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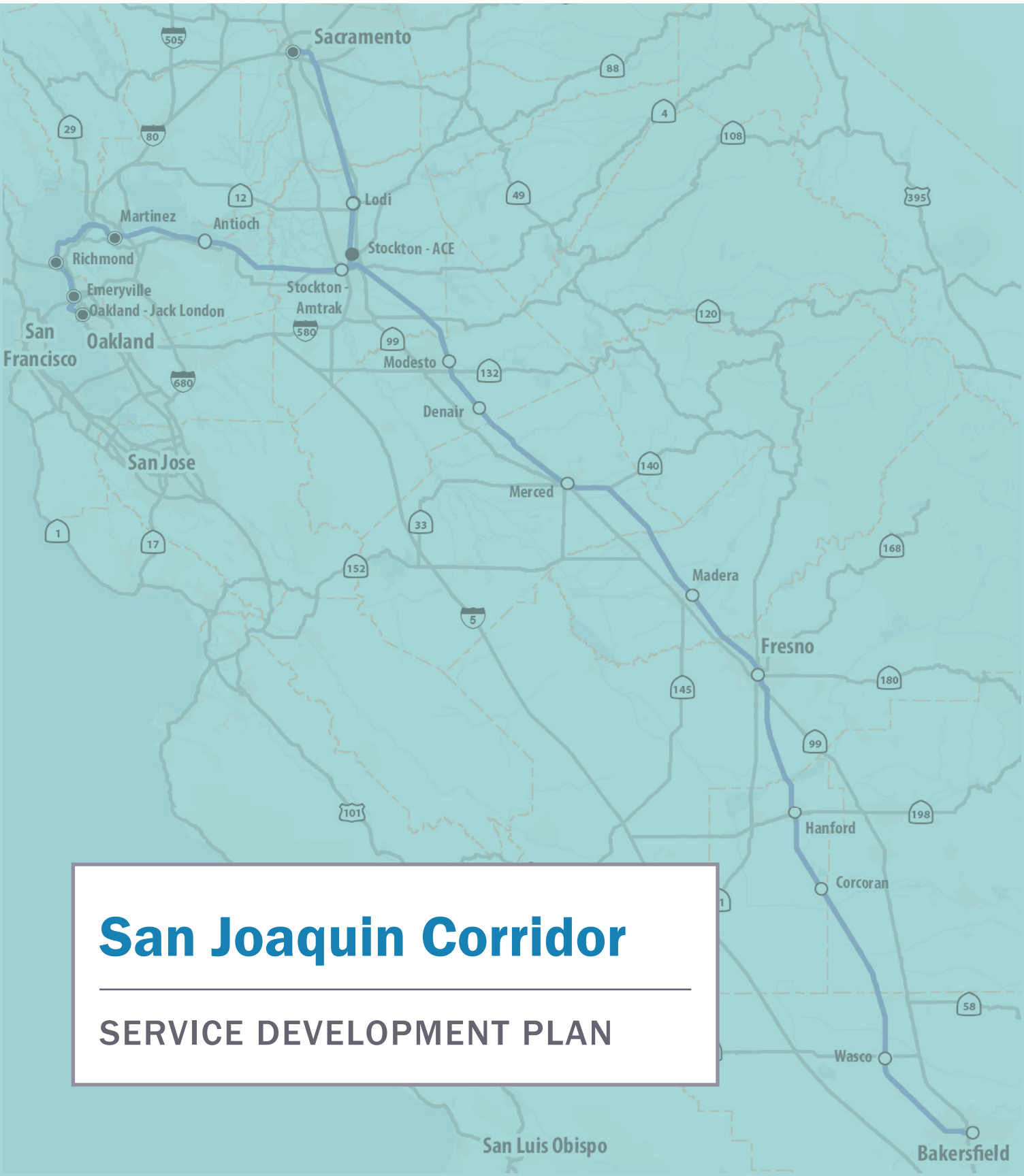

San Joaquin Corridor

SERVICE DEVELOPMENT PLAN

The contents of this report reflect the views of the author who is responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California or the Federal Railroad Administration. This publication does not constitute a standard, specification or regulation.

FINAL SUBMITTAL

May 2013

SERVICE DEVELOPMENT PLAN

San Joaquin Corridor

Prepared for

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List of Acronyms

AB – Assembly Bill

AC Transit – Alameda-Contra Costa Transit District

ACE – Altamont Corridor Express

Amtrak – National Railroad Passenger Corporation

Amtrak/Caltrans Model – Amtrak/California Intercity Passenger Rail Forecasting Model

ARB – Air Resources Board

ARRA – American Recovery and Reinvestment Act of 2009

ATLC – Active Transportation and Livable Communities

Authority – California High-Speed Rail Authority

BART – Bay Area Rapid Transit

BATA – Bay Area Toll Authority

BNSF – BNSF Railway

BT&H – State of California Business, Transportation and Housing Agency

CAA – Clean Air Act

CALCOG – California Association of Councils of Governments

Caltrain – Peninsula Corridor Joint Powers Board

Caltrans – California Department of Transportation

CAPEX – capital expenditure

CBD – Central Business District

CCJPA – Capitol Corridor Joint Powers Authority

CDFG – California Department of Fish and Game

CEC – California Energy Commission

CIB – California Interregional Blueprint

CO – Carbon Monoxide

CO_2 – Carbon Dioxide

COFC – container-on-flat-car

COGs – Councils of Governments

Corps – Army Corps of Engineers

Corridor – San Joaquin Corridor

CRCC – Coast Rail Coordinating Council

CRIS – Caltrans Reporting Information System

CSRLA – California Shortline Rail Association

CSRP – California State Rail Plan

CTC – California Transportation Commission

D.C. – District of Columbia

Delta – San Joaquin–Sacramento Delta

DOR – Division of Rail

EIR/EIS – Environmental Impact Report/Environmental Impact Statement

EMFAC – California Air Resources Board Emissions Factor

EPA – Environmental Protection Agency

FAF3 – Federal Highway Administration's Freight Analysis Framework

FAQs – frequently asked questions

FCOG – Fresno Council of Governments

FRA – Federal Railroad Administration

FY – fiscal year

GenSet – Generator Set

GHG – greenhouse gas

HEP – head-end power

HSIPR – High-Speed Intercity Passenger Rail

HSR – High-Speed Rail

HSR R&R Model – High-Speed Rail Ridership and Revenue Model

I-5 – Interstate 5

IOS – Initial Operating Segment

IPCC – Intergovernmental Panel on Climate Change

KCAG – Kings County Association of Governments

KCOG – Kings County Association of Governments

LAUS – Los Angeles Union Station

LOSSAN – Los Angeles-San Diego-San Luis Obispo

LOSSAN North – Los Angeles–San Diego–San Luis Obispo Rail Corridor Agency – North Corridor

LOSSAN South – Los Angeles–San Diego–San Luis Obispo Rail Corridor Agency – South Corridor

MAS – Maximum Authorized Speed

MAX – Modesto Area Express

MCAG – Merced County Association of Governments

MCTC – Madera County Transportation Commission

mph – miles per hour

MPO – Metropolitan Planning Organization

MTC – Metropolitan Transportation Commission

NAAC – Native American Advisory Committee

NAICS – North American Industry Classification System

NCRPWG – Northern California Rail Partners Working Group

NCTD – North County Transit District

NCURS – National California Unified Rail Service

NGEC – Next-Generation Equipment Committee

No-Build Alternative – No-Build/No-Action Alternative

NOI – Notice of Intent

NO_x – nitrogen oxide

NPDES – National Pollution Discharge Elimination System

NRC – National Research Council of the National Academies

O&M – operations and Maintenance

OCTA – Orange County Transportation Authority

OPC – Ocean Protection Council

OPEX – operating expenditure

OTP – on-time performance

PIOs – Public Information Officers

PISOP – Public Involvement and Stakeholder Outreach Plan

PRIIA – Passenger Rail Investment and Improvement Act of 2008

PSDP – Preliminary Service Development Plan

PTA – Public Transportation Account

PTC – Positive Train Control

R&R – California High-speed Rail Ridership and Revenue Model

RCTF – Rural Counties Task Force

RM – Regional Measure

ROG – reactive organic gasses

ROW – right-of-way

RTC – Rail Traffic Controller

RTD – Regional Transit District

RTP – Regional Transportation Plan

RWQCB – Regional Water Quality Control Board

SACOG – Sacramento Area Council of Governments

SacRT – Sacramento Regional Transit

SamTrans – San Mateo County Transit District

SANDAG – San Diego Association of Governments

SCAG – Southern California Association of Governments

SCCRTC – Santa Cruz County Regional Transportation Commission

SCS – Sustainable Communities Strategies

SCT – South Country Transit

SCTG – Standard Classification of Transported Goods

SCVTA – Santa Clara Valley Transportation Authority

SDMTS – San Diego Metropolitan Transit System

SDP – Service Development Plan

SED – socioeconomic data

SFO – San Francisco International Airport

SGC – Strategic Growth Council

SHA – State Highway Account

SIP – State Implementation Plan

SJCOG – San Joaquin Council of Governments

SJJPA – San Joaquin Joint Powers Authority

SJRRC – San Joaquin Regional Rail Commission

SJVRC – San Joaquin Valley Rail Committee

SOV – single-occupancy vehicle

SPLC – Standard Point Location Code

SR – State Route

StanCOG – Stanislaus Council of Governments

STB – Surface Transportation Board's

STCC – Standard Transportation Commodity Code

STIP – State Transportation Improvement Program

SWPPP – Storm Water Pollution Prevention Plan

TAC – Technical Advisory Committee

TAMC – Transportation Agency for Monterey County

TAZs – transportation analysis zones

TCAG – Tulare County Association of Governments

TOD – Transit-Oriented Development

TOFC – trailer-on-flat-car

U.S. – United States

UPRR – Union Pacific Railroad

VCTC – Ventura County Transportation Commission

VHT – vehicle hours traveled

VMT – vehicle miles traveled

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1.0 Introduction

The Service Development Plan (SDP) for improved intercity passenger rail service in the San Joaquin Corridor (Corridor) describes the Corridor and identifies proposed service expansion and operational improvements. Additionally, the SDP presents the rationale for improved and expanded services, and identifies candidate rail infrastructure investments needed to support growth and deliver improved operations. A summary of the findings and recommendations can be found in Chapter 14.

The SDP expands the analysis of the service improvements for the preferred service improvement package outlined in the alternatives analysis portion of the SDP (chapters 1-5). The SDP defines and analyzes several service options, including studies of rail capacity, land-use, capital improvements and costs, environmental impacts, operations and maintenance (O&M) costs, and ridership and revenue forecasts.

The SDP, was provided to several entities for review, including: the Federal Railroad Administration (FRA), National Railroad Passenger Corporation (Amtrak), the Union Pacific Railroad (UPRR), BNSF Railway (BNSF), Altamont Corridor Express (ACE), California High Speed Rail Authority (Authority), Capitol Corridor Joint Powers Authority, and several other governmental agencies. Scenarios for analysis were developed with input from the Northern California Rail Partners Working Group (NCRPWG) (described further in Section 1.1.2 below).

Analysis of the Corridor reflects the proposed implementation of the California High-Speed Rail (HSR) first construction section of the Initial Operating Segment (IOS) between Madera and just north of Bakersfield, which is scheduled for completion in 2018. Completion of the IOS will connect the Central Valley to the Los Angeles Basin with the addition of the Bakersfield to Palmdale section scheduled for completion in 2022 per the California High-Speed Rail Program Revised 2012 Business Plan (2012 Business Plan). It will bring high-speed, electric passenger operations to California, tying together the Central Valley with the Los Angeles Basin as a first step toward a statewide high-speed rail system.

Caltrans Division of Rail (DOR) along with other rail operators is working with the Authority on the integration of rail networks in California. Network integration will coordinate conventional and high-speed rail (HSR) services and improvements to enhance passenger rail services in California. Network integration includes blended operations of the *San Joaquin*, Capital Corridor, ACE, and Caltrain services in the unified network as part of the proposed Northern California Unified Rail Service (NCURS) Plan.

The SDP examines how the *San Joaquin* service will be restructured to operate some trains over the California HSR first construction section of the IOS as part of the blended system approach described in the *2012 Business Plan*. Blended service and operations refers to the integration of high-speed trains with existing intercity passenger and commuter/regional rail systems by way of coordinating infrastructure investment, scheduling, ticketing, and other means. The SDP for the *San Joaquin* will focus on near-term improvements between now and 2018. The planning horizon Year 2020 for operations and ridership studies reflect operation of blended service on the first construction section of the IOS prior to initiation of full HSR service in California.

The SDP examines a set of scenarios as to how the *San Joaquin* service can be restructured. The SDP assumes that *San Joaquin* trains will travel on the first construction segment of the IOS. This assumption is consistent with the work plan for the FRA grant that funds this SDP. However, planning for blended HSR service in northern California continues, and the assumption used to develop the scenarios in this SDP may not remain in the final service scenario chosen for the Central Valley. The subsequent service restructuring of the *San Joaquin* in conjunction with full HSR operations is the subject of continuing analysis and studies. This SDP is a blueprint for near term service improvements that could operate from 2018 through 2022. This SDP focuses on the improvements necessary to initiate service in 2018 on the

first construction section of the IOS. This SDP does not examine any incremental improvements that might be made between 2018 and 2022.

1.1 Background

The San Joaquin Corridor operates between Stockton and Bakersfield, with branches on the north end to Sacramento and Oakland (see Exhibit 1.1). The Corridor is the fifth-most heavily traveled Amtrak passenger rail route in the nation. The 365-mile Route carried over 1.2 million passengers in Calendar Year 2012. The primary passenger markets are a mix of regional business travelers and intercity leisure travelers. The *San Joaquin* service is parallel to the proposed HSR alignment between Sacramento and Bakersfield.

The San Joaquin Corridor traverses an area of great geographical variation. The Central Valley is a large, flat valley bordered by the Sierra Nevada to the east and the Coast Ranges and San Francisco Bay to the west and the Tehachapi Mountains on the south. The Central Valley stretches approximately 450 miles from northwest to southeast and is divided by the watersheds of the Sacramento and San Joaquin Rivers. The northern portion of the Central Valley is referred to as the Sacramento Valley and the southern portion is the San Joaquin Valley. The San Joaquin Corridor directly spans 11 counties: Alameda, Contra Costa, Fresno, Kern, Kings, Madera, Merced, Sacramento, San Joaquin, Stanislaus, and Tulare. Approximately 35 miles of the Corridor, between Sacramento and Stockton, extends into the southern reaches of the Sacramento Valley.

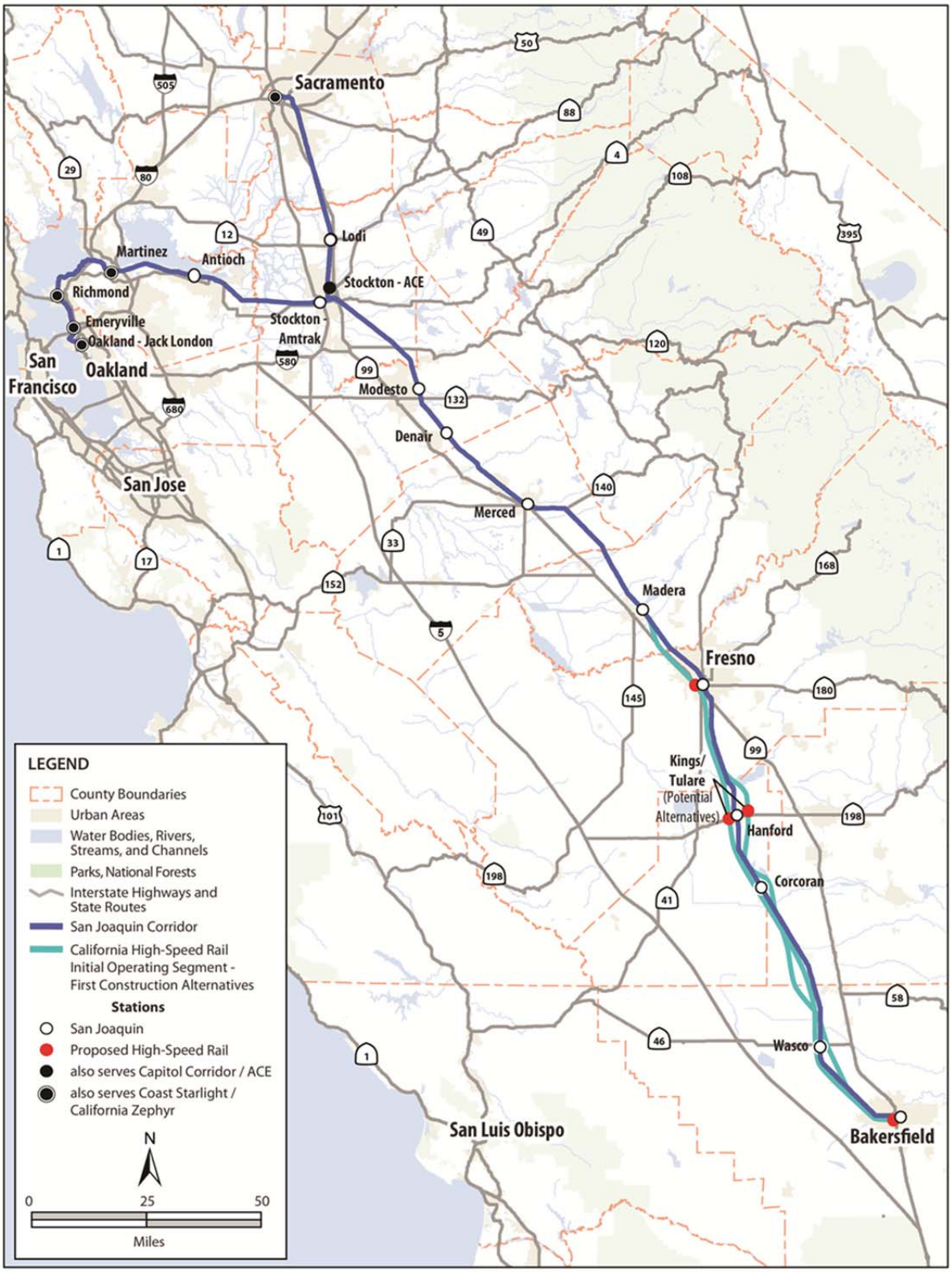
An extensive network of dedicated Amtrak Thruway buses connecting with the *San Joaquin* Corridor expands the service area and is essential to the performance of the route. In addition to the Thruway bus service connections in Bakersfield to Los Angeles and other points in southern California, other Amtrak Thruway bus service connections are provided at Sacramento, Stockton, Oakland, Emeryville, Martinez, Merced , and Hanford. In FY 2012, 46 percent of San Joaquin passengers used a Thruway bus one or both end(s) of their route. See Exhibit 1.1 for the *San Joaquin* service area map.

The current *San Joaquin* operating schedule includes six daily round-trip trains: four between Oakland and Bakersfield and two between Sacramento and Bakersfield. All trains in the Corridor run between Bakersfield and Stockton where the line diverges. Four of the daily round-trips continue to Oakland while two of the daily round-trips continue to Sacramento. In order to provide the six-frequency service between all points on the route, connecting buses are provided between Stockton and Sacramento for trains serving Oakland–Bakersfield; and for trains serving Sacramento–Bakersfield, connecting buses are provided between Stockton, Oakland, and San Francisco.

Central Valley communities served include Sacramento, Lodi, Stockton, Modesto, Turlock/Denair, Merced, Madera, Fresno, Hanford, Corcoran, Wasco, and Bakersfield. Delta/Bay communities of Antioch, Martinez, Emeryville, and Richmond are also served by the San Joaquin Corridor. Los Angeles is not served directly; connecting Thruway bus services transport passengers between Bakersfield and Los Angeles Union Station (LAUS) as well as other principal destinations in Southern California. Interconnectivity with local transit and other intercity and regional rail services is provided at many stations. For example, transfer to Bay Area Rapid Transit (BART) is provided at Richmond, transfer to ACE is provided at Stockton, transfer to the *Capitol Corridor* is provided at Sacramento, Martinez, and at Oakland, or intermediate stations at Richmond, and Emeryville. Transfers to the Sacramento Regional Transit (SacRT) light rail system is provided at Sacramento. Transfers to other local and regional transit systems are made at locations throughout the Corridor and include:

- Alameda–Contra Costa Transit District (AC Transit)
- Benicia Breeze
- Contra Costa County Connection.

