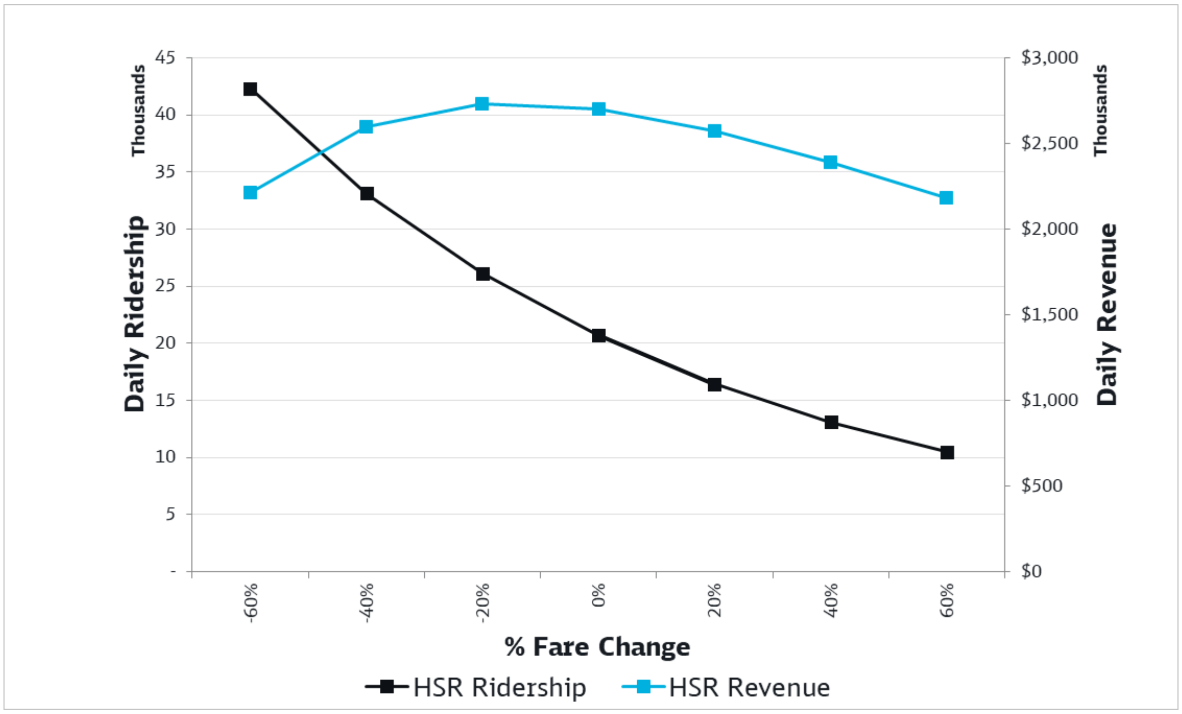
The results in Figure 3.8 and Figure 3.9 appear reasonable and aligned with wider benchmarks, however, the model is a strategic ridership model, not a fare or ticket choice model. In addition, the revenue curves are generally quite flat around the revenue-maximizing points, unlike the ridership curves, which have much steeper slopes. Hence, from a public policy perspective, fares slightly lower than revenue-maximizing levels may lead to only marginal losses in farebox revenue but substantial increases in ridership, resulting in significant public benefits that may easily offset the loss in revenue. As such, these results should be considered for future refinements to fare structures alongside any wider evidence and equity objectives of the project, comparable travel options, and objectives of the project around ridership maximization vs revenue maximization.

Phase 1 Curves

The Phase 1 fare sensitivity analysis indicates that long-distance trips have the potential for higher revenues with fare decreases, whereas short-distance trips have the potential for higher revenues with fare increases. Figure 3.10 illustrates ridership and revenue variations with fare changes for long-distance MTC–SCAG trips. The forecast reaches a maximum HSR system revenue at around 20% lower fares compared to base levels.