Exhibit 1.1: San Joaquin Corridor



- Fresno Area Express
- Merced County Transit
- Rio Vista Delta Breeze

In the Corridor, the rail rights-of-way (ROW) and infrastructure are owned by UPRR and BNSF. UPRR and BNSF grant trackage rights to each other depending on ownership and route segment. The *San Joaquin* Corridor comprises 365 route miles, 316 miles between Oakland and Bakersfield with 13 intermediate stops; and 49 miles between Sacramento and Stockton with one additional intermediate stop. Amtrak operates the *San Joaquin's* under provisions of its contracts with the BNSF and UPRR. UPRR owns 39 miles at the north end of the route between Oakland and Port Chicago and 49 miles in the segment between Stockton and Sacramento. Predominant right-of-way ownership is by BNSF, which owns the 276-miles of railroad right-of-way between Port Chicago, located west of Stockton on Suisun Bay near Concord, and Bakersfield.

The railroad along this corridor is primarily single-track with 26.1 miles of double track divided among five segments. The BNSF interchanges with the UPRR at Port Chicago. The *San Joaquin* Oakland-bound trains then use the UPRR tracks from Port Chicago to Oakland. For Sacramento-bound trains, the BNSF–UPRR interchange takes place in Stockton, and service between Sacramento and Stockton is then provided by the UPRR. Table 1.1 describes the current ownership, segment mileage; maximum authorized speed (MAS), general number of mainline tracks and signal characteristics of the *San Joaquin* route. This ownership and mileage is depicted in Table 1.1.

Table 1.1 San Joaquin Corridor Ownership and Track Characteristics

Between	Mile Post	And	Mile Post	Route Miles	Track Owner	Mainline Tracks	MAS (mph)	Signal System
Oakland Jack London Square	7	Oakland 10th St.	4.2	2.8	UPRR	2	50	CTC
Oakland 10th St.	2.2	Martinez	31.7	29.5	UPRR	2	79	CTC
Martinez	34.7	Port Chicago	41.3	6.6	UPRR	1	79	CTC
Port Chicago	1,163.5	Stockton	1,120.7	42.8	BNSF	1-2	79	CTC
Stockton	1,120.7	Bakersfield	886.9	233.8	BNSF	1	79	CTC
Sacramento	89	Elvas	91.8	2.8	UPRR	2	35	CTC
Elvas	38.8	Stockton	84.7	45.9	UPRR	1	60	CTC
			Total Route Miles	*364.2*				

The *San Joaquin* service is operated by Amtrak under contract to Caltrans. Recently, the "Intercity Passenger Rail Act of 2012" (AB 1779), was enacted by the California State Legislature and signed by Governor Brown on September 29, 2012. AB 1779 authorizes regional government agencies' to form the San Joaquin Joint Powers Authority (SJJPA) to take over the governance and management of the existing *San Joaquin* intercity passenger rail service. AB 1779 defines the allowable composition of the SJJPA, and allows an interagency transfer agreement between Caltrans and the SJJPA to be completed between June 30, 2014 and June 30, 2015. In order to transfer responsibility of the *San Joaquin* intercity passenger rail service to the SJJPA, AB 1779 requires that the transfer must result in administrative or operating cost reductions. With this measure, the SJJPA is required to protect existing services and facilities and seek to expand service as warranted by ridership and available revenue. Under the provisions of AB 1779, the State will continue to provide funding for service operations, administration and marketing. Furthermore, Caltrans would remain responsible for the development of the Statewide

Rail Plan and the coordination and integration between the three state-supported intercity passenger rail services.

1.1.1 San Joaquin Corridor Strategic Plan

The San Joaquin Corridor has been the subject of numerous studies to understand, plan, and develop passenger services in order to provide an attractive alternative to highway travel. The most recent study – the *San Joaquin Corridor Strategic Plan* (*San Joaquin Strategic Plan*)[(i)] – was prepared by Parsons Brinckerhoff for the California Department of Transportation (Caltrans), Division of Rail (DOR) and was completed in March 2008. Development of the report's strategic recommendations was based on the following efforts:

- Evaluation of the policy and physical state of the Corridor.
- Assessment of operating conditions, including identification of capacity bottlenecks.
- Identification of funded or programmed capital investments.

Key stakeholders involved in the development of the plan included Caltrans, Amtrak, BNSF, UPRR, and the San Joaquin Valley regional transportation planning agencies. Public input on the plan suggested 1) improving communications regarding passenger services and ensuring station safety and security in the short-term; 2) adding more frequent service and more stations in the medium-term; and, 3) providing passenger rail between Stockton and Bakersfield on the UPRR Fresno Subdivision, and direct connections to Los Angeles and the San Francisco Bay Area in the long-term.

The *San Joaquin Strategic Plan (2008)* recognizes that the current *San Joaquin* trains could interface with the proposed HSR to serve as collectors/distributors with potential transfer stations in major cities, such as Sacramento, Merced, Fresno, and Bakersfield. These stations could allow passengers to transfer to and from the *San Joaquin* service trains to the HSR. Other opportunities will arise for the *San Joaquin* service to "bridge" the HSR service while it is under construction in different regions, such as between the San Francisco Bay Area and Merced.

The following Corridor service policies and programs have been identified for improving system capacity and safety:

- Positive Train Control. The FRA mandated the installation of Positive Train Control (PTC) systems by December 2015 through passage of the Rail Safety Improvement Act of 2008. PTC is intended to keep trains under their maximum speed limit and within the limits of authorization to be on a specific track. Funding needs for PTC has been documented in the State Transportation Improvement Plan (STIP) and included in the High-Speed Intercity Passenger Rail (HSIPR) Program.
- Track Capacity. The *San Joaquin Strategic Plan (2008)* identified several sections of double-track, siding extensions and curve realignments coinciding with short-, medium-, and long-term service enhancements.

In support of the environmental evaluation of infrastructure requirements needed for service improvements in the Corridor, the BNSF has performed capacity modeling for substantial increases in trains as well as raising the top speed from 79 miles per hour (mph) to 90 mph.[(ii)]

1.1.2 Northern California Blended Service Plan

Planning of the blended service program is ongoing. The NCRPWG [(iii)] is a voluntary coordinating organization principally used as a forum for identifying and screening planning proposals from Northern California that will assist the Authority in developing the blended service plan for Northern California

involving the *Capitol Corridor*, Peninsula Corridor Joint Powers Board (PCJPB or Caltrain), Altamont Corridor Express, and the *San Joaquin* passenger train services.

This group has considered the following key issues:

- Service concepts.
- Potential schedules.
- Integration of ticketing, reservations and passenger information to improve the "user friendliness", and accessibility of the services to the public.
- Candidate infrastructure improvements including developing accommodations for conventional operations along California HSR track.
- Potential equipment needs.

This SDP transmits the results of planning and analysis conducted to date for implementation of the proposed NCURS along the San Joaquin Corridor. The SDP represents a blueprint for meeting the transportation demand through the Corridor utilizing the California High-Speed Rail first construction section of the Initial Operation Segment (IOS). Consequently, this SDP will only evaluate options for increasing service levels, reducing travel times, increasing service reliability, and enhancing the safety and accessibility of rail travel from 2018 through 2022. The Authority, Caltrans the San Joaquin Joint Powers Authority and others may coordinate the preparation of a future SDP for the blended service program involving operation of HSR and *San Joaquin* service in the years beyond 2022 in preparation for commencement of HSR service on the IOS, between Merced and North San Fernando Valley in 2022.

1.1.3 Organization of the San Joaquin Corridor SDP

As shown below, the SDP includes the following Chapters:

1. Introduction
2. Purpose and Need
3. Rationale
4. Identification of Alternatives
5. Evaluation of Alternatives
6. Planning Methodologies
7. Outreach Efforts
8. Ridership Demand and Revenue Forecast
9. Operations Modeling
10. Stations and Access Analysis
11. Conceptual Engineering and Capital Programming
12. Operating and Maintenance and Capital Replacement Forecast
13. Public Benefits and Impacts Analysis
14. Summary Service Development Plan

1.2 Relationship of the San Joaquin SDP to Other Documents

1.2.1 SDP Support for State Rail Plan

Planning analyses used in the SDP will form the basis for the service concepts and improvements included in the California State Rail Plan (CSRP). The San Joaquin Corridor SDP will be consistent with the SDPs for other State-supported rail services and, to the extent possible, will be consistent with concurrent planning by the *Capitol Corridor*, ACE, and the Authority.

1.2.2 SDP Support for Northern California Unified Service Plan

This SDP will describe how *San Joaquin* trains could be routed from Bakersfield to Madera via the first construction section of the IOS then over existing rail lines north to Stockton where services would connect to a unified regional network comprised of the *San Joaquin*, the ACE and the *Capitol Corridor*. This phase could involve blended operations with trains interlining between the high-speed track and conventional rail routes shared with freight traffic.

This *San Joaquin* SDP evaluates several alternatives resulting in one preferred service scenario. This is one of many other service scenarios that may evolve and be studied with additional operations modeling and other analyses forthcoming in the next year. See Exhibit 1.2 for a map of the California HSR system and other intercity rail routes.

Caltrans is responsible for preparing this SDP for 2018. Other related planning exercises are also occurring concurrently. The Authority is continuing to plan for the construction and use of the first construction section of the IOS from just north of Bakersfield to Madera and are developing their 2014 Business Plan. Currently, both the BNSF and the UPRR are conducting capacity analysis services in the Central Valley or for additional rail passenger services connecting to the Central Valley. There is a current study on the Stockton Hub, which is an important hub to connect regional services in the Valley. The NCRPWG continues to meet to aid in the planning for network integration in the Central Valley and Northern California. The scope and funding for additional planning for the *San Joaquin* route and use of network integration in the Central Valley is under discussion with FRA, Authority, Caltrans, the NCRPWG and other stakeholders.

1.2.3 Relationship to Corridor Environmental Analyses

The *San Joaquin Corridor Programmatic Environmental Impact Report (EIR) 2035 Vision – Initial Study (Initial Study),* released November 2012 [(iv)] provided initial environmental analysis for development of the San Joaquin Corridor SDP. The SDP evaluates Corridor information, including identification and assessment of a future program of rail corridor service scenarios and system improvements based on existing intercity travel demand and future growth, along with existing and future goods movement needs. In addition, the environmental process will provide an updated perspective on agency, stakeholder, and public plans, issues, needs, and perceptions that will be invaluable to the development of future SDPs.

Exhibit 1.2: California High-Speed Rail Phase 1 Blended Services

2.0 Purpose and Need

This Purpose and Need Statement is intended to provide the basis for San Joaquin Corridor planning efforts. The SDP identifies and evaluates the need for conventional rail improvements to help relieve the growing capacity and congestion constraints on intercity travel using existing air, highway, and passenger rail infrastructure in the San Joaquin Corridor. This includes the identification and evaluation of a specific service development scenario among other being developed, with multiple alternatives being considered. It also assesses how incremental improvements would serve the purpose of improving the existing conventional rail infrastructure and how best to utilize the first construction section of the IOS in order to realize benefits as soon as possible. This includes the identification and evaluation of a specific service development scenario among others being developed, with multiple alternatives being considered to initiate "Blended Service" along the Corridor as identified in the *2012 Business Plan* and described in Chapter 1.

The overall goal of the proposed improvements identified and evaluated in the SDP will be the improvement of mobility, reliability, and safety in this segment of the State's rail system by expanding service, decreasing travel times, and improving rail infrastructure in a cost-effective and environmentally sensitive manner from 2018 through the year 2022. The Authority, Caltrans and *San Joaquin* Joint Powers Authority will coordinate the preparation of a future SDP for the blended service program involving operation of HSR and *San Joaquin* service in the years beyond 2022 when electrified service is initiated on the IOS.

2.1 Purpose

The purpose of the proposed rail improvements to the San Joaquin Corridor is the development of a safer and more reliable conventional speed passenger rail system that provides added capacity in response to increased travel demand along the Corridor. These improvements may take advantage of the capacity and travel time benefits provided by the operation of service over the California HSR first construction section of the IOS between Madera and just north of Bakersfield. As discussed further below, the existing capacity of the transportation system is insufficient to meet existing and future demand, and the current and projected future system congestion will continue to result in reduced reliability, slower travel speeds, increased travel times, and deteriorated air quality.

In summary, the need for improvements to the corridor relates to the following issues:

- Increase in travel demand due to growing Corridor population and employment.
- Constrained travel options due to the Corridor's physical setting.
- Constrained rail operations due to the condition of the existing rail system infrastructure.
- Need for improved travel time, reliability, and safety to serve projected rail passenger ridership and freight rail activity.
- Need to increase system capacity with minimal impacts to local communities, natural resources, and air quality.
- Need to support California's sustainability goals.

Corridor rail system improvements would contribute to the viability of the San Joaquin Corridor, support operations of the future HSR blended system, and provide connectivity with local transit systems.

The purpose of the San Joaquin Corridor planning efforts is to identify and evaluate possible rail improvements to relieve the growing capacity and congestion constraints on intercity travel using the

Corridor's rail infrastructure operating near or at its design capacity. The project purpose for improved intercity Corridor rail improvements has been established and documented in Metropolitan Planning Organization (MPO) Regional Transportation Plans (RTPs), the adopted *California State Rail Plan (2008),* the *San Joaquin Strategic Plan (2008)* and the California High-Speed Rail Authority program and project-level Environmental Impacts Reports (EIRs) and Environmental Impact Statements (EIS) and *2012 Business Plan*. Corridor improvements are required to: address the forecasted growth in population, employment, and resulting travel demand; improve the rail infrastructure to accommodate the projected increase in rail passenger ridership and freight rail activity; and provide additional capacity while minimizing impacts to Corridor communities, natural resources, and air quality.

Increase in Travel Demand

Between 2011 and 2040, the Central Valley portion of the San Joaquin Corridor is projected to experience a 44.4 percent increase in population from approximately 5.4 million in 2011 to a total of 7.8 million residents in 2040. The population in the San Joaquin Valley has exceeded the statewide growth rate since 1970;[(v)] more than ten percent of the State's population resides in this region. Much of the population growth is projected to stem from the overflow from urban coastal areas as people seek affordable housing within commuting range of major metropolitan areas.

The capacity of the San Joaquin Corridor's intercity transportation system is insufficient to meet future demand. Congestion of the system will continue to result in deteriorating air quality, reduced reliability, and increased travel times. The state highway system, commercial airports, and conventional passenger rail system serving the intercity travel market will require large public investments for expansion and maintenance in order to accommodate future growth over the next 20 years and beyond. The need for improvements to the Corridor relates to the following key issues:

- Passenger travel demand for trips between the major metropolitan areas of Sacramento, the San Francisco Bay Area, and the Central Valley communities will continue to increase. Trips within the Central Valley will also increase substantially.
- If left unaddressed, rail capacity constraints will result in increased congestion and travel delays.
- Reduced reliability of travel stemming from congestion and delays, accidents and other factors will affect the quality of life and economic well-being of residents, businesses, and tourism in the Central Valley.
- Provide a viable transportation alternative to the automobile that promotes the use of local feeder transit service, transit oriented development and infill in existing urban areas, and will improve air quality.

Protection of Communities, Natural Resources, and Air Quality

The Clean Air Act (CAA) enacted in 1970, defines the Environmental Protection Agency's (EPA) responsibilities for protecting and improving the nation's air quality and makes "transportation conformity" the responsibility of the U.S. Department of Transportation and regional MPOs. Transportation conformity addresses air quality attainment and maintenance strategies contained in the State Implementation Plan (SIP), which are used to evaluate transportation alternatives, including the No-Build/No-Action Alternative (No-Build Alternative). Under both federal and State standards Los Angeles, the San Francisco Bay Area, Sacramento and San Joaquin Valley Counties[(vi)] are designated as "Ozone Non-Attainment Areas" where conformity requirements apply. The region must also reduce greenhouse gas (GHG) emissions, in response to Assembly Bill (AB) 32 (Schwarzenegger 2006), the Global Warming Solutions Act.

Meeting federal and State air quality standards over the next 20 to 40 years will likely require reductions in the total distance traveled by vehicles. This can be accomplished by: integrating land use and transportation planning and development to reduce automobile dependency and use; implementing

operational improvements; developing transportation demand strategies; using new technologies that improve transportation efficiencies: and providing an alternative to the single-occupant automobile. Moving passengers by rail produces less pollution (including GHG) per passenger mile traveled compared to typical automobile use and would aid in reducing emissions throughout the region. The proposed San Joaquin Corridor rail improvements would help implement these strategies.

Implementing Corridor transportation system capacity improvements is required to accommodate the forecasted travel demand growth. This is especially true in environmentally sensitive areas of the Central Valley and San Francisco Bay Area. In addition, the Corridor operates through the residential and downtown commercial areas of the cities and communities that it serves. Expanded highway construction, and increased motor vehicle use and congestion may lead to greater pressure on natural resources and negatively impact the quality of life in San Joaquin Valley agricultural communities. Rail capacity improvements would minimize these impacts by taking advantage of existing rail right-of-way and by focusing future development in existing urban areas.

2.2 Need

The need for rail improvements to the San Joaquin Corridor was established based on: future Corridor population and employment growth, and a corresponding increase in travel demand; limited travel options; constrained existing rail system infrastructure; and the need for improved travel times, reliability, and safety.

2.2.1 Corridor Transportation Market Challenges

Table 2.1 shows the demographic trends anticipated in the San Joaquin corridor between 2011 and 2040.

Table 2.1: San Joaquin Corridor Demographic Profile

Category[1]	1980	1990	2000	2011	2015	2020	2025	2030	2035	2040
Total Population	4,372	5,644	6,582	7,569	7,945	8,429	8,944	9,471	10,055	10,680
Population Density	176	227	265	304	319	339	360	381	404	429
# of Households	1,603	2,005	2,255	2,596	2,755	2,907	3,045	3,169	3,289	3,490
Total Employment	1,610	2,098	2,515	2,470	2,684	2,776	2,868	2,976	3,121	3,295
Wholesale Emp.	69	87	101	93	97	96	96	97	102	108
Retail Emp.	224	260	285	271	280	276	274	278	295	320
Prof Services Emp.	147	244	312	307	338	353	368	383	398	407
Other Emp.	1,169	1,506	1,817	1,801	1,972	2,054	2,134	2,221	2,330	2,464

Source: Moody's Economy.com 2011.
Notes:
- Figures expressed in thousands, except population density, which is expressed as total population per square mile.
- "Emp." = Employment

Over the next 30 years, Corridor population is expected to grow by 3.4 million residents (42.4 percent) in the San Joaquin Corridor including Alameda and Contra Costa Counties. The greatest absolute growth in new residents between 2011 and 2040 is expected in the following counties:

- Sacramento (624,000 residents).
- Alameda (520,000 residents).
- Contra Costa (465,000 residents).
- Fresno (371,500 residents).

- Kern (324,500 residents).

Corridor population is estimated to grow at a rate of 42.4 percent between 2011 and 2040. The greatest rates of county population growth are expected to be in the following counties:

- Madera (80.2 percent).
- Merced (44.9 percent).
- Sacramento (43.6 percent).
- Contra Costa (43.5 percent).
- Kings (41.6 percent).

Population density is expected to grow from 304 to 429 residents per square mile between 2011 and 2040. The most densely populated counties in 2040 are projected as follows:

- Alameda (2,763 residents per square mile).
- Contra Costa (2,132 residents per square mile).
- Sacramento (2,131 residents per square mile).
- San Joaquin (703 residents per square mile).
- Fresno (220 residents per square mile).

Central Valley Population Growth

California's Central Valley, is largely known for its agricultural production, and has become one of the fastest growing population centers in California. The Central Valley segment of the Corridor refers to only those counties that lie within the Central Valley, which would include the nine counties in the San Joaquin Valley plus Sacramento County. The population of the Central Valley is projected to increase by 44.4 percent with more than 2.4 million new residents for a total of 7.8 million residents by 2040 as shown in Table 2.2. The total number of new households is expected to increase to 672,000 from 2011 to 2040, a 37.3 percent increase.

Table 2.2: Central Valley Population Forecast (2011–2040)

Category	2011	2015	2020	2025	2030	2035	2040	Change 2011–2040	Percent Change
Total Population (Thousands)	5,432	5,748	6,117	6,504	6,905	7,356	7,846	+2,414	+44.4%
Population Density (Pop./Sq.Mi.)	206.6	218.6	232.6	247.3	262.6	279.7	298.4	+91.4	+44.4%
Total Households (Thousands)	*1,799*	*1,925*	*2,048*	*2,53*	*2,248*	*2,351*	*2,471*	*+672*	*+37.3%*

Source: Moody's Economy.com, 2011.

Corridor Population Growth by County

The distribution of new Central Valley and Corridor residents is presented in Table 2.3. A majority of the growth is projected to occur in Sacramento, Fresno, and Kern Counties. While a majority of the future total population growth will occur in the Sacramento County portion of the Corridor, Madera County is projected to experience the highest percentage growth in population.

Table 2.3: San Joaquin Corridor Population Forecasts by County (2011–2040)

County	2011	2040	Percent Change
Fresno	941,380	1,312,940	+39.5%
Kern	831,110	1,155,660	+39.1%
Kings	152,960	216,590	+41.6%
Madera	154,960	279,180	+80.2%
Merced	253,630	367,410	+44.9%
Sacramento	1,433,150	2,057,340	+43.6%
San Joaquin	700,700	983,630	+40.4%
Stanislaus	514,030	734,210	+42.8%
Tulare	450,360	738,790	+64.0%
Central Valley Subtotal	*5,434,291*	*7,847,790*	*+44.4%*
Alameda	1,517,640	2,037,900	+34.3%
Contra Costa	1,069,670	1,534,810	+43.5%
Los Angeles	10,048,450	13,317,360	+32.5%
Mariposa	17,998	20,138	+11.9%
San Francisco	831,934	1,060,064	+27.4%
Corridor Total	*18,919,983*	*25,818,062*	*+36.4%*

Source: Moody's Economy.com, 2011.

Employment Growth

Employment in the Central Valley is expected to grow slightly slower than population, with 830,000 new jobs anticipated by 2040, for a total of 3.3 million. This represents a growth rate of 33.4 percent from 2011. The greatest absolute growth in jobs is expected in:

- Sacramento (183,000 jobs).
- Alameda (174,000 jobs).
- Fresno (132,000 jobs).
- Contra Costa (116,000 jobs).
- San Joaquin (57,000 jobs).

Professional services employment will experience the greatest rate of job growth (32.6 percent), followed by retail (18.1 percent) and wholesale employment (16.1 percent).

Employment Growth by County

Over the next 30 years, employment in the Central Valley is expected to grow by 587,280 jobs (36.1 percent) to a total of 2.2 million jobs, as shown in Table 2.4.

Table 2.4: Central Valley Employment Forecasts (2011–2040)

	2011	2015	2020	2025	2030	2035	2040
Employment (Thousands)	1,628,560	1,776,160	1,842,490	1,906,670	1,981,110	2,085,310	2,215,840

Source: Moody's Economy.com, 2011.

The distribution of new jobs is projected to be as follows with a majority of the employment growth occurring in Sacramento and Fresno Counties:

- Sacramento – 183,000 new jobs (31.2 percent of the Central Valley's future employment growth).
- Fresno – 132,000 new jobs (22.0 percent of the Central Valley's future employment growth).

A majority of the Central Valley's future total employment growth will occur in Sacramento, Fresno, and Stanislaus Counties as shown in Table 2.5.

Table 2.5: San Joaquin Corridor Employment Forecast by County (2011–2040)

County	2011	2040	Percent Change
Fresno	284,580	416,980	+46.5%
Kern	226,520	280,170	+23.7%
Kings	35,510	47,520	+33.8%
Madera	32,680	51,050	+56.2%
Merced	56,150	69,240	+23.3%
Sacramento	550,710	733,940	+33.3%
San Joaquin	189,300	246,350	+30.1%
Stanislaus	147,140	212,210	+44.2%
Tulare	105,950	158,380	+49.5%
Central Valley Subtotal	*1,628,560*	*2,215,840*	*+36.1%*
Alameda	628,560	802,320	+27.6%
Contra Costa	319,320	435,530	+36.4%
Los Angeles	3,808,198	4,924,370	+29.3%
Mariposa	5,436	5,822	+7.1%
San Francisco	534,804	733,472	+37.1%
Corridor Total	*6,924,878*	*9,117,354*	*+31.6%*

Source: Moody's Economy.com, 2011.

Agriculture is an important factor in the socioeconomic structure of the Central Valley. Employment in the agricultural sector accounts for about 13 percent of the labor force, and the region is one of the most productive agricultural areas in the world. According to the ranking of market value of agricultural products sold, nine of the nation's top ten producing counties are in California. Counties served by the San Joaquin Corridor are ranked first (Fresno), second (Tulare), third (Kern), and eighth (Kings) in agricultural revenues generated in California. [(vii)]

As an economic driver and a factor in the socioeconomic structure of the San Joaquin Valley, agriculture will likely continue to play an important role in the future. However, lower land and labor costs in the San Joaquin Valley compared to those of other regions have attracted businesses to the region over the past two decades. Many businesses are attracted by the low-cost labor and the relatively low land prices. In 2011, the three leading sectors of employment in the San Joaquin Valley were government (260,000 jobs), agriculture (225,000 jobs), and health services (85,000 jobs). Manufacturing, especially in smaller metropolitan areas, is also important to the region's economic growth. Manufacturing is an important stage of value-added production and its continued and expanded role in the processing of agricultural products is regarded as an important source of future economic growth.

2.2.2 Corridor Transportation Market Opportunities

As described in Chapter 1, cities directly served by the San Joaquin Corridor service include Bakersfield, Wasco, Corcoran, Hanford, Fresno, Madera, Merced, Denair (Turlock), Modesto, Stockton, Antioch, Martinez, Richmond, Emeryville, Oakland, Lodi, and Sacramento. Los Angeles and San Francisco (and

many other destinations) are served via Thruway bus. Population growth and the increasing interconnectedness of the San Joaquin Valley's economies are creating a surge in travel along State Route (SR)-99 and Interstate 5 (I-5), the two north-south highway corridors connecting the San Joaquin Valley with the rest of California.

The San Joaquin Corridor total travel market (including all modes and potential destinations) is expected to grow 31.5 percent, from 256.5 million to 337.4 million annual trips from 2000 to 2030. Much of this trip growth is anticipated within the San Joaquin Valley. For instance, excluding the large Alameda–Contra Costa travel market, trips grow from 97.9 million to 149.1 million (52.3 percent).

Key land uses in the Corridor include employment centers, civic centers, public and private colleges, cultural and entertainment venues, agricultural areas operations and facilities, parks, and recreational resources. The Corridor's destinations and activity centers result in a diverse set of local and regional travel markets including:

- Business travelers and commuters accessing business and employment centers located in downtown Los Angeles, San Francisco, and cities in the San Joaquin Valley.
- Agricultural workers traveling to jobs and delivery trucks taking products to shipping locations.
- Students, teachers, and employees traveling to and from public and private educational institutions, including the California State University, Sacramento, University of California, Merced, California State University, Fresno, and Fresno Pacific University, California State University, Bakersfield, California State University, Stanislaus, and University of the Pacific at Stockton and a number of technical and community colleges.
- Visitors accessing the area's many tourist destinations including; museums, theaters, and special event generators; historic missions; and numerous wineries.
- Residents and visitors traveling to the many state, regional, and local recreational facilities in the corridor, some of which attract out-of-state visitors, such as Yosemite, Kings Canyon, and Sequoia National Parks.
- Residents visiting families and friends.

Corridor Rail System Trip Purpose

Table 2.6 shows a comparison of the *San Joaquin* rail service trip purpose from 2000 to 2030 with only minor changes projected to occur. In 2000, 60 percent of trips along the Corridor were made for recreational or other purposes, while 40 percent were business or commute trips. By 2030, the share of business trips is projected to increase to 45 percent reflecting more intercity commute trips, and a corresponding minor decrease in recreation and other travel. The percentage of recreation/other trips is well above statewide passenger rail levels.

Table 2.6: Existing and Forecast Passenger Rail Trip Purpose (2000–2030)

Trip Purpose	San Joaquin		Statewide	
	2000	2030	2000	2030
Business/Commute	40%	45%	55%	55%
Recreation/Other	60%	55%	45%	45%

2.2.3 Current and Forecasted Travel Demand for All Modes

A summary of the annual county-to-county total two-way person trips for 2000, and the travel projected for 2030 along the San Joaquin Corridor is illustrated in Exhibit 2.1 and summarized in Tables 2.7 to 2.9. The trip calculation data is developed from the Authority ridership and revenue model which uses 2000 as the base data, therefore 2000 is the most recent data available.

Note that these trip tables selected only the counties with station locations, which excluded Tulare County and the major metropolitan counties of Los Angeles and San Francisco. These ten counties are defined as the "core" corridor.

From 2000 to 2030, the San Joaquin core corridor travel market is expected to grow 31.5 percent, from 256.7 million to 337.5 million annual trips. Much of this trip growth is anticipated within the San Joaquin Valley. For instance, excluding the large Alameda–Contra Costa travel market, trips grow from 97.9 million to 149.1 million (52.3 percent). Tables 2.7 and 2.8 display the five greatest county flows in the Corridor, the majority of which are short-haul trip between neighboring counties. In 2030, the greatest flows are:

- Contra Costa–Alameda (189.4 million annual trips).
- San Joaquin–Stanislaus (31.3 million annual trips).
- Fresno–Merced (12.4 million annual trips).
- Fresno–Stanislaus (11.5 million annual trips).
- Merced–Stanislaus (11.5 million annual trips).

From 2000 to 2030, trips from extended counties to the core corridor are expected to increase by 155.9 million, to 622.0 million annual trips (33.4 percent). These extended counties include counties within the travel market shed outside of the San Joaquin core counties and include the major travel destinations in San Francisco and Los Angeles. The greatest sources of trips from extended counties to the core corridor in 2030 are:

- San Francisco (185.8 million annual trips, which includes 177.4 million annual trips between San Francisco and Alameda/Contra Costa counties).
- Santa Clara (179.9 million annual trips, which includes 158.0 million annual trips between Santa Clara and Alameda/Contra Costa counties).
- Solano (83.5 million annual trips, which includes 71.5 million annual trips between Solano and Alameda/Contra Costa counties).
- Tulare (47.6 million annual trips).
- Los Angeles (32.2 million annual trips).

Table 2.7: 2000 San Joaquin Core Corridor Annual Two-Way Person Trips (Millions)

County	Alameda	Contra Costa	Fresno	Kern	Kings	Madera	Merced	Sacra-mento	San Joaquin	Total
Contra Costa	158.8									158.8
Fresno	0.7	0.6								1.3
Kern	0.8	0.8	2.0							3.6
Kings	0.1	0.1	5.3	1.3						6.8
Madera	0.1	0.1	0.0	0.1	0.2					0.5
Merced	0.9	0.6	9.1	0.1	1.1	1.8				13.6
Sacramento	5.1	4.9	0.5	0.8	0.1	0.1	0.3			11.8
San Joaquin	4.9	4.6	0.4	0.4	0.0	0.3	2.3	4.7		17.6
Stanislaus	2.4	1.9	8.7	0.2	0.0	1.6	7.4	0.9	19.6	42.7
Total	*173.8*	*13.6*	*26.0*	*2.9*	*1.4*	*3.8*	*10.0*	*5.6*	*19.6*	*256.7*

Source: The Authority Model

Table 2.8: 2030 Projected San Joaquin Core Corridor Annual Two-Way Person Trips (Millions)

County	Alameda	Contra Costa	Fresno	Kern	Kings	Madera	Merced	Sacra-mento	San Joaquin	Total
Contra Costa	189.4									189.4
Fresno	0.9	1.0								1.9
Kern	1.1	1.2	2.5							4.8
Kings	0.1	0.1	7.9	1.6						9.7
Madera	0.2	0.2	0.0	0.1	0.3					0.8
Merced	1.3	0.9	12.4	0.2	1.2	3.3				19.3
Sacramento	7.3	8.0	0.9	1.2	0.1	0.2	0.5			18.2
San Joaquin	7.5	7.7	0.6	0.6	0.1	0.6	3.3	7.9		28.3
Stanislaus	3.4	2.8	11.5	0.3	0.0	2.9	11.5	1.4	31.3	65.1
Total	*211.2*	*21.9*	*35.8*	*4.0*	*1.7*	*7.0*	*15.3*	*9.3*	*31.3*	*337.5*

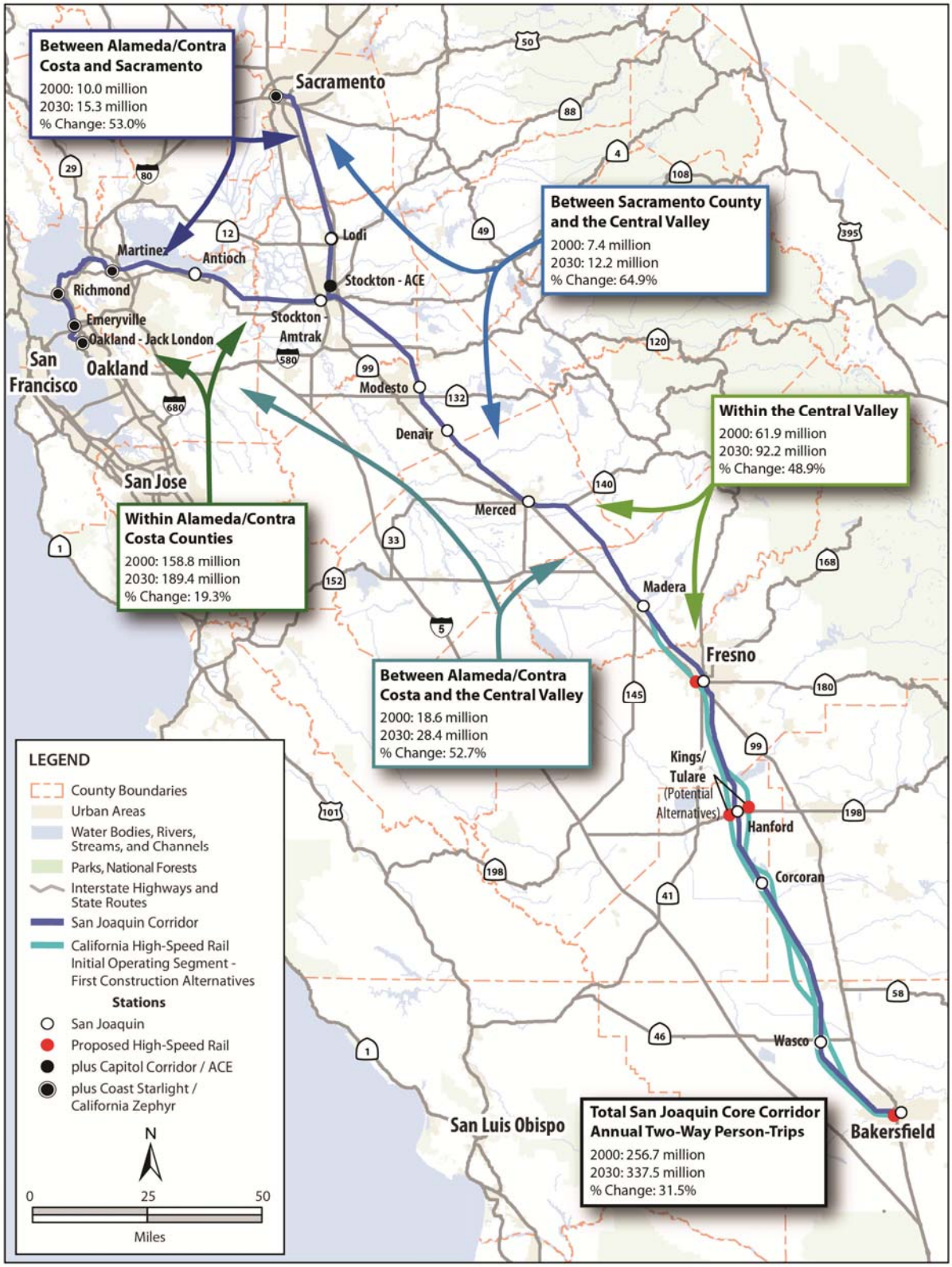
Source: The Authority Model

Table 2.9: 2000 to 2030 San Joaquin – Percent Change in Core Annual Two-Way Person Trips

County	Alameda	Contra Costa	Fresno	Kern	Kings	Madera	Merced	Sacra-mento	San Joaquin	Total
Contra Costa	19%									19%
Fresno	29%	67%								46%
Kern	38%	50%	25%							33%
Kings	0%	0%	49%	23%						43%
Madera	100%	100%	0%	0%	50%					60%
Merced	44%	50%	36%	100%	9%	83%				42%
Sacramento	43%	63%	80%	50%	0%	100%	67%			54%
San Joaquin	53%	67%	50%	50%	0%	100%	43%	68%		61%
Stanislaus	42%	47%	32%	50%	0%	81%	55%	56%	60%	52%
Total	*22%*	*61%*	*38%*	*38%*	*21%*	*84%*	*53%*	*66%*	*60%*	*31%*

Source: The Authority Model

Exhibit 2.1: San Joaquin Core Corridor Annual Two-Way Person-Trips (All modes)



2.2.4 Corridor Capacity Constraints

Between 2010 and 2030, the San Joaquin Corridor is projected to experience a 41.1 percent increase in population in the core, a 44.4 percent increase in population in the Central Valley, and a 33.4 percent and 36.1 percent increase in employment in the core and Central Valley respectively. Travel activity in the San Joaquin Corridor is projected to increase by 31.5 percent between 2000 and 2030, and an additional 8.0 percent by 2040 (107.4 million new trips). Constraints on highway expansion along with increasing highway congestion will have an increase in demand for rail service expansion to keep pace with growth in population, employment and resulting increases in overall trip demand.

Constrained Travel Options

The options for connecting from the Central Valley to California's largest metropolitan areas include driving the full distance, driving to a regional or larger airport and then flying, riding an intercity bus or using the San Joaquin intercity passenger rail and Thruway bus to the final destination. The limited options of direct, fast, and safe connections to the major metropolitan areas affects the Central Valley economically, limit the area from which Central Valley businesses draw customers and employees, and reduce the accessibility of job markets for residents.

The Central Valley has two principal north-south highways: I-5 and SR-99. I-5 is the main interstate highway on the west coast of the United States, running largely parallel to the Pacific Ocean from the Mexican border to the Canadian border. It serves some of the largest cities on the west coast, including Seattle, Portland, Sacramento, Los Angeles, and San Diego. I-5 is routed along the more remote western edge of the Central Valley and is removed from the population centers such as Bakersfield and Fresno and other intermediate urban centers located along SR-99 and the UPRR and BNSF railroads.

Consequently, between Stockton and Bakersfield, the major urban areas of the Corridor are served by a single major highway, the four-lane to six-lane SR-99, which experiences frequent periods of congestion and travel delays. SR-99 has inconsistent design geometrics, which often lead to pinch points and resulting congestion in urbanized areas of the San Joaquin Valley. The *SR-99 Business Plan (2009)* includes priority projects to widen the highway from four lanes to a minimum of six lanes throughout the corridor. In addition, the *SR-99 Business Plan (2009)* includes projects to widen SR-99 to eight lanes in some urban areas, where feasible.

Aside from the major international airports at Los Angeles and San Francisco, air travel access is limited to major airline service available at Sacramento and Oakland. Central Valley airports at Stockton (STK), Modesto (MOD), Merced (MCE), Fresno (FAT), Visalia (VIS), and Bakersfield (BFL) have very limited service frequencies and have direct service only to California airports in Los Angeles, San Francisco, and San Diego. The high air travel pricing and small aircraft used reflects lack of competition in the smaller market area. Improved rail connection to air travel access and the future HSR system could serve as an alternative to the congested highways in the Corridor.

Constraints on highway and airport expansion along with increasing highway congestion increase demand for rail service expansion as noted. Consequently, rail system improvements are important to accommodating future travel growth in this constrained Corridor.