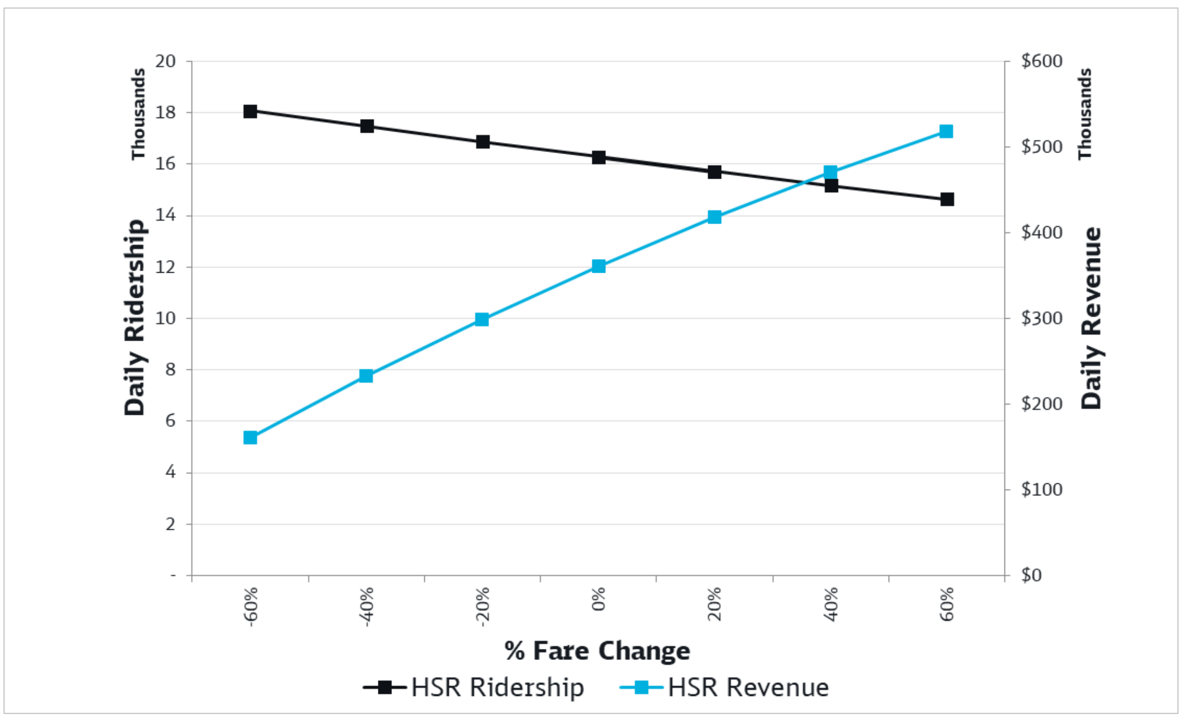
However, there are differences in behaviors when it comes to short-distance markets, reflecting the competitive position of HSR in those markets. The short-distance HSR ridership markets, SCAG–SCAG and MTC–MTC, have maximum HSR revenue greater than +60% over the base fares.

Figure 3.10: Phase 1 Fare Sensitivity Curves – MTC-SCAG Trips



Source: Steer

Figure 3.11: Phase 1 Fare Sensitivity Curves – MTC-MTC Trips



Source: Steer

The SCAG–SCAG and MTC–MTC markets have a low-price elasticity, indicating the potential to increase revenue via higher fares without losing much ridership. Conversely, the MTC–SCAG market has a high price elasticity, indicating the potential to increase both ridership and revenue.

Fares Sensitivity Tests

A combination of boarding fares and per-mile fares provided by DB ECO were tested for the fare sensitivity analysis.

Valley to Valley Tests

For the Valley to Valley scenario, fare sensitivity tests were conducted for the following scenarios:

San Francisco – Bakersfield service to use 2020 BP fares: Fare scenarios V2V-2.1 to V2V-2.6, with the assumption of revenue-risk HSR fares on the Merced-Bakersfield section, are tested with varying per-mile fares in the model. The sensitivity tests are listed in Table 3.16.

Table 3.16: Fare Sensitivity Tests – Valley to Valley

Scenario	Sensitivity Test	Fare Cap
V2V-1.0	2020 Business Plan Fares	$100.00
V2V-2.0	2020 Business Plan Fares	No max fare
V2V-2.1	Use a fixed boarding fare and 60% lower per-mile fare	No max fare
V2V-2.2	Use a fixed boarding fare and 40% lower per-mile fare	No max fare
V2V-2.3	Use a fixed boarding fare and 20% lower per-mile fare	No max fare
V2V-2.4	Use a fixed boarding fare and 20% higher per-mile fare	No max fare
V2V-2.5	Use a fixed boarding fare and 40% higher per-mile fare	No max fare
V2V-2.6	Use a fixed boarding fare and 60% higher per-mile fare	No max fare

Source: DB ECO

Phase 1 Tests

For the Phase 1 scenario, two fare sensitivity tests were conducted with/without service types:

San Francisco – Los Angeles/Anaheim service to use the same per-mile fares applied to all service types: Fare scenarios PH1-2.1 to PH1-2.6, with the assumption of revenue-risk HSR fares on the Merced-Bakersfield section, are tested with varying per mile fares in the model.