Constrained Rail System Infrastructure

Improvement and expansion of the Corridor's intercity rail system has not kept pace with the travel demand resulting from existing increases in population and employment. The rail system infrastructure serving the Corridor's intercity travel market is currently operating at or beyond its design capacity, and requires major improvements to meet existing demand and projected growth over the next 20 years. Although, certain near-term infrastructure improvement projects identified in the San Joaquin Strategic Plan (2008) have been initiated and are underway, additional infrastructure is needed to support

increasing service frequencies and higher operating speeds require. The near-term pending projects include:

- Port Chicago to Bakersfield – PTC. (partially allocated)
- Mid-route – layover facility (not designed; permitted, $14.6 million programmed).
- Merced to Le Grand – second main track (fully designed and permitted, 50 percent programmed).
- Stockton to Escalon – second main track (fully designed and permitted, 10 percent funded).
- Port Chicago to Oakley – second main track (fully designed and permitted, 20 percent funded).

Need for improved Travel Times, Reliability, and Safety

Among the critical factors that impact the public's choice of transportation are travel time, reliability, and safety. Travel time and reliability are critical for all travelers, but particularly for work and business-related trips which require a more time-certain arrival. As highway congestion intensifies, travel delays increase and travel reliability worsens, non-automobile modes such as rail become more attractive options for travel. The Corridor's highway system currently experiences significant congestion during peak periods and has limited opportunities for expansion. With the projected annual trip growth, automobile travelers will experience increasing highway congestion and resulting travel delays. Corridor rail travel has the potential to serve future travel demand with faster and more reliable service if system improvements are made. Currently, *San Joaquin* intercity rail travelers experience frequent delays and reduced reliability due to single-track operations, limited sidings, and outdated communication systems.

The Corridor is also experiencing an increase in roadway congestion, particularly in travel chokepoints on SR-99 and I-5, with more and more vehicles on the roadways and more frequent and faster trains, the potential for rail/automobile collisions increase. Rail improvements can address this need by reducing or eliminating the hazards of highway-rail crossings, as well as provide new or upgraded pedestrian crossings along the Corridor.

2.3 Scope and Objective of the Plan

2.3.1 Scope

The San Joaquin Corridor faces significant mobility challenges as continued growth in population, employment, and tourism activity is projected to generate increased travel demand straining the existing transportation network. Development of an effective rail system is necessary to meet the future mobility needs of residents, businesses, and visitors. The San Joaquin Corridor faces future transportation challenges as evidenced by the following:

- Increasing Travel Demand. By 2040, the Corridor's population is projected to grow by approximately 42.2 percent and employment by 34.0 percent with a corresponding increase in travel demand. Although a significant portion of this growth is in the Bay Area, a majority of the growth in population and employment will emanate from the Central Valley. From 2000 to 2030, the San Joaquin Corridor travel market is expected to grow 31.5 percent, from 256.5 million to 337.4 million annual trips. Much of this trip growth is anticipated within the San Joaquin Valley.
- Constrained Travel Options. While the Corridor is served by a transportation system that includes air, highway, and rail services, system capacity is insufficient to meet the future travel demands. The urban centers of the San Joaquin Valley are served principally by two major highways SR-99, which experiences frequent congestion and travel delays, and I-5 in San Joaquin and Sacramento counties which can also be quite congested. Due to the Corridor's physical setting there is limited space for the expansion of the highway system or the construction

of new highway alternatives. While the Corridor has passenger rail services providing intercity and business travel options, trains are slower than driving and system riders experience frequent travel delays due to rail infrastructure constraints.

- Significant Highway Congestion. Current travel demand generated by residents and visitors results in frequent highway congestion and travel delays, particularly at urban chokepoints along SR-99 and I-5. With the projected population and employment growth, a majority of the future travel demand is anticipated to be met by automobile travel, which will result in increased highway congestion. There is limited space and funding available for highway system improvements. As highway congestion intensifies, travel delays will increase and reliability decline. Rail travel could become an increasingly attractive option for personal, business, and goods-movement trips.
- Constrained Rail System Capacity. Corridor rail service could accommodate an increasing portion of the projected travel demand growth, but operational capacity is constrained by a track system that is undersized for the rail volumes it currently accommodates much less any future service increases. Many segments of the Corridor have single-track operations, and sidings are limited in number and length causing trains to stack at either end of the single-track section, resulting in delays and reducing the attractiveness of rail as a travel mode choice. Communication systems need to be upgraded and PTC needs to be implemented over the length of the corridor. The Corridor's rail system is currently operating beyond its design capacity, and major infrastructure improvements are required to provide a more reliable, safe, competitive, and attractive intercity travel option.
- Need for Increased Travel Capacity without Impacting Air Quality, Communities, and Natural Resources. Growing Corridor travel demand will require transportation system capacity and operating improvements, which could have negative impacts on regional and local air quality, local communities, and natural resources. Improvements in the San Joaquin Corridor are particularly sensitive in these impact areas. The entire core corridor is identified as Non-Attainment for ozone based on federal air quality conformity requirements for ozone. Rail activity in the Corridor passes through residential neighborhoods and the commercial centers of many communities, and operates in the environmentally sensitive setting of prime agricultural land and the San Francisco Bay Area portion of the Corridor. Meeting federal and state air quality standards over the next 20 to 40 years will likely require the employment of a variety of strategies such as new technologies, cleaner energy and greater efficiency, as the state transitions to zero- and near-zero-emission technologies. Rail system capacity could be increased with air quality benefits (including GHG emissions) and minimal impacts to local communities and natural resources.

Expansion of the San Joaquin Corridor's intercity rail system has not kept pace with the current growth in population, employment, travel, and tourism, but will require improvements to meet projected future demand and growth. These proposed Corridor rail infrastructure projects would provide for a reliable, safe, and more attractive intercity travel option. Rail system improvements would provide additional capacity that would relieve some of the projected near-term demand on the highway system, potentially slowing the need to further expand highways and airports, or reduce the scale of those expansions, reducing their associated cost, community, and environmental impacts. The San Joaquin Corridor rail improvements would augment the highway system, thereby creating an interconnected, multimodal solution, allowing for better mobility throughout the Corridor. Intercity passenger and high-speed rail can generate substantial GHG savings by diverting passengers from airplanes and automobiles to more energy efficient trains. In addition, Corridor rail improvements would contribute to the successful implementation of the planned HSR system, and provide connectivity with local transit systems.

2.3.2 Objectives

In the *California State Rail Plan (2008)*, Caltrans has described the overall objectives and policies for intercity rail improvements as:

- Increase the cost-effectiveness of State-supported intercity passenger rail systems.
- Increase capacity on existing routes.
- Reduce running times to attract additional riders and to provide a more attractive service.
- Improve the safety of State-supported intercity rail service.

The Corridor-specific objectives for this SDP include:

- Develop the first of a number of operating scenarios for the continuous improvement of the San Joaquin Corridor.
- Develop a plan for the continued improvement of the San Joaquin Corridor that complements and incorporates the recommendations of the *2012 Business Plan* including operating blended service on the first construction section of the IOS located between Madera and just north of Bakersfield.
- Clearly demonstrate the purpose and need for new or improved passenger rail service.
- Analyze alternatives for providing the new or improved service, and identify the alternative that best addresses the purpose and need
- Demonstrate the financial and operational feasibility of the selected alternative, including identification of operational improvements required to support new or improved service.
- Describe how implementation of the selected alternative may be divided into discrete phases.

Within a multi-modal strategy, improving rail service in this Corridor would provide the following benefits:

- Address increasing travel needs.
- Alleviate demand on constrained highway system.
- Reduce travel times.
- Increase reliability and safety.
- Increase travel capacity with minimal impacts to the Corridor's communities and natural resources.
- Provide potential benefits to air quality and lowering GHG emissions.

3.0 Rationale

The expansion of service in the San Joaquin Corridor is needed to respond to population and employment growth and increased travel demand over the next 20 years. This service expansion will include more frequent trains operating at higher speeds in the Central Valley.

San Joaquin service improvements could utilize the first construction section of the IOS, between Madera and just north of Bakersfield, to cut travel times between Oakland/Sacramento and Bakersfield. It is envisioned that some *San Joaquin* trains could be routed from Bakersfield to Madera via the first construction section of the IOS and over existing rail lines north from Madera to Stockton where services would connect and/or be routed via a unified regional network comprised of the *San Joaquin*, the Altamont Corridor Express (ACE) and the *Capitol Corridor* services. This would involve blended operations with trains interlining (transferring) between the high-speed rail track and conventional rail routes shared with freight traffic. Improved and expanded San Joaquin Corridor rail service would provide the following benefits:

- Provide additional transportation system capacity to serve Corridor growth in a cost-effective manner with minimal impacts to natural resources, and air quality and greenhouse gas emissions.
- Increase use of intercity passenger rail service as part of a multi-modal strategy identified in regional and county goals and plans.
- Provide an alternative for those who cannot, or choose not to, drive or fly.
- Provide more predictable travel times for rail passengers.
- Provide travel time savings for rail passengers.
- Accelerate delivery of rail investment benefits in the Central Valley.
- Support California's sustainability goals.

Corridor rail system improvements would benefit other passenger transportation systems that would interface with the Corridor rail service:

- Support *Capitol Corridor* operations. At the northern end of the Corridor, many trips span the service areas of the *Capitol Corridor*, and improvements in the San Joaquin Corridor would complement and support the improvements identified for the *Capitol Corridor*.
- Support ACE operations. At Stockton, *San Joaquin* service destined for Sacramento stops at the same station served by ACE commuter trains. The ACE commuter service presently operates between Stockton and San Jose. Proposed expanded service could extend ACE services north to Sacramento and south to Merced, and could enable expanded *San Joaquin* intercity passenger service to use the ACE corridor to directly serve the Tri-Valley and Silicon Valley. These service improvements would provide for an expanded and integrated network of unified regional rail services in Northern California.
- Support proposed Coast Corridor operations. Connecting bus service between the Coast Corridor at Paso Robles and the San Joaquin Corridor at Hanford will allow faster rail-to-bus-to-rail trips between the stations on the Central Coast and stations in the San Joaquin Valley. These trips will become even faster once the new NCURS outlined in the *2012 Business Plan* begins operating over the first construction section of the IOS between Madera and just north of Bakersfield.[(viii)] Travel time will be reduced even further on initiation of electrified high-speed rail service in the Central Valley.

- Support operations of the future HSR system. The *San Joaquin* will provide important, complementary rail feeder services to the HSR system. During the phased implementation of the HSR system, the *San Joaquin* will provide rail connecting service to the Bay Area, Northern San Joaquin Valley, and Sacramento. Where these connections will be made is the subject of on-going study by the Authority and other regional rail agencies.
- Under the scenarios proposed in this SDP, *San Joaquin* services will provide continued rail access to communities in the Central Valley. Between Merced and Bakersfield, *San Joaquin* local trains and one through train would continue to stop at Hanford, Corcoran, and Wasco. These stations are not served by trains operating on the first construction section of the IOS of the California HSR system.
- Provide stronger interface with local transit systems. Corridor improvements would provide for a stronger interface with transit services operating to and from the Corridor's passenger rail stations. Corridor stations include the following: Sacramento, Lodi, Oakland, Richmond, Martinez, Antioch, Stockton, Modesto, Turlock, Merced, Madera, Fresno, Hanford, Corcoran, Wasco, and Bakersfield.

In terms of freight rail service on this Corridor, investments needed to expand passenger service and improve passenger service performance objectives in some cases may also benefit goods movement in the State by enhancing the capacity and reliability of the route as an alternative to the principal north-south corridors located in the Central Valley.

3.1 Capacity Benefits

Corridor improvements would provide additional capacity to serve San Joaquin Corridor growth in a cost-effective manner with minimal impacts to local communities, natural resources, and air quality. The improvements have independent utility, are not dependent on the completion of other Corridor programs to be successful, and provide measurable benefits to intercity rail service.

Providing additional highway system capacity could have negative impacts on regional and local air quality, local communities, and natural resources. With respect to air quality in the San Joaquin Corridor, the entire Central Valley and the San Francisco Bay Area are designated as "Ozone Non-Attainment Areas" based on federal air quality conformity requirements. The Corridor passes through residential neighborhoods and the commercial centers of many communities, and operates through environmentally sensitive settings. Rail system capacity could be increased within existing ROW with air quality and other sustainability benefits and minimal impacts to local communities and natural resources.

3.2 Multi-Modal System Benefits

Increased intercity passenger rail service is a key component of multi-modal strategies identified in the Corridor's regional and county goals and plans. While the Corridor is served by a transportation system that includes air, highway, and rail services, existing system capacity is insufficient to meet the future travel demands. Between Stockton and Bakersfield the Corridor's urban areas are primarily served by two major highways the four-lane SR-99 and the I-5. The *SR-99 Business Plan (2009)* includes priority projects to widen the highway from four lanes to a minimum of six lanes throughout the corridor. In addition, the *SR-99 Business Plan (2009)* includes projects to widen SR-99 to eight lanes in some urban areas, where feasible.

Regional and county multi-modal transportation plans have been developed in recognition of future growth and have adopted the rail mode as a key element. Improved intercity rail service plans in the San Joaquin Corridor would support regional and county goals and plans related to growth, smart growth, economic development, air quality and GHG emissions, sustainability, and a balanced transportation system. Improving passenger rail service would enhance rail travel as an increasingly viable and

attractive option for personal and business trips, particularly for those residents who do not or cannot drive.

A combination of highway and rail improvements greatly enhances the interconnectivity of the transportation system by improving accessibility and mobility choices.

3.3 Operational Benefits

Improvements to the San Joaquin Corridor's existing rail system infrastructure north of Merced, such as improved signaling and extension of critical sidings, would improve operational reliability for both passenger and freight trains. Attracting more customers to intercity rail through improved performance will offer a key mobility choice.

As presented in Chapter 9, the operations simulation modeling shows that the proposed capital program would produce capacity and operational benefits, including reductions in train travel times, improved on-time performances (OTP), speed increases, and the additional capacity required to increase train frequencies.

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4.0 Identification of Alternatives

This chapter describes the *San Joaquin* service alternatives that were evaluated including the "No-Build Alternative" and four "Build Alternatives". The "No-Build Alternative" reflects continued operation of the current San Joaquin Corridor service with no expansion and no infrastructure improvements other than those already committed and funded. The "Build Alternatives" present several scenarios among many for the initiation of the "Blended Service" options in support of the NCURS identified in the *2012 Business Plan as described in Chapter 1.*

The Regional Governance Working Group for the San Joaquin Rail Service has submitted considerable input to Caltrans DOR. This input includes a number of concepts that could potentially increase the ridership and viability of the *San Joaquin* service as a complementary feeder service to HSR. These concepts include adding more stations to the *San Joaquin* service, having different fare structures such as higher fares for express services (HSR or *San Joaquin* trains using the first construction section of the IOS) vs. lower fares for slower *San Joaquin* service with additional stops, and having the first *San Joaquin* trains start in the San Joaquin Valley to reach Oakland, Sacramento, and Bakersfield at the beginning of the work day. None of these concepts have been evaluated in this SDP. These and other operational improvements that change the focus of the *San Joaquin* from a conventional intercity passenger rail service operating on the first construction section of the IOS to a complementary regional feeder service supporting the future parallel HSR line is subject to future studies by the Authority and newly formed San Joaquin Joint Powers Authority.

The focus of this SDP is one scenario among several Build Alternatives presumed for the initiation of improved *San Joaquin* service in the Corridor by 2018 (as studied in the Year 2020 planning horizon) utilizing the first construction section of the IOS This SDP evaluates conceptual service options and potential rail infrastructure investments required to implement service expansion as described in this chapter. Subsequent project-specific engineering, operations planning and environmental analysis would be performed to provide more detailed information on required improvements, implementation costs and environmental impacts for individual projects included in the preferred Build Alternative.

4.1 Previous Corridor Planning Studies

Several planning studies have identified and proposed improvements for the San Joaquin Corridor. The findings of these studies are presented in this section.

The *San Joaquin Strategic Plan (2008)* provides short-term and long-term visions for *San Joaquin* rail service, including specific projects to address anticipated economic growth and rail needs. The *San Joaquin Strategic Plan (2008)* formalized the short-term (2012 to 2014), medium-term (2015 to 2020), and long-term (2020 to 2040) vision for passenger rail service in the Central Valley. The purpose of the plan is to develop a program of improvements that will increase ridership, revenue, rail capacity, reliability, and safety within the Corridor. Key stakeholders involved in the development of the plan included Amtrak, BNSF, Caltrans District 6, UPRR, and the San Joaquin Valley regional transportation planning agencies. Public input on the plan suggested 1) improving communications regarding passenger services and ensuring station safety and security in the short-term; 2) adding more frequent service and more stations in the medium-term; and 3) providing passenger rail in the UPRR corridor, and direct connections to the Bay Area and Los Angeles in the long term.

The *San Joaquin Strategic Plan (2008)* also recognizes that the current *San Joaquin* trains could interconnect with the proposed California HSR to serve as collectors/distributors with potential transfer stations in major cities, such as Sacramento, Merced, Fresno, and Bakersfield. These stations could allow passengers to transfer to and from the *San Joaquin* service trains to trains operating on the first construction section of the IOS of the high-speed rail system. The IOS of the California HSR system will

connect Merced to the San Fernando Valley gateway to Los Angeles – closing the state's single largest gap in intercity passenger rail service. Other opportunities will arise for the *San Joaquin* service to "bridge" the HSR service while it is under construction in different regions, such as between the Bay Area and Merced and between Palmdale and Los Angeles.

The *California State Rail Plan* (2008), prepared by Caltrans, evaluated capital and operational improvements that will increase *San Joaquin* service to eight daily roundtrips by 2018 with 90 percent OTP. One new roundtrip service will operate between Oakland and Bakersfield; the other new roundtrip service will operate between Sacramento and Bakersfield. This plan also seeks to reduce the travel time between Oakland and Bakersfield to less than six hours and between Sacramento and Bakersfield to less than five hours. The increased Amtrak service will provide more connections between Amtrak and the HSR System.

The Metropolitan Transportation Commission (MTC), the Authority, BART, and Caltrain, along with a coalition of rail passenger and freight operators prepared a comprehensive Regional Rail Plan for the Bay Area, as required by the voters in the Regional Measure 2 (RM2) Traffic Congestion Relief Program. The *Regional Rail Plan* was completed in 2007 and examined ways to incorporate passenger trains into existing rail systems, improve connections to other trains and transit, expand the regional rapid transit network, increase rail capacity and coordinate rail investment around transit-friendly communities and businesses. The report specifically calls attention to serving "in-commuters" from the Central Valley. The report notes that "the greatest increase in travel growth into the Bay Area over the next few decades is anticipated to come from these regions to the east. By 2030, in-commute into the Bay Area by commuters from the Sacramento Valley will rise over 200 percent (+49,000 commuters) and San Joaquin Valley will grow by 112 percent (+60,000 commuters). Without stronger transit systems leading to the main Central Valley cities and connecting them to each other, there will be fewer opportunities for the cities to plan for the kind of development that the Bay Area is moving towards."

The *Regional Rail Plan* (2007) includes "expansion of regional service in the Central Valley to provide a regional corridor service between Sacramento and Merced over the long-term, blending with ACE services and complementing the *San Joaquin* intercity passenger trains. Regional trains would operate on hourly schedules between Merced and Sacramento. Additional trains would operate from Modesto to Oakland or San Jose also on an hourly schedule resulting in 30-minute service over the Altamont Pass between the San Joaquin Valley and the Bay Area." These plans are consistent with ACE's long-term plans and are reflective of the Caltrans DOR plans to have hourly service on the *San Joaquin* route over the long-term.

The Authority revised its *2012 Business Plan* and committed to implement the HSR project in phases beginning with an IOS in the Central Valley between Merced and the San Fernando Valley. The first construction section of the IOS between Madera and just north of Bakersfield could be available to be put into use by the *San Joaquin* service immediately upon completion to improve service on the *San Joaquin*. This service will link with other systems, such as *Capitol Corridor,* ACE and Caltrain to create a new, improved network reaching from Sacramento and the San Francisco Bay Area to Bakersfield. It is the intent of this "Blended Service" to carry passengers faster and more reliably and to begin reaping benefits while the balance of the California HSR project is constructed as funding becomes available.

The *San Joaquin Corridor Programmatic Environmental Impact Report (EIR) 2035 Vision – Initial Study (2012)* evaluates programmatic service concept alternatives for passenger rail in the San Joaquin Valley, including service goals, objectives, and expected outcomes. The *Initial Study (2012)* examines expansion from the current six daily round trip trains to eight or 11 round trips (total of 16 to 22 trains) operating at speeds up to 90 mph maximum authorized speed (MAS) on the Bakersfield–Stockton segment of the line. To Oakland six to ten round trips are studied and to Sacramento three to six round trips are studied.