San Francisco – Los Angeles/Anaheim service to use differential per mile fares applied to different service types: Fare scenarios PH1-3.1 to PH1-3.6, with the assumption of revenue-risk HSR fares on the Merced-Bakersfield section, are tested with varying per mile fares in the model.

Table 3.17: Fare Sensitivity Tests – Phase 1 without Service Type Differentiation

Scenario	Sensitivity Test	Fare Cap
PH1-1.0	2020 Business Plan Fares	$100.00
PH1-2.0	2020 Business Plan Fares	No max fare
PH1-2.1	Use a fixed boarding fare and 60% lower per-mile fare	No max fare
PH1-2.2	Use a fixed boarding fare and 40% lower per-mile fare	No max fare
PH1-2.3	Use a fixed boarding fare and 20% lower per-mile fare	No max fare
PH1-2.4	Use a fixed boarding fare and 20% higher per-mile fare	No max fare
PH1-2.5	Use a fixed boarding fare and 40% higher per-mile fare	No max fare
PH1-2.6	Use a fixed boarding fare and 60% higher per-mile fare	No max fare

Source: DB ECO

Table 3.18: Fare Sensitivity Tests – Phase 1 with Service Type Differentiation

Scenario	Sensitivity Test	Fare Cap
PH1-3.0	Use an optimized boarding fare and optimized per-mile fare	No max fare
PH1-3.1	Use an optimized boarding fare with the following per-mile fares: Express Service Per-Mile Fare: No Change Limited Service Per-Mile Fare: 25% Lower Default Service Per-Mile Fare: 50% Lower	No max fare
PH1-3.2	Use an optimized boarding fare with the following per-mile fares: Express Service Per-Mile Fare: No Change Limited Service Per-Mile Fare: 12.5% Lower Default Service Per-Mile Fare: 25% Lower	No max fare
PH1-3.3	Use an optimized boarding fare with the following per-mile fares: Express Service Per-Mile Fare: 25% Higher Limited Service Per-Mile Fare: No Change Default Service Per-Mile Fare: 25% Lower	No max fare
PH1-3.4	Use an optimized boarding fare with the following per-mile fares: Express Service Per-Mile Fare: 50% Higher Limited Service Per-Mile Fare: 25% Higher Default Service Per-Mile Fare: No Change	No max fare
PH1-3.5	Use optimized boarding fare ×2 with the following per-mile fares: Express Service Per-Mile Fare: 25% Higher Limited Service Per-Mile Fare: No Change Default Service Per-Mile Fare: 25% Lower	No max fare

Source: DB ECO

Revisions to Fare Structure

Based on the fare sensitivity analysis and the fares tests conducted, DB ECO developed a revised fare policy for the Base Case scenarios. Based on the fare sensitivity assessment, the following broader conclusions can be derived:

The intra-region fares for MTC–MTC in Valley to Valley and Phase 1 and SCAG–SCAG in Phase 1 were much lower, to begin with, than the inter-region fares in the 2020 BP and hence had a potential to increase both boarding fares and per mile fares for higher revenue generation.

The inter-region fares for most long-distance market-to-market movements had the potential to decrease for higher revenue generation. The fares for MTC–SCAG in Phase 1 were greater than the revenue-maximizing fare in the 2020 BP, and hence, lower fares increase both ridership and revenue concurrently. This aligns with public sector policy objectives for HSR to become a competitive alternative for major inter-region travel over air and auto travel.

Table 3.19 and Table 3.20 display the HSR fare policy applied for Base Case scenarios in the 2024 Business Plan.

For the Valley to Valley scenario, the MTC–MTC fares are higher, and the Inter-region fares are lower than in the 2020 BP. The boarding fares are the same for all HSR services, and the per-mile fares vary by service type, with no maximum fare cap.

Table 3.19: HSR Fare Policy – Valley to Valley (2018 $)

Region	Boarding Fare ($)	Limited Service Per Mile Fare ($/mile)	Default Service Per Mile Fare ($/mile)	Fare Cap
MTC – MTC	$29.62	$0.23	$0.17	No max fare
Inter-region	$27.92	$0.18	$0.14	No max fare

Source: DB ECO

For the Phase 1 scenario, the MTC–MTC and SCAG–SCAG fares are higher, and the Inter-region fares are lower than in the 2020 BP. The boarding fares are the same for all HSR services, and the per-mile fares vary by service type, such that express services have the highest per-mile fares and default services have the lowest per-mile fares, with no maximum fare cap.