*BNSF San Joaquin Valley Capacity Analysis (2010)*examined the infrastructure requirements necessary to support eight and 11 trains operating at speeds of 79 mph and 90 mph MAS. BNSF also prepared cost estimates for the projects deemed necessary to support increased service frequencies over the *San Joaquin route.* The BNSF Capacity Analysis is described in greater detail in Chapter 9.

Previous studies have proposed the following improvements grouped into infrastructure, equipment and service enhancements:

- Track upgrades including second main tracks, curve realignments, and cross-tie replacement.
- Siding improvements including lengthening and rehabilitation and the installation of new track and/or sidings along secondary rail segments in order to extend passenger rail service into Richmond along the BNSF.
- Replace existing bridges and culverts or install new ones in order to ensure the best performance of drainage structures.
- Improve highway/railroad track intersections in order to enhance safety of railroad operations and to minimize impacts on local circulation systems.
- Increase the maximum operating speed of passenger trains in all segments of the existing San Joaquin Corridor from 79 mph to 90 mph MAS) where practicable and feasible.
- Building the first construction section of the IOS between Merced and north of Bakersfield.
- Obtain additional operating equipment (rolling stock) to meet the forecasted customer demand for passenger trains.
- Construct new or additional layover or maintenance facilities.
- Additional Thruway bus services.
- Improve station facilities to support expansion of future train operations, including platform expansion/extension and reconstruction, pedestrian crossings, parking, and associated facilities for connecting modes (bus/shuttle stations, bicycle facilities, sidewalks, and access roads).

4.1.1 Existing Corridor Rail Service

Current San Joaquin Corridor intercity passenger train operations consist of six daily round-trip trains on the Bakersfield–Stockton segment (total of 12 trains); four daily round-trips on the Stockton–Oakland segment (total of eight trains); and two daily round-trip trains on the Stockton–Sacramento segment (total of four trains). The *San Joaquin Strategic Plan (2008)* envisioned expansion from the current six daily round-trip trains to eight or 11 trains (total of 16 to 22 trains) on the Bakersfield–Stockton segment of the line operating at speeds up to 90 mph MAS.

There are 19 stations along the *San Joaquin* route. The terminal stations are Sacramento and Oakland in the north and Bakersfield in the south. Passengers can connect with Amtrak long distance trains, notably the *Coast Starlight* and *California Zephyr*, and *Capitol Corridor* trains at Martinez and Sacramento. Stations in Richmond and Emeryville permit easy transfers to San Francisco BART trains or Amtrak Thruway buses to San Francisco respectively. A major hub in Stockton, where the line splits, connects *San Joaquin* trains to Amtrak Thruway buses and ACE trains. Station locations are identified in Exhibit 1.1.

Another component of current passenger train service along the San Joaquin Corridor is the extensive connecting Thruway bus system that supports the train operations. All trains at Bakersfield and Los Angeles are met by a Thruway bus connecting south to Los Angeles or north to Bakersfield. All trains at Stockton are met by a Thruway bus continuing either to Oakland or Sacramento, whichever terminus the

train does not serve. The Thruway bus system extends north to Redding, east to Reno and Las Vegas, Nevada; south to Indio; and all along the California coast from Arcata to San Diego. Throughout the system, interconnections are available between buses and other Amtrak intercity routes (such as the *Pacific Surfliner* and *Capitol Corridor*), with Amtrak long-distance routes (such as the *Coast Starlight* or the *Sunset Limited*); and with the various commuter rail systems, notably ACE and Metrolink. Bus motor coaches are leased from local companies. All bus motor coaches are required to meet Amtrak motor coach design and safety requirements. Exhibit 4.1 presents the San Joaquin Corridor passenger train route and the connecting bus routes and Northern California commuter services that directly connect with *San Joaquin* trains. About 46 percent of *San Joaquin* passengers use a bus on at least one end of their trip.

Exhibit 4.1: San Joaquin and Connecting Thruway Bus and Rail Services

Current freight operations average 24 to 26 daily trains on the BNSF between Stockton and Bakersfield; ten trains on the BNSF between Port Chicago and Stockton; 24 trains on the UPRR between Oakland and Martinez; and 40 trains on the UPRR Fresno Subdivision between Sacramento and Stockton; some BNSF freight traffic with trackage rights over UPRR is routed via the Sacramento Subdivision between Sacramento and Stockton along with a limited number of UPRR freights. Future freight trains may increase in number and length. When coupled with the contemplated passenger rail service increases, inadequate sidings and other rail capacity constraints will negatively impact freight and intercity rail performance.

4.1.2 Future Corridor Blended Rail Service Plans

Planning efforts and results of studies for service improvements on the *San Joaquin* were summarized in Section 4.1. Service improvement options outlined in those studies (particularly the 2012 EIR - Initial Study) included operating scenarios that increased the level of round-trip daily trains from six to either eight or 11 daily trains and for increasing operating speeds from 79 mph maximum authorized speed (MAS) up to 90 mph. BNSF commenced capacity analysis on these two levels of service and speeds. Since that time, the Authority issued its revised *2012 Business Plan*. The *2012 Business Plan* promotes blended or NCURS. The work plan prepared by Caltrans for the FRA grant specified that any scenarios to be studied in the SDP utilize the first construction section of the IOS from Madera to just north of Bakersfield, and continue some service on the BNSF route between Madera and Bakersfield stopping at all existing stations along the route.

Planning for the blended system in Northern California commenced in the spring of 2012 once the *2012 Business Plan* was released. The NCRPWG participated in the determination of planning scenarios for the initiation of service on the first construction section of the IOS. Caltrans developed planning scenarios for initial service commencing in 2018 using the 2020 planning horizon year for ridership and revenue forecasting. The planning scenarios depict service level increases of eight and 11 round-trip trains as determined by previous studies and included in current BNSF capacity analyses for Caltrans. The planning scenarios for the SDP contemplate up to 11 trains operating on the first construction section of the IOS at speeds up to 125 mph. These planning scenarios include up to six trains operating on the existing BNSF route that would stop at the existing Hanford, Corcoran, and Wasco Amtrak stations at speeds of either 79 mph or 90 mph. Five trains would be local shuttle trains that operate between Madera and Bakersfield. There would be one through train that operates between Oakland and Bakersfield. The SDP will explore and determine the appropriate number of *San Joaquin* trains that could utilize the first construction section of the IOS and the BNSF line during the interim period before high-speed rail service begins to operate on the IOS when true high-speed rail service is initiated in 2022. Other analyses are on-going by the Authority and other agencies and additional scenarios will be developed.

This SDP is the first formal planning document to examine Northern California blended service and concentrates its analysis on the use of the first construction section of the IOS. In conjunction with this work, additional capacity analysis is currently underway by the BNSF and the UPRR to verify proposed frequency increases and related passenger rail improvements. In a related study, the Authority, passenger rail operators, and the two Class 1 railroads are participating in an analysis of the Stockton diamond area where the *San Joaquin* service and freight railroad operations share a common junction.

Some station improvements would be required at Madera and Bakersfield to facilitate transfers between local shuttle trains operating on the BNSF route between Madera and Bakersfield and *San Joaquin* trains operating on the first construction section of the IOS.

The operating scenarios and routes are illustrated in Exhibits 4.4 – 4.7 and the four “Build Alternatives” are described in Section 4.3.

4.1.3 Corridor Blended Service Improvements

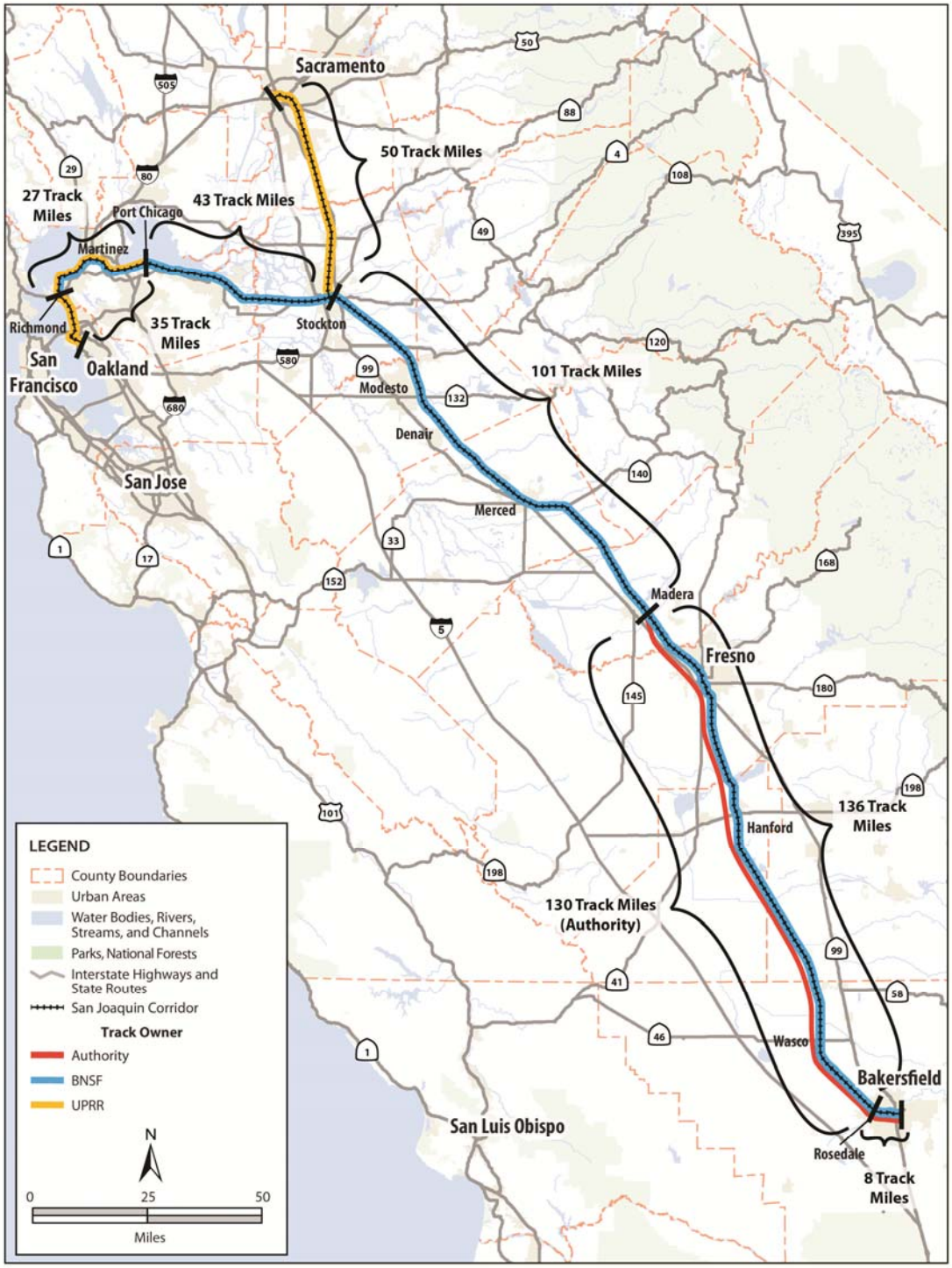
Corridor improvements to accommodate additional service have been identified utilizing the first construction section of the IOS in a cost-effective and environmentally sensitive manner. The services would operate over seven conventional rail line segments and the first construction section of the IOS of the HSR, which are depicted in Exhibit 4.2:

- Rosedale to Bakersfield (BNSF) – approximately eight track miles.
- Madera to Bakersfield (BNSF) – approximately 136 track miles.[ix]
- Madera to Bakersfield (Authority) – approximately 130 track miles.
- Stockton to Madera (BNSF) – approximately 101 track miles.
- Sacramento to Stockton (UPRR) – approximately 50 track miles.[x]
- Port Chicago to Stockton (BNSF) – approximately 43 track miles.
- Port Chicago to Richmond (BNSF) – approximately 27 track miles.
- Port Chicago to Oakland (UPRR) – approximately 35 track miles. [xi]

These improvements to the existing BNSF rail lines would require additional tracks, sidings, bridges, culverts, grade crossings, utility crossings, staging areas and road improvements as part of the general design. The improvements have been identified by BNSF using Rail Traffic Controller (RTC) train capacity modeling. There are no improvements required on the UPRR. The improvement projects may also require permit acquisition, and when necessary, land acquisition. The improvement projects fall into eight categories:

- Track Upgrades. The key to operating at MAS in mixed use (passenger and freight) operations is the condition of the infrastructure (rail, ties, and sidings), track geometry, signal system and level of maintenance. Improvements such as additional and extended sidings, double tracking, and curve realignments are necessary in order to maintain the Corridor as a Federal Railroad Administration (FRA) Class V railroad. In addition to system infrastructure improvements, there are ongoing rail and tie replacement needs. While the BNSF and UPRR continue to maintain the Corridor to FRA standards, the Corridor is characterized primarily by single-track operations with short sidings. The track geometry requires trains to operate at slower than maximum FRA allowable speed (79 mph) over several segments of the Corridor and siding lengths and conditions make expanded service train meets both difficult and time consuming.
- Siding and Siding Extensions. A siding is a short section of track adjacent to a main track, used for meeting or passing trains. Sections of the Corridor have sidings requiring extension, or require the provision of new sidings to maximize the utility of the existing track configuration. Extending and upgrading existing sidings where possible would provide additional capacity, reduce trip times, and improve operational reliability for both passenger and freight traffic. Constrained siding availability and length would impact the ability of passenger trains and freight trains to pass each other, affecting travel times, on time performance and reliability. Meanwhile, market factors (labor costs, locomotive fleet utilization, etc.) are leading to longer freight trains. The operational result is that passenger trains, rather than freight trains, are frequently forced into a siding when two trains meet because the siding is not long enough to accommodate the freight trains. Where siding lengths of 5,000 feet were once sufficient, freight trains now operate at lengths approaching 9,000 feet. Corridor sidings where meets are expected to occur, whether new or extensions of existing facilities, thus need to have a minimum length of 10,000 feet. As sidings are lengthened, they should also be upgraded to permit higher speeds.

Exhibit 4.2: San Joaquin Rail Route Segments by Track Owner



- Construction of Second (or Third) Main Tracks. Providing additional segments of mainline tracks in areas of heavy rail traffic would allow for increased train frequencies, improved operational reliability, increased capacity, and decreased train delays.
- Curve Realignments. Curve realignments allow for reduced trip times by increasing train speeds on curved tracks and prolonging track life, reducing the frequency of repair or maintenance needs.
- Station Improvements. Station improvements include providing new or improved station platforms, improved transit connectivity, and customer amenities such as additional parking, electronic signage with real-time arrival and departure information, and automated ticket vending machines. Benefits of station improvements include increased platform capacity and safety, and improved customer service and information. Other station improvements are required for Blended Service including infrastructure and facilities needed for cross platform transfers and Thruway bus connections.
- Maintenance and Storage Facilities. Expansion of the San Joaquin services and development of the proposed NCURS as described in the *2012 Business Plan* discussion on "Blended Service" and as further evaluated in this SDP will require development of expanded maintenance facilities once HSR service is initiated in 2022. A candidate site has been identified between the UPRR mainline and the American River about two miles east of the downtown Sacramento station. A minimum of 40 acres would be needed to accommodate about eight full trainsets with storage for spares.
- Rolling Stock Upgrades. Rolling stock upgrades include purchasing new railcars and locomotives to operate the proposed passenger services. In addition to improving the passenger experience (e.g., amenities and ride comfort), new rolling stock can offer tangible travel time benefits—trains with tilting capabilities, for example, can reduce or eliminate the need for trains to reduce speed on low-radius curves, allowing trains to maintain higher average speeds.
- Bus System Modifications. Amtrak Thruway bus system modifications may be required to provide shuttle services between stations in the Central Valley and to improve connections to trains in Stockton from departure terminals in Sacramento and Oakland. The capital costs of Thruway bus system modifications are not included in any of the estimates as they are unknown at this time.

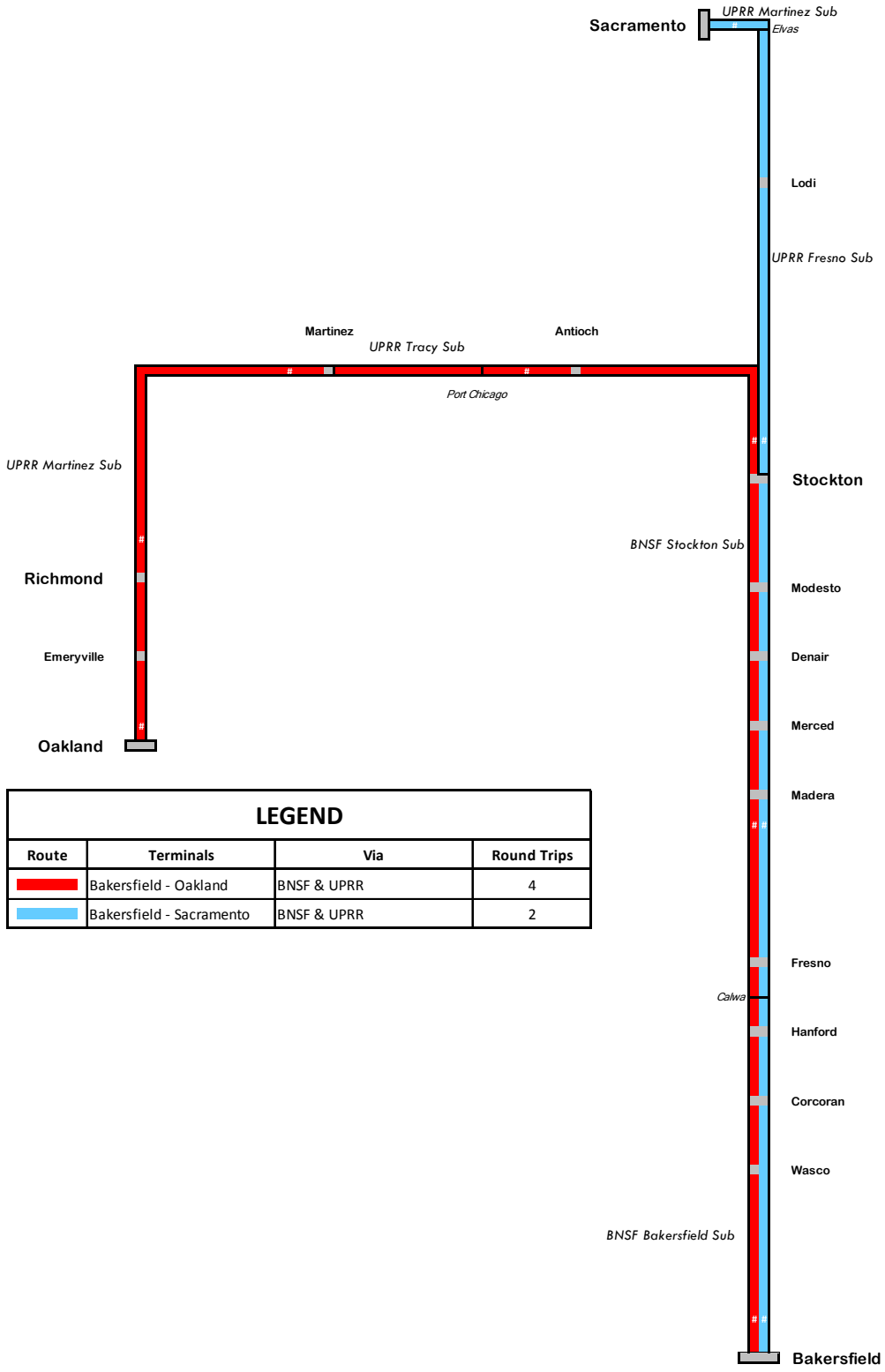
4.2 No-Build Alternative

The No-Build Alternative provides a baseline discussion of the continuation of the current Corridor system and is depicted in Exhibit 4.3.

Under the No-Build Alternative, the existing rail system would not be expanded beyond the six daily round-trip trains currently operating between Oakland/Sacramento and Bakersfield. The projects are solely for improving safety, the reliability of schedule adherence of the current six round trips and to allow for rescheduling of those trains. Existing and other near term improvements included in the No-Build Alternative include only those projects that have already been approved for local, county, state, and federal funding and included as a near term project in the State Rail Plan. These projects include:

- Port Chicago to Bakersfield – PTC (partially allocated).
- Mid-route – layover facility (not designed, permitted, $14.6 million programmed).
- Merced to Le Grand – second main track (fully designed and permitted, 50 percent programmed).
- Stockton to Escalon – second main track (fully designed and permitted, 10 percent funded).