Table 3.20: HSR Fare Policy – Phase 1 (2018 $)

Region	Boarding Fare ($)	Express Service Per Mile Fare ($/mile)	Limited Service Per Mile Fare ($/mile)	Default Service Per Mile Fare ($/mile)	Fare Cap
MTC – MTC	$29.62	$0.29	$0.23	$0.17	No max fare
SCAG – SCAG	$29.62	$0.29	$0.23	$0.17	No max fare
Inter-region	$27.92	$0.23	$0.18	$0.14	No max fare

Source: DB ECO

The HSR Bus, which provides connecting bus services south of Bakersfield in the Valley to Valley scenario, have fixed fares between stations. The HSR Bus fixed fares are displayed in Table 3.21.

Table 3.21: HSR Bus Fixed Fares (2018 $)

Station To/From Bakersfield	Fixed Fare
Burbank	$11.00
Los Angeles	$11.00
Anaheim	$11.00

Source: DB ECO

These new fare policy assumptions were applied to Base Case scenarios in the CRRM for the 2024 Business Plan to develop ridership and revenue forecasts; these are discussed in the next section.

Forecasting Assumptions

There were myriad updates made to CRRM assumptions for the Base Case scenarios in the 2024 Business Plan. These Future Year assumptions were incorporated in addition to the Base Year assumptions discussed in detail in the previous chapter. All assumptions were made considering the objectives of the CHSRA to produce HSR ridership and revenue forecasts with respect to statewide network connectivity to other transit modes.

In Future Year scenarios, it is assumed that statewide transit networks are better connected, with an integrated service plan encompassing HSR, conventional rail and connecting buses. Given this, the inter-mode transfer penalty has been reduced from 94 minutes in the Base and Business as Usual scenarios to 47 minutes in the Valley to Valley and Phase 1 scenarios. The transfer penalty reflects the disutility and inconvenience of transferring between services in addition to the actual modeled transfer time. The values were developed based on the Stated Preference Survey conducted by Steer and remain consistent with comparable European research into this penalty.

As part of HSR service planning, the connecting services for new HSR Buses and existing Intercity Buses will terminate at the Merced and Bakersfield HSR stations, thus providing faster access between HSR and Bus services. Based on this assumption, access distances for HSR–Bus connections were reduced. This step made the combination of HSR and Bus modes an attractive option and in-scope for the trips which previously could only use direct long-distance bus (such as Greyhound or Flixbus) from origin to destination.

Ridership and Revenue Forecasts

The Ridership, Revenue, Passenger Miles Traveled (PMT) and Passenger Hours Traveled (PHT) estimates for the Valley to Valley and Phase 1 scenarios are reported in Table 3.22 and Table 3.23 respectively. To develop forecasts for future years 2030, 2040 and 2050, the transit network, fare structure and socioeconomic data assumptions for future years were input to the CRRM and the Base Case scenarios were modeled.

Full CRRM model runs were conducted with trip generation, trip distribution, mode choice and route assignment. In addition to the existing and diverted Rail/HSR passengers from other modes, the model incorporates an increase in overall system travelers known as induced demand. Induced demand reflects additional travelers generated in the system who were previously not traveling at all in response to new HSR services and corresponding transportation improvements. The percentage of HSR ridership diverted from other modes and from induced demand for the Valley to Valley and Phase 1 scenarios are reported in Table 3.24 and Table 3.26, respectively. The differences in overall travel time and travel cost between the BAU and Build scenarios determine induced demand in the network, which can originate from resident trips or non-resident trips.

Year of Expenditure Dollars

The revenue forecasts in this report are displayed in Year of Expenditure (YOE) $ to reflect monetary values during Future Years. The methodology to convert revenue from Base Year to YOE $ consists of two components:

1. Converting values from Base Year 2018 $ to June 2023 $ using the observed California Consumer Price Index.
2. Converting values from June 2023 $ to YOE $ using the California Consumer Price Index (California Department of Finance) and the United States Federal Reserve Inflation Target.

Valley to Valley Forecasts

The Valley to Valley scenario is estimated to generate 12.22 million HSR riders and $1206.43 million revenue in Future Year 2040. The following forecasts are lower than those published in the 2020 BP due to more robust modeling assumptions and lower socioeconomic forecasts.