Exhibit 4.3: Baseline Service



LEGEND			
Route	Terminals	Via	Round Trips
	Bakersfield - Oakland	BNSF & UPRR	4
	Bakersfield - Sacramento	BNSF & UPRR	2

- Port Chicago to Oakley – second main track (fully designed and permitted, 20 percent funded).

4.3 Build Alternatives

Each Build Alternative has been defined to include several components: technology, route, station locations, and operating speeds. Common to all of the Build Alternatives are trains equipped with Amtrak California bi-level passenger cars of several types: coach-baggage car, cafe (dining) car, coach car, cab car, and cab-baggage car. A cab car is a typical coach with an engineer's operating cab and headlights on one end, allowing the train to be operated in push-pull mode, which eliminates the need to turn the train at each end-point. A cab-baggage is similar, but with space on the lower level for checked-luggage storage. Two types of diesel-electric locomotives are currently used on the *San Joaquin*, the EMD F59PHI and the GE P42. These locomotives are capable of operating at sustained maximum speeds of 110 mph. US EPA Tier 4 emissions Next Generation diesel-electric locomotives will be acquired in sufficient quantity to provide propulsion for trains operating at speeds up to 125 mph on the first construction section of the IOS between Madera and north of Bakersfield. Caltrans acquired and is rehabilitating former New Jersey Transit “Comet” cars, to include Amtrak standard seating with tables, electrical outlets at each seat and ADA compliant toilets. These cars could be assigned to the local shuttle trains operating between Madera and Bakersfield and would be common to all Build Alternatives.

Major infrastructure improvements are required to provide a reliable, safe, competitive, and attractive intercity travel option. The differences in infrastructure requirements relate to the number of trains being operated, the route, and speed option selected. The Build Alternative provides a set of site-specific improvement projects for the San Joaquin Corridor to address infrastructure constraints for each of the Build Alternatives based on capacity analysis conducted to date.[xii] Projects are identified based on previous studies and plans presented in Section 4.1. Rail improvement projects are described in this document from north to south and are organized by county. Previously identified improvements on the BNSF line between Madera Acres and Rosedale would not be required if service expansion is focused onto the first construction section of the IOS line. However, track connections to the first construction section of the IOS near Madera Acres and Rosedale would need to be provided. Retention of local service along the BNSF between Madera Acres and Bakersfield could require continuous double track between Rosedale and Bakersfield at a minimum.

A jointly owned Caltrans-Amtrak maintenance facility is in service in Oakland to serve the *San Joaquin* and *Capitol Corridor* trains. However, expansion of the *San Joaquin* service and development of the proposed NCURS as described in the *2012 Business Plan* discussion on “Blended System” will require development of expanded maintenance facilities. A candidate site has been identified in Sacramento between the UPRR mainline and the American River about two miles east of the Sacramento Valley Station. A minimum of 40 acres would be needed to accommodate about eight full trainsets with storage for spares.[xiii] Service expansion of the blended system concept after implementation of the Initial Operating Section with electrified high-speed trains would require additional equipment as well as further expansion of operations and maintenance facilities, which will require further study. The initial Build Alternatives and operating scenarios are depicted in Exhibits 4.4 through 4.7.

4.3.1 Build Alternative A

Build Alternative A provides a total of seven round-trips on the first construction section of the IOS to/from Bakersfield and three round-trips on the BNSF south of Madera to/from Bakersfield. The seven round-trips on the first construction section of the IOS include four to/from Oakland, one to/from Sacramento, one to/from both Oakland and Sacramento with separate sections that split/combine in Stockton and one between Madera and Bakersfield only. The three round-trips on the BNSF include one to/from Oakland and two shuttles that provide a cross-platform transfer to/from the first construction section of the IOS trains at Madera. The local shuttle trains operate between Madera and Bakersfield. The splitting of trains

increases the frequencies to both Sacramento and Oakland without increasing the number of slots for passenger trains south of Stockton. A total of eight daily round-trip through trains operate between Oakland/Sacramento and Bakersfield. Build Alternative A does not provide for a connection between San Joaquin trains and ACE service in Stockton.

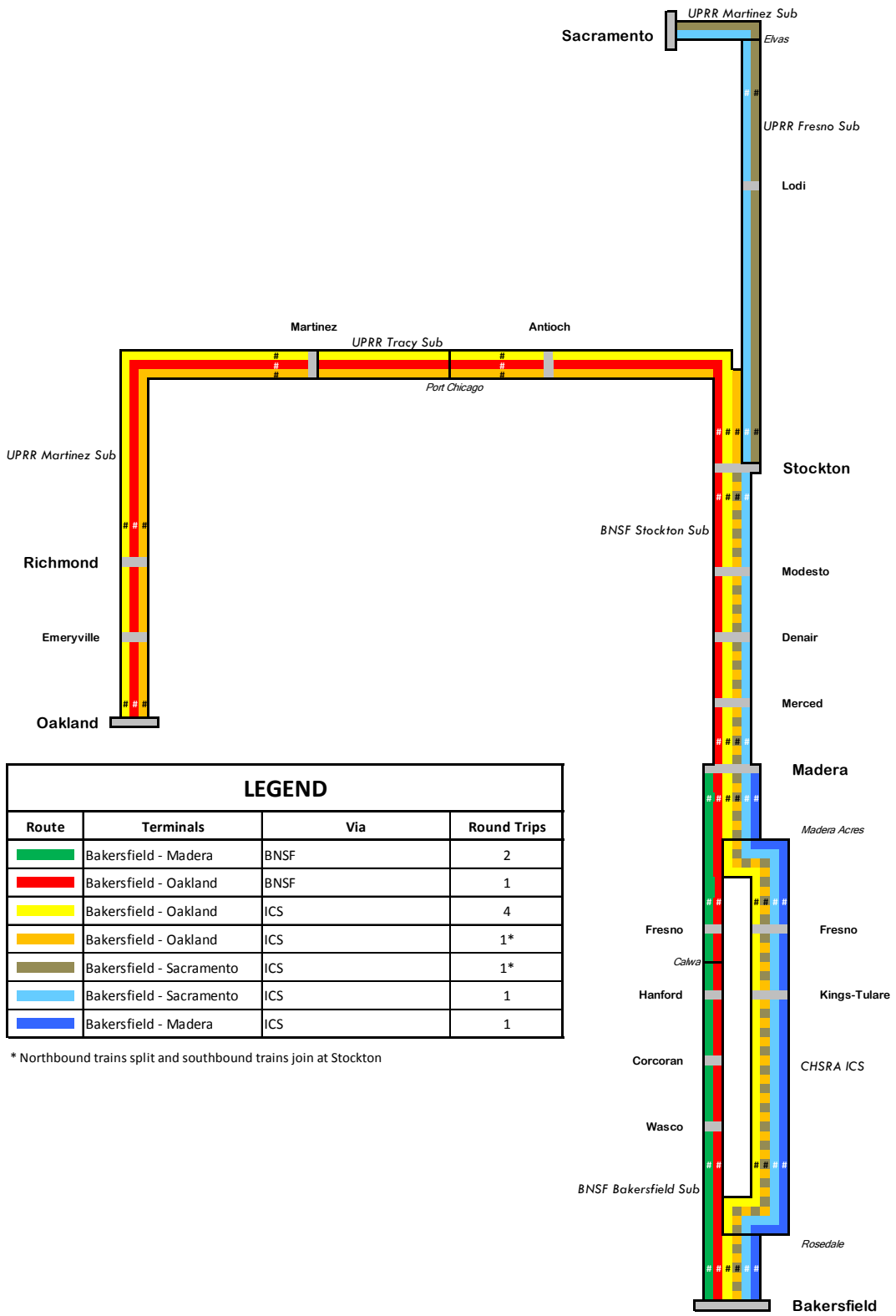
New connections between the existing BNSF line and the first construction section of the IOS will be required in the vicinity of Madera Acres and Rosedale. These connections would likely require new ROW to accommodate the transition between lines. This new first construction section of the IOS parallel route alignment decreases the level of potential impact to the existing BNSF freight operations in this area. The existing single track on the BNSF line between Rosedale and Jastro will need to be double tracked to provide a continuous double track between Rosedale and Bakersfield. For the 90 mph speed option along the length of the BNSF route, infrastructure is required beyond the improvements in the existing and committed base No-Build Alternative. These improvements include double tracking Jastro–Shafter (13 Miles); Merced–LeGrand (Segment 2) and Stockton–Escalon (Segments 2 through 4). Signal improvements would need to be installed. Requirements vary for the two target speeds of 90 mph and 125 mph.

4.3.2 Build Alternative B

Build Alternative B provides a total of seven round-trips on the first construction section of the IOS to/from Bakersfield and six round-trips on the BNSF south of Madera to/from Bakersfield. The seven round-trips on the first construction section of the IOS again include four to/from Oakland, one to/from Sacramento, one to/from both Oakland and Sacramento with separate sections that split/combine in Stockton, and one between Madera and Bakersfield only. The six round-trips on the BNSF include one to/from Oakland and five shuttles that provide a cross-platform transfer to/from the first construction section of the IOS trains at Madera. A total of eight daily round-trip through trains operate between Oakland/Sacramento and Bakersfield. Build Alternative B provides for a connection between San Joaquin trains and ACE service in Stockton.

A new connection between the existing BNSF line and the first construction section of the IOS of the HSR tracks will be required in the vicinity of Madera Acres and Rosedale. These connections would likely require new right-of-way to accommodate the transition between lines. The existing single track on the BNSF line between Rosedale and Jastro will need to be double tracked to provide a continuous double-track between Jastro and Bakersfield along this section of the alignment. For the 90 mph speed option along the length of the BNSF route, additional infrastructure is required beyond the improvements in the existing and committed base No-Build Alternative These improvements include double tracking Jastro–Shafter (13 Miles); Merced–LeGrand (Segment 2) and Stockton–Escalon (Segments 2 through 4). Signal improvements would need to be installed. Requirements vary for the two target speeds of 90 mph and 125 mph.

Exhibit 4.4: Build Alternative A Service Scenario

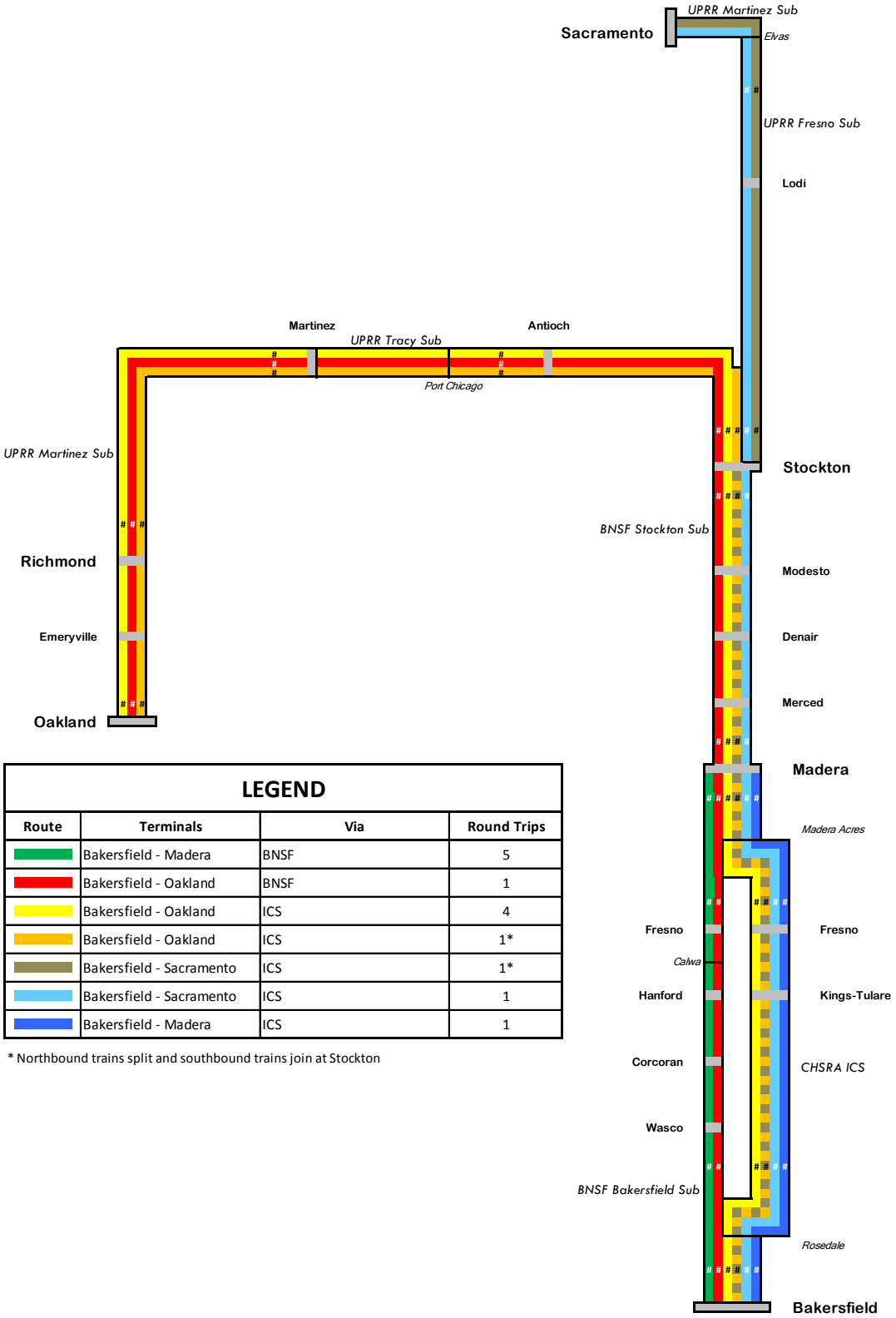


LEGEND

Route	Terminals	Via	Round Trips
	Bakersfield - Madera	BNSF	2
	Bakersfield - Oakland	BNSF	1
	Bakersfield - Oakland	ICS	4
	Bakersfield - Oakland	ICS	1*
	Bakersfield - Sacramento	ICS	1*
	Bakersfield - Sacramento	ICS	1
	Bakersfield - Madera	ICS	1

* Northbound trains split and southbound trains join at Stockton

Exhibit 4.5: Build Alternative B Service Scenario



LEGEND

Route	Terminals	Via	Round Trips
	Bakersfield - Madera	BNSF	5
	Bakersfield - Oakland	BNSF	1
	Bakersfield - Oakland	ICS	4
	Bakersfield - Oakland	ICS	1*
	Bakersfield - Sacramento	ICS	1*
	Bakersfield - Sacramento	ICS	1
	Bakersfield - Madera	ICS	1

* Northbound trains split and southbound trains join at Stockton

4.3.3 Build Alternative C

Build Alternative C provides a total of 11 round-trips on the first construction section of the IOS to/from Bakersfield and six round-trips on the BNSF south of Madera to/from Bakersfield. The 11 round-trips on the first construction section of the IOS include eight to/from the Bay Area – five to/from Oakland and three to/from Richmond via Franklin Canyon; one to/from Sacramento, one to/from both the Bay Area (Richmond via Franklin Canyon) and Sacramento with separate sections that split/combine in Stockton, and one between Madera and Bakersfield only. The six round-trips on the BNSF include one to/from Oakland and five shuttles that provide a cross-platform transfer to/from the first construction section of the IOS trains at Madera. In addition Scenario C also provides for a connection between San Joaquin Valley trains and ACE service in Stockton.

A new connection between the existing BNSF line and the first construction section of the IOS of the HSR tracks will be required in the vicinity of Madera Acres and Rosedale. These connections would likely require new right-of-way to accommodate the transition between lines. The existing single track on the BNSF line between Rosedale and Jastro will need to be double tracked to provide a continuous double track between Jastro and Bakersfield along this section of the BNSF alignment. The BNSF track between Port Chicago and Richmond would need to be upgraded and the line extended to the Richmond BART Station with passenger platforms and pedestrian access ways constructed.

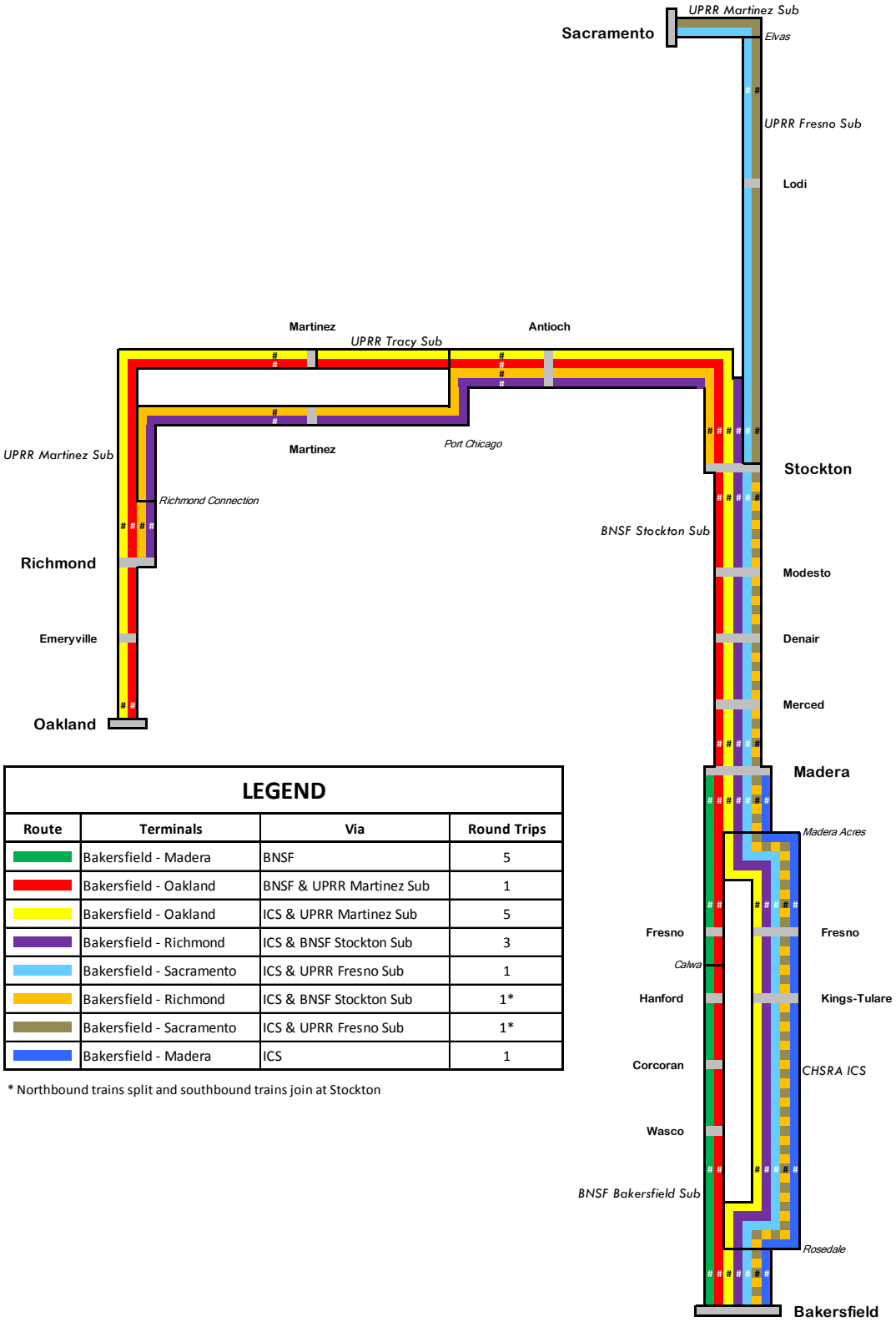
For the 90 mph speed option along the length of the BNSF route, additional double track is required between Port Chicago and Pittsburgh, Riverbank and Milepost 1090.8; Ballico–Fluhr through Madera and between Gregg–Fresno, Corcoran–Allensworth, Sandrini–Elmo and Wasco–Una. If the Madera–Bakersfield local shuttle trains operate at 79 mph MAS, the double track projects and related improvements between Madera and Shafter are not required.

Signal improvements would need to be installed. Requirements vary for the two target speeds of 90 mph and 125 mph.

4.3.4 Build Alternative D

Build Alternative D provides a total of 11 round-trips on the first construction section of the IOS to/from Bakersfield and six round-trips on the BNSF south of Madera to/from Bakersfield. The 11 round-trips on the first construction section of the IOS include five to/from Oakland; one to/from Sacramento, four to/from both the Bay Area (Richmond via Franklin Canyon) and Sacramento (one via the UPRR and three via the Sacramento Subdivision (former Western Pacific) with separate sections that split/combine in Stockton, and one between Madera and Bakersfield only. The six round-trips on the BNSF include one to/from Oakland and five shuttles that provide a cross-platform transfer to/from the first construction section of the IOS trains at Madera. In addition, Build Alternative D also provides for a connection between San Joaquin Valley trains and ACE service in Stockton.

Exhibit 4.6: Scenario C Service

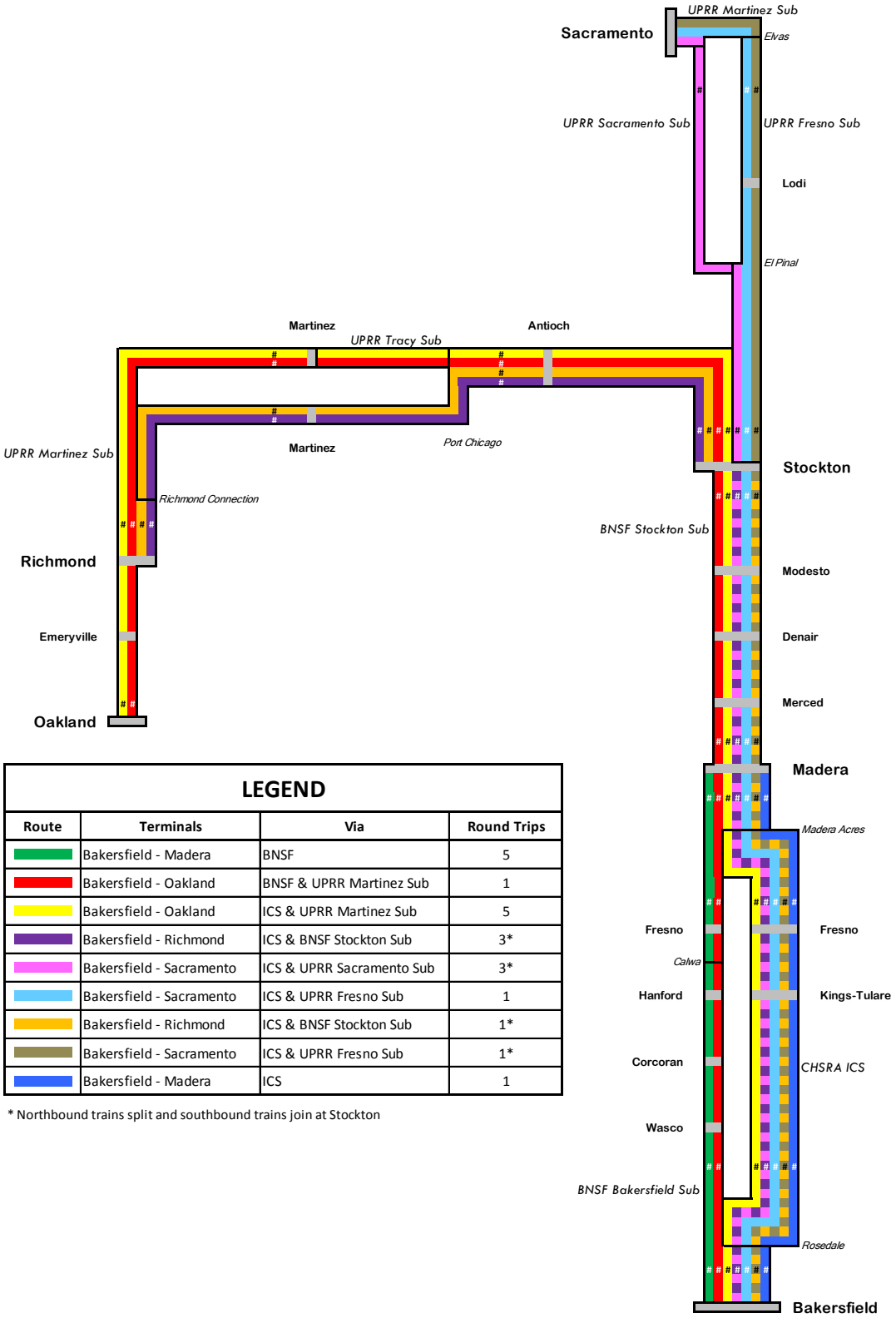


LEGEND

Route	Terminals	Via	Round Trips
	Bakersfield - Madera	BNSF	5
	Bakersfield - Oakland	BNSF & UPRR Martinez Sub	1
	Bakersfield - Oakland	ICS & UPRR Martinez Sub	5
	Bakersfield - Richmond	ICS & BNSF Stockton Sub	3
	Bakersfield - Sacramento	ICS & UPRR Fresno Sub	1
	Bakersfield - Richmond	ICS & BNSF Stockton Sub	1*
	Bakersfield - Sacramento	ICS & UPRR Fresno Sub	1*
	Bakersfield - Madera	ICS	1

* Northbound trains split and southbound trains join at Stockton

Exhibit 4.7: Scenario D Service



LEGEND

Route	Terminals	Via	Round Trips
	Bakersfield - Madera	BNSF	5
	Bakersfield - Oakland	BNSF & UPRR Martinez Sub	1
	Bakersfield - Oakland	ICS & UPRR Martinez Sub	5
	Bakersfield - Richmond	ICS & BNSF Stockton Sub	3*
	Bakersfield - Sacramento	ICS & UPRR Sacramento Sub	3*
	Bakersfield - Sacramento	ICS & UPRR Fresno Sub	1
	Bakersfield - Richmond	ICS & BNSF Stockton Sub	1*
	Bakersfield - Sacramento	ICS & UPRR Fresno Sub	1*
	Bakersfield - Madera	ICS	1

* Northbound trains split and southbound trains join at Stockton

A new connection between the existing BNSF line and the first construction section of the IOS of the HSR tracks will be required in the vicinity of Madera Acres and Rosedale. These connections would likely require new right-of-way to accommodate the transition between lines. This new parallel route alignment decreases the level of potential impact to the existing BNSF freight operations in this area. The existing single track on the BNSF line between Rosedale and Jastro will need to be double-tracked to provide a continuous double track between Madera and Bakersfield alignment. To increase service between Stockton and Sacramento new double track would be required the entire length of the UPRR Fresno Subdivision or upgrading and double tracking the Sacramento Subdivision. The UPRR Sacramento Subdivision will need to be upgraded to permit 70 mph to 79 mph passenger trains; extension of the Phillips siding to 10,000 feet would provide for a mid-corridor passing point suitable for accommodating long freight trains to permit train meets and overtakes. It is anticipated that some signal improvements would need to be installed. There is opposition to the use of the Sacramento Subdivision by stakeholders in Sacramento. The alignments used are for planning purposes, and do not indicate any future routing decisions.

For the 90 mph speed option along the length of the BNSF route, additional double track is required between Port Chicago and Pittsburgh, Riverbank and MP 1090.8; Ballico–Fluhr, through Madera, and between Gregg–Fresno, Corcoran–Allensworth, Sandrini–Elmo and Wasco–Una.

If the Madera–Bakersfield local shuttle trains operate at 79 mph MAS, the double track projects through Madera, and between Ballico–Fluhr, Gregg–Fresno, Corcoran–Allensworth, Sandrini–Elmo and Wasco–Shafter and related improvements are not required.

Signal system improvement requirements vary for the two target speeds of 79 mph and 90 mph.

4.3.5 San Joaquin Rail infrastructure Improvement Projects

A comprehensive list of projects compiled from the *San Joaquin Strategic Plan (2008)*, *Initial Study (2012)*, *BNSF San Joaquin Valley Capacity Analysis (2010)* and then vetted as part of the California State Rail Plan (CSRP) review process is contained in Table 4.1, which lists planned investments by timeframe for the San Joaquin route. The proposed projects have been grouped into the near-term (2013 to 2015), mid-term (2015 to 2018), and long-term (2018 to 2040) time frames. Near-term projects are allocated or programmed, Mid-term projects are necessary for the utilization of Scenario A, long-term projects are all other projects.

Because planning for the NCURS (as well as 2025 and 2040 *San Joaquin* route service once true HSR has started) is in the initial phases, all the capital projects necessary for integrated conventional intercity, HSR and commuter rail in northern California have not yet been identified. Therefore specific capital projects that would allow the implementation of all of the planning scenarios discussed above have not yet been included in Table 4.1. Because other analyses are on-going and additional scenarios and Build Alternatives may be developed, these lists are indicative of the improvement projects required and are not finalized.

However, BNSF has been working closely with Caltrans to identify and develop costs for the track projects that would be necessary to implement eight and 11 trains on the San Joaquin route at 79 mph and 90 mph. For the most part these projects are the projects that would be necessary for the scenarios studied for 2020 when San Joaquin trains are planned to run on the initial construction section of the IOS Scenarios A-D). BNSF developed the cost estimates for the eight train scenarios at 79 mph and 90 mph based on designed and engineered projects with CEQA clearance. The cost estimate for the 11 train projects are based on conceptual engineering for similar projects on the route.

In Table 4.1 under the column “Source Document,” the source of these projects is indicated as BNSF capacity analysis. These projects are not programmed nor have received allocations, but they are included as mid - term projects because they are necessary for the implementation of the use of the first

construction segment of the IOS in 2018. Projects not required for the "blended service" are defined as long-term projects. Some additional track projects would be necessary in 2018 that were not studied by the BNSF for the *San Joaquin* service improvements, including the Stockton Hub project. The Stockton Hub project is currently being studied by BNSF on behalf of ACE. Additional track work would likely be necessary between just north of Bakersfield (where some trains would move over to the IOS) and Bakersfield. On that short segment of BNSF track, between ten and 17 trains are planned to operate.

Table 4.1: San Joaquin Rail Infrastructure Improvement Projects

Project	Cost (Millions, Year 2012 dollars)	Source(s)
Joint Use Projects		
Near Term (2013 to 2015)		
-	-	-
Non-Joint Use Projects		
Near-Term (2013 to 2015)		
Positive Train Control (PTC) (Port Chicago to Bakersfield)	$24.50	Proposition 1A, *San Joaquin Strategic Plan (2008)*
Mid-route layover facility	$14.60	STIP, Proposition 1B (Intercity Rail Improvement)
Mid-Term (2016 to 2018)		
Merced to Le Grand second main track (segments 1)	$40.40	Proposition 1A, *San Joaquin Corridor Strategic Plan (2008),* Northern California Rail Partners Working Group; BNSF Capacity Analysis
Stockton to Escalon second main track (segments 3-4)	$54.00(1)	STIP, SJCOG RTP (financially-constrained) San Joaquin Corridor Strategic Plan (March 2008), Northern California Rail Partners Working Group; BNSF Capacity Analysis
Jastro to Una Segment 1	$42.00(1)	*San Joaquin Corridor Strategic Plan (2008)*, Northern California Rail Partners Working Group; BNSF Capacity Analysis
Port Chicago to Oakley second main track	$55.00(1)	STIP, TCRP, Proposition 1B (Intercity Rail Improvement), *San Joaquin Corridor Strategic Plan (2008)*, Northern California Rail Partners Working Group; BNSF Capacity Analysis
Una – Shafter (Segment 2)	$22.00	*San Joaquin Corridor Strategic Plan (2008)*, Northern California Rail Partners Working Group; BNSF Capacity Analysis
Stockton Hub Track Upgrades/Related Facilities	$100.00(1)	Northern California Rail Partners Working Group
Long-Term (2018 to 2040)		
New Sacramento 65th Street Station	NA	Sacramento Regional Transit District (RT)
New Elk Grove Station	$8.50(3)	SACOG RTP (financially-constrained)

Project	**Cost (Millions, Year 2012 dollars)**	**Source(s)**
Port Chicago to Pittsburg transfer modifications (BNSF Railway (BNSF)/Union Pacific Railroad (UPRR) track connection)	$18.00	*Amtrak: California Passenger Rail System: 20-Year Improvement Plan Technical Report (2001)*
Merced to Le Grand second main track (segments 2-3)	$24.1	Proposition 1A, *San Joaquin Corridor Strategic Plan (2008),* Northern California Rail Partners Working Group
Stockton to Escalon second main track (segments 1-2)	$36.00	STIP, SJCOG RTP (financially-constrained) San Joaquin Corridor Strategic Plan (March 2008), Northern California Rail Partners Working Group
Bixler Curve Realignment	$18.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Extension of Orwood siding	$20.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Lodi to Akers second main track	$50.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Planada to Madera second main track and curve realignments	$190.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Extension of Pittsburg siding	NA	*San Joaquin Corridor Strategic Plan (2008)*
Corridor-Wide Signal Upgrades (90 miles per hour (mph)	$55.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Holt to Stockton second main track	$75.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Modesto curve realignment and Riverbank to Dry Creek Bridge second main track	$60.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Merced River Curve Realignment	$13.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Winton to Merced second main track	$52.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Fresno grade crossing improvements (eight locations), diamond crossing replacement (Sunmaid and Calwa), and second main track (Fig Garden to San Joaquin River)	$46.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Gregg Double track	$24.3	*San Joaquin Corridor Strategic Plan (2008); BNSF Capacity Analysis*
Fig Garden Double track	$27.0	*San Joaquin Corridor Strategic Plan (2008); BNSF Capacity Analysis*
New Hammond siding (mile post (MP) 999.4)	$3.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Conejo to Hanford curve realignments, West Conejo to West Shirley track Improvements, and Hanford diamond crossing replacement	$90.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Corcoran to Angiola second main track	$63.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001); BNSF Capacity Analysis*
Ballico to Denair Second Main Track	$36.00	*Amtrak 20-Year Plan (2001)*
Bowles to West Conejo passenger-only second main track	$52.00	*Amtrak 20-Year Plan (2001)*
Allensworth - Corcoran	$130.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Wasco to Shafter second main track	$70.00	*Amtrak 20-Year Plan (2001)*

Project	Cost (Millions, Year 2012 dollars)	Source(s)
Jastro Curve Realignment	$50.00	*San Joaquin Corridor Strategic Plan (2008)*, *Amtrak 20-Year Plan (2001)*
Gregg – Madera Double track (11 trains at 90 mph)	$40.00	*BNSF Capacity Analysis*
Oakley – Port Chicago Double track (11 trains at 90 mph)	$37.6	*BNSF Capacity Analysis*
Elmo – Sandrino Double Track (11 trains at 90 mph)	$45.0	*BNSF Capacity Analysis*

Sources: *California Passenger Rail System: 20-Year Improvement Plan Technical Report* (Amtrak, 2001); BNSF Line Capacity Simulation Study January 2011 (presentation) and the Authority Integrated Northern California Project List, October 2012.

Notes:

- "NA" indicates not available or not applicable.
- (1) Original project cost from source of document assumes 2013 dollars. Cost escalation between 2012 and 2013 is assumed to be negligible, and no adjustments were made for costs provided in 2013 dollars.
- (2) Some elements of the project scope may be duplicated by other projects listed here.
- (3) Original project cost from source document is a year-of-expenditure (YOE) cost estimate, and may include contingency or other assumptions. As a result, no cost escalation or other adjustments were made for YOE costs.

The planning-level project cost estimates for many of the identified improvement projects were developed in the Amtrak *California Passenger Rail System: 20-Year Improvement Plan Technical Report (20-Year Plan,* March 2001) and from other sources consulted in developing the list of proposed improvements. A systematic review of the projects indicated that these cost estimates were generally reasonable and acceptable for planning purposes, and contained sufficient detail to permit their use in the SDP. However, many of the cost estimates were developed in previous years and are no longer current. As a result, a cost escalation factor was applied to bring these specific estimates to Year 2012 dollars. New cost estimates were developed for project cost estimates that did not appear reasonable based on the information available regarding project scope.

Projects that may be undertaken separately by the Authority for the first construction section of the IOS required to ensure independent utility are not listed as these projects are not the responsibility of Caltrans for implementation. These projects include the first construction section of the IOS, track connections, between the first construction section of the IOS and the BNSF in the vicinity of Madera and just north of Bakersfield near Rosedale, and track signals and crossovers on the first construction section of the IOS. These projects would be common to all Build Alternatives.

Other projects required for NCURS being undertaken by ACE and *Capitol Corridor* also are not listed as these projects are not the responsibility of Caltrans for implementation. On-going studies by the Authority and others may result in additional projects being developed.

4.3.6 No-Build Alternative Project List

The No-Build Alternative represents the base case for all comparisons. Because the No-Build Alternative project costs affect all Build Alternatives exactly the same way, the incremental cost approach was utilized for evaluation of alternatives. The No-Build Alternative in a comparative analysis is a "zero" cost alternative for evaluation purposes and all the Build Alternatives are measured as the incremental cost of building the infrastructure necessary to support the service improvements described. However, Table 4.2 highlights the actual estimated cost of the No-Build Alternative.

Table 4.2: Capital Projects Needed for Improving Existing Service

ID No.	Project	Cost (Millions, Year 2012 Dollars)	Common No-Build Alternative			
			Scenario A	Scenario B	Scenario C	Scenario D
SJ-1	Positive Train Control (Port Chicago to Bakersfield)	$24.50	♦	♦	♦	♦
SJ-2	Mid-route layover facility	$14.60	♦	♦	♦	♦
	TOTAL Estimated Cost	*$39.10*	*$39.10*	*$39.10*	*$39.10*	*$39.10*

Note:

- The ♦ symbol in indicates that the projects are common to all the Build Alternatives and would have the same costs added to the incremental costs of each Build Alternative.

4.3.7 Build Alternative Project Lists

Caltrans DOR and BNSF reviewed the *San Joaquin* rail infrastructure improvement projects listed in Table 4.1 and determined that many of the projects are not necessary to implement improved service in 2018 based on the previous studies. The prior studies suggested service levels of eight and 11 round-trip trains along the entire length of the BNSF route segment south of Stockton. The findings presented by the BNSF capacity analysis discussed in Chapter 9 provided BNSF's determination of the necessary capital projects for the alternatives studied in the Capacity analysis. In tandem with the conceptual engineering discussed in Chapter 11, this information was used to define those projects necessary to support the levels of service and speed options studied previously. Table 4.3 shows the projects and estimated costs for 79 mph and 90 mph MAS options with eight and 11 trains operating over the BNSF segments of the existing route. Project costs differ from prior studies due to project refinement.

Table 4.3: Capital Projects Needed for Improved Service Levels

ID No.	Improvement Project	Miles	Estimated Capital Costs ($millions)			
			79 mph MAS		90 mph MAS	
			8 trains	11 trains	8 trains	11 trains
SJ-23	Gregg Double Track	5.0	$23.4	$23.4	$23.4	$23.4
SJ-3	Merced-LeGrand Segment I	8.4	$40.4	$40.4	$40.4	$40.4
SJ-4	Stockton-Escalon Segment 3 & 4	9.5	$54.0	$54.0	$54.0	$54.0
SJ-8	Oakley-Port Chicago Segment 2	3.1	$55.0	$55.0	$55.0	$55.0
SJ-6	Jastro to Una Segment 1	7.0		$42.0	$42.0	$42.0
SJ-3	Merced-LeGrand Segment 2	6.2		$24.4	$24.4	$24.4
SJ-4	Stockton-Escalon Segment 2	7.7		$22.0	$22.0	$22.0
SJ-6	Una to Shafter Segment 2	3.5		$22.0		0

ID No.	Improvement Project	Miles	Estimated Capital Costs ($millions)			
			79 mph MAS		90 mph MAS	
			8 trains	11 trains	8 trains	11 trains
SJ-28	Angiola to Corcoran Double track	22.4		$63.0		0
SJ-24	Fig Garden Double track	4.5		$27.0		$27.0
SJ-23	Gregg to Madera Double track	6.6		$40.0		$40.0
SJ-8	Oakley-Port Chicago Segment 1 & 4	3.5		$37.6		$37.6
SJ-32	Shafter to Wasco Double Track	11.5				$70.0
SJ-31	Elmo to Sandrino Double track	7.5				$45.0
SJ-31	Allensworth to Corcoran Double track	22.4				$130.0
SJ-28	Fluhr to Ballico Double track	10.8			.	$65.0
Total estimated costs			*$172.8*	*$450.8*	*$261.2*	*$697.80*

Source: Caltrans, BNSF

However, as a consequence of operating some *San Joaquin* trains over the first construction section of the IOS and limiting the number of trains operating over the existing BNSF route between Madera and Rosedale north of Bakersfield to six daily trains (existing service), several infrastructure projects can be postponed until future operating and service development plans are prepared by the Authority and other agencies to account for the start of HSR service in 2022. All trains operating on the first construction section of the IOS would operate up to 125 mph MAS. Trains operating on the UPRR and BNSF segments of the existing route would operate up to either 79 mph or 90 mph MAS. The projects that can be postponed on account of the first construction section of the IOS include:

- Gregg Double Track
- Angiola to Corcoran Double Track
- Fig Garden Double Track
- Shafter to Wasco Double Track
- Elmo to Sandrini Double Track
- Allensworth to Corcoran Double Track

Using logic, reasoning, and engineering judgment the projects necessary to support the 79 mph and 90 mph MAS blended service operating scenarios in the Build Alternatives described in Section 4.3 are shown in Tables 4.4 and 4.5. Project locations for all the projects listed in Table 4.1, 4.4 and 4.5 are shown in Exhibit 4.8 through 4.9 to provide a general understanding of geographic position.