Table 3.22: Valley to Valley Ridership, Revenue, PMT, PHT (in millions)

Year	Ridership	Revenue [1]	PMT	PHT
2030	11.80	$960.40	1530.77	15.28
2040	12.22	$1206.43	1569.01	15.70
2050	12.54	$1501.42	1594.06	15.98

[1] Revenue includes HSR and HSR Bus
Source: DB ECO

Table 3.22: Valley to Valley HSR BUS Ridership, Revenue, PMT, PHT (in millions)

Year	Ridership	Revenue [1]	PMT	PHT
2030	1.80	$960.40	223.41	5.34
2040	1.83	$1206.43	226.45	5.41
2050	1.84	$1501.42	227.92	5.44

[1] Revenue includes HSR and HSR Bus
Source: DB ECO

The forecasts indicate a systemwide average trip length of 128.38 miles and an average trip time of 1 hr 17 min for Valley to Valley HSR service. The connecting HSR Bus service is estimated to generate an additional 1.83 million riders in Future Year 2040 on top of the overall HSR ridership. For MTC–Central Valley trips, the main competitor to HSR is auto travel, in which travel time for

HSR is generally faster compared to auto, and travel cost for HSR is generally higher compared to auto. There are limited daily flights between regions within the Valley to Valley HSR corridor, such that air can only be considered a viable competitor for connecting trips to the Los Angeles Basin. Table 3.24 indicates an overwhelming majority of HSR riders are diverted from auto, with only a small proportion of trips from induced demand in the absence of full Phase 1 service.

Table 3.24: Valley to Valley Mode Share and HSR Diversions (2040)

Mode	% Statewide Trips	% HSR Trips Diverted
Auto	95.17	71.63
Bus	0.22	1.48
Rail	2.04	6.02
Air	1.94	5.87
HSR	0.62	—
Combo	—	12.94
Induced	—	2.06

Source: DB ECO

Comparing annual ridership and revenue between the 2020 BP forecasts and updated Valley to Valley forecasts, we observe that current ridership is 33.66% lower and current revenue is 37.67% lower than 2020 BP forecasts in Future Year 2040. The difference in socioeconomic growth assumptions accounts for a portion of this reduction, with residual differences between ridership and revenue due to more refined modeling assumptions, network configurations, and updated service patterns for connecting rail and bus services.

Phase 1 Forecasts

The Phase 1 scenario is estimated to generate 28.39 million HSR riders and $3,576.00 million revenue in Future Year 2040. The following forecasts are lower than those published in the 2020 BP due to more conservative modeling assumptions and lower socioeconomic forecasts.

Table 3.25: Phase 1 Ridership, Revenue, PMT, PHT (Unlinked trips in millions)

Year	Ridership	Revenue	PMT	PHT
2030	27.57	$2854.85	6688.92	56.84
2040	28.39	$3576.00	6854.20	58.27
2050	29.01	$4443.93	6971.46	59.27

Source: DB ECO

The forecasts indicate a systemwide average trip length of 241.47 miles and an average trip time of 2 hr 03 min for Phase 1 HSR service. For long-distance MTC–SCAG trips, the main competitors to HSR are auto and air travel in which travel time for HSR is generally faster compared to auto and slower compared to air, and travel cost for HSR is generally higher compared to auto and comparable to air, depending on HSR service type. There are myriad daily flights between three major airports in the San Francisco Bay Area and five major airports in the Los Angeles Basin. Table 3.26 indicates an overwhelming majority of HSR riders are diverted from auto with a significant proportion of trips from induced demand, a direct benefit due to the substantial connectivity and travel time improvements that HSR can bring to a region.

Table 3.26: Phase 1 Mode Share and HSR Diversions (2040)

Mode	% Statewide Trips	% HSR Trips Diverted
Auto	94.56	74.24
Bus	0.22	0.14
Rail	2.00	6.85
Air	1.92	4.35
HSR	1.30	—
Combo	—	5.80
Induced	—	8.61

Source: DB ECO

Comparing annual ridership and revenue between the 2020 BP forecasts and updated Phase 1 forecasts, we observe that current ridership is 26.42% lower and current revenue is 13.75% lower than 2020 BP forecasts in Future Year 2040. The difference in socioeconomic growth assumptions account for a portion of this reduction with residual differences between ridership and revenue due to more refined modeling assumptions, network configurations, and updated service patterns for connecting rail and bus services.

In conclusion, the HSR ridership and revenue forecasts for both Valley to Valley and Phase 1 suggest a solid volume of passengers using the service. Combined with the resulting societal and economic gains, HSR will provide a net benefit to the state of California.

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