Table 4.4: Capital Projects Needed for Blended Service (79 mph)

ID No.	Project	Build Alternatives ($millions)			
		Scenario A	Scenario B	Scenario C	Scenario D
SJ-7	Stockton Hub Track Upgrades/Related Facilities	0	0	100.0	100.0
SJ-9	Merced to Le Grand second main track (Segment 1)	$40.4	$40.4	$40.4	$40.4
SJ-8	Stockton to Escalon second main track (Segments 3 & 4)	54.0	54.0	54.0	54.0

ID No.	Project	Build Alternatives ($millions)			
		Scenario A	Scenario B	Scenario C	Scenario D
SJ-11	Jastro to Una (Segment 1)	42.0	42.0	42.0	42.0
SJ-2	Port Chicago to Oakley Segment 2	55.0	55.0	55.0	55.0
SJ-3	Port Chicago to Oakley (Segments 1 & 4)	0	0	37.6	37.6
SJ-10	Una - Shafter (Segment 2)	22.0	22.0	22.0	22.0
SJ-5	New Elk Grove Station	0	0	0	8.5
SJ-6	Double track UPRR Sacramento Subdivision (ex-WP) between Stockton and Sacramento	0	0	0	1,219.6
SJ-1	Extend BNSF to Richmond	0	0	35.0	35.0
SJ-4	Sacramento 65th Street Station	0	0	NA	NA
TOTAL ESTIMATED PROBABLE COST (79 mph)		*$213.4*	*$213.4*	*$386.0*	$1,614.1

Source: AECOM, Caltrans DOR, BNSF, and Northern California Rail Working Group

Table 4.5: Capital Projects Needed for Blended Service (90 mph)

ID No.	Project	Build Alternatives ($millions)			
		Scenario A	Scenario B	Scenario C	Scenario D
SJ-7	Stockton Hub Track Upgrades/Related Facilities	0	0	100.0	100.0
SJ-11	Merced to Le Grand second main track (Segment 1)	$40.4	$40.4	$40.4	$40.4
SJ-12	Merced to LeGrand (Segment 2)	24.4	24.4	24.4	24.4
SJ-8	Stockton to Escalon second main track (Segments 3 & 4)	54.0	54.0	54.0	54.0
SJ-9	Stockton to Escalon (Segment 2)	0	24.4	24.4	24.4
SJ-14	Jastro to Una second main track (Segment 1)	42.0	42.0	42.0	42.0
SJ-2	Port Chicago to Oakley Segment 2	55.0	55.0	55.0	55.0
SJ-3	Port Chicago to Oakley (Segments 1 & 4)	0	0	37.6	37.6
SJ-13	Una - Shafter – (Segment 2)	22.0	22.0	22.0	22.0
SJ-10	Fluhr to Ballico	0	0	65.0	65.0
SJ-5	New Elk Grove Station	0	0	0	8.5
SJ-6	Double track UPRR Sacramento Subdivision (ex-WP) between Stockton and Sacramento	0	0	0	1,219.6
SJ-1	Extend BNSF to Richmond	0	0	35.0	35.0
SJ-4	Sacramento 65th Street Station	0	0	NA	NA
TOTAL ESTIMATED PROBABLE COST (90 mph)		*$237.8*	*$262.2*	*$499.8*	*$1,727.9*

Source: AECOM, Caltrans DOR, BNSF, and Northern California Rail Working Group

Exhibit 4.8: San Joaquin Corridor Capital Projects Blended Service (Scenarios at 79 mph)

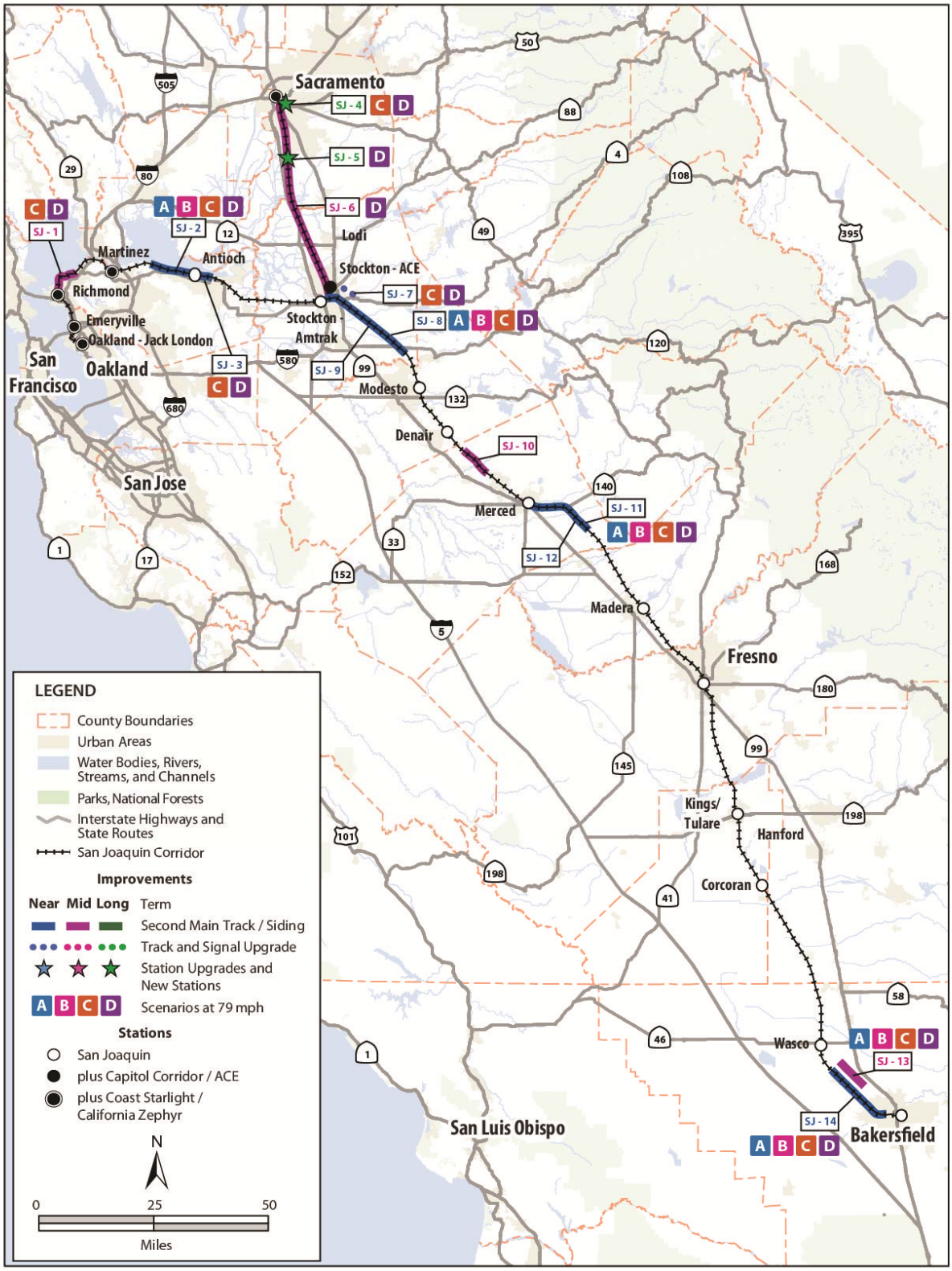
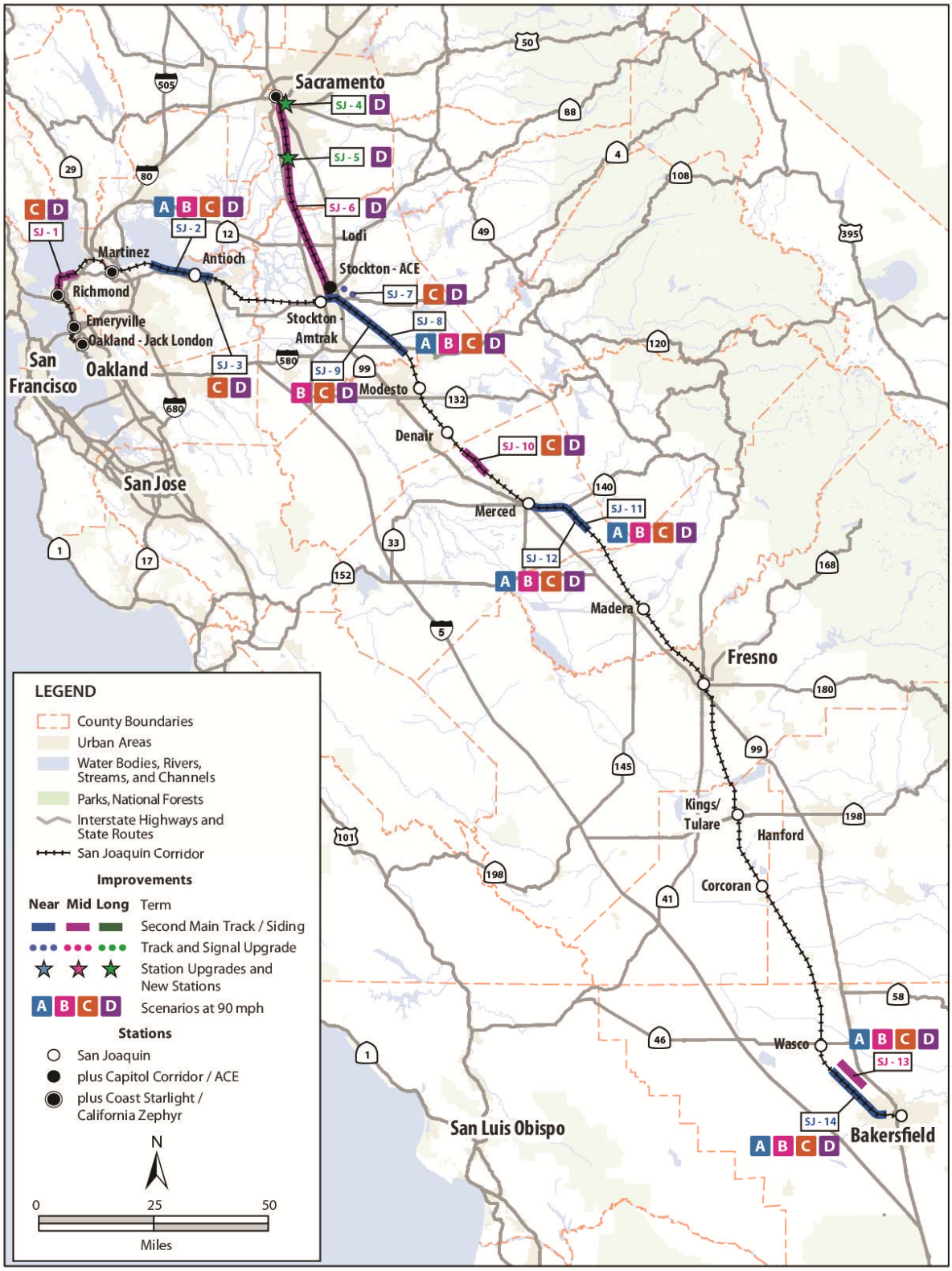


Exhibit 4.9: San Joaquin Corridor Capital Projects Blended Service (Scenarios at 90 mph)



4.3.8 Bus System Modifications Needed to Support Blended Service

Modifications to the existing bus system within the San Joaquin Corridor would be necessary as part of the proposed Project, including possible modifications to existing bus routes and development of additional bus routes. Modifications to the bus system may also occur as part of facilities expansion. Expanding the capacity of the current bus system would increase capacity and thus increase the amount of ridership for the overall Amtrak system. Expanding the capacity of the current bus system does not involve direct acquisition of new buses, because the feeder bus service is contracted; the State does not own or operate the buses.

Thus, expansion of the Amtrak bus feeder system simply requires modifications of contracts with the bus service providers in response to future demand throughout the extended San Joaquin Corridor service area.

Potential facility improvements to the bus system within the San Joaquin Corridor may include the following elements:

- Bus drop off/loading areas.
- Bus layover facilities.
- Additional bus transfer centers.
- Bus pullout areas.

Potential route improvements to the bus system within the San Joaquin Corridor may include the following:

- Minor reroutes of existing lines.
- Additional routes to service increased passengers of proposed secondary (bus feeder) segments.
- Additional bus stops.
- Decreased connection times.
- More service added to account for increased train frequencies, especially connections in Bakersfield, Stockton and new connections in Madera.

5.0 Evaluation of Alternatives

The No-Build Alternative and Build Alternatives were evaluated to determine the reasonableness and feasibility of the alternatives, in order to identify those alternatives that will be carried forward into further analysis. The criteria assess how well each alternative meets the following:

- The purpose and need for the action.
- Technical feasibility (ROW and engineering constraints).
- Economic feasibility (market potential and/or ridership, capital, and operating costs).
- Environmental concerns.

5.1 Evaluation Criteria

The following criteria assess how each alternative meets the San Joaquin Corridor purpose and need, considering factors relating to the passenger's experience in using rail services, such as travel times, station locations and availability of connections, and service reliability and frequency. Evaluation of the Build Alternatives will be conducted using logic and reasoning to determine which alternatives have the highest probability of satisfying the purpose and need within the SDP time frame of service initiation in 2018. Only those projects that can be built for start of improved *San Joaquin* service in 2018 utilizing the first construction section of the IOS will be considered for advancement to more detailed technical studies. Projects that can be implemented between 2018 and 2022 are not being advanced because of the uncertainty of future service levels being planned by the Authority and other regional rail agencies.

Travel Time

The No-Build Alternative is represented by the existing *San Joaquin* service, which is currently scheduled to take approximately 6 hours, 10 minutes running southbound between Oakland and Bakersfield and approximately 5 hours, 20 minutes running southbound between Sacramento and Bakersfield. The No-Build Alternative does not satisfy the purpose and need of improving travel time in the Corridor.

The Build Alternatives would operate both over the existing BNSF route (local shuttle train service between Madera and Bakersfield) as well as over the first construction section of the IOS between Madera and Rosedale, which is about eight miles northwest of Bakersfield. The Build Alternatives and operating scenarios are described in more detail in Chapter 4.

The most significant trip time savings is achieved by operating trains up to 125 mph MAS on the first construction section of the IOS between Madera and north of Bakersfield. The estimated trip time from Oakland to Bakersfield is reduced to approximately 5 hours, 30 minutes, a savings of about 40 minutes over existing schedules.[(xiv)] All the Build Alternatives achieve travel time savings by reducing trip time.

The BNSF performed capacity simulations that reflected a 90 mph MAS operating over the existing BNSF tracks between Port Chicago and Bakersfield. Average speed of the service increased from 55 mph with station stops to just a little over 60 mph. There would be a travel time savings of about ten minutes on the BNSF portion of the route north of Madera.

The increase in the number of trains operating on the BNSF between Rosedale and Bakersfield may require additional track capacity, including a possible third track. This is the subject of on-going analyses by the Authority in cooperation with BNSF. Upgrading the existing BNSF line between Madera and north of Bakersfield is inconsistent with the NCUS plan and Authority *2012 Business Plan* to blend services utilizing the parallel first construction section of the IOS. The Build Alternatives have three to five local shuttle trains operating between Madera and Bakersfield plus one through Oakland – Bakersfield train,

which is either fewer or the same number of trains as the existing service. Consequently no additional track improvements are needed in this section of the BNSF for service initiation in 2018.

As it is unknown whether funding will be available to develop all of the infrastructure along the BNSF to provide for 90 mph MAS and/or acquire enough locomotives to operate over the first construction section of the IOS at 125 mph, ridership studies will be performed to identify the benefits of additional investments over conventional locomotives operating at MAS 79 mph on the BNSF and 110 mph on the first construction section of the IOS.

Station Location

All of the existing stations are located within existing communities, and most are near the center of town and the Central Business District (CBD). This part of California was primarily settled as the railroads were built in the Central Valley and the towns usually grew up around the train stations. Stations located adjacent to the CBD are also located near the densest concentrations of jobs and housing, and are convenient to major destinations.

Compared to the No-Build Alternative, the Build Alternatives would provide a new *San Joaquin* station at the proposed site of the Fresno HSR station stop along the UPRR as well as a potential stop in the vicinity of the proposed Kings/Tulare HSR stop near the Hanford Amtrak station.[(xv)] Ridership studies by the Authority will inform the decision to provide a Kings/Tulare stop along the "express" line using the HSR first construction section of the IOS. Express trains would by-pass Hanford, Corcoran, and Wasco. However, the existing stations in Hanford, Corcoran, and Wasco would continue to be served by up to six daily local shuttle trains operating between Madera and Bakersfield.

An improved Madera Station could be moved to a new or expanded location for a rail to rail connection between future HSR and *San Joaquin* trains and Thruway buses. This is the subject of future study by the Authority and other regional rail agencies.

The Authority is proposing to build a temporary platform for *San Joaquin* express trains in Fresno located near the future site of the HSR station across from the historic Southern Pacific Depot. A potential Kings/Tulare HSR Station would be located east of SR 43 (Avenue 8) and north of the Cross Valley Rail Line (San Joaquin Valley Railroad) in accordance with plans being developed by the Authority as documented in the project level Fresno–Bakersfield EIR/EIS.

An improved station in Stockton has been proposed as part of the Integrated Northern California "Blended Service" Program but would be developed subsequent to initiation of blended services in 2018. Capacity and operational studies are presently underway to evaluate the need for a revised Stockton station as well as other potential improvements to the "Stockton Diamond" where the BNSF and UPRR lines cross at grade.

The San Joaquin Corridor station locations are identified in Exhibit 1.1.

Connections

Compared to the No-Build Alternative, the Build Alternative would provide improved intermodal connections and accessibility due to increased train frequencies as well as more closely coordinated service between the San Joaquin Corridor, *Capitol Corridor* and Altamont Corridor Express (ACE), and local transit agencies.

In Stockton, connections to San Jose could be made with ACE trains, Thruway buses and the local transit agency. Trains operating through to Oakland/Richmond also provide a connection to the *Capitol Corridor*, providing rail service between the Central Coast, the East Bay and the Sacramento Valley. Connections to San Francisco Bay Area Rapid Transit and the San Francisco International Airport (SFO) (via BART) can be made at Richmond.

Amtrak Thruway buses serve many stations throughout California. For the *San Joaquin* service Thruway buses connect to trains principally at Bakersfield, Emeryville, Oakland, Sacramento, and Stockton. It is through the combined use of Amtrak Thruway buses and trains that the *San Joaquin* service reaches north to Redding, east to Reno and Las Vegas, Nevada; south to Indio; and coastal communities from Arcata to San Diego. Scheduled bus service connections at Bakersfield provide opportunities to connect with Metrolink and *Pacific Surfliner* service serving the Los Angeles basin and Southern California. Other Thruway buses at Bakersfield serve the Inland Empire region of Southern California. Potential bus connections between the proposed Coast Daylight Corridor and the San Joaquin Corridor would allow passengers to make faster rail/bus trips between the Salinas Valley and the San Joaquin Valley. These connections could include additional service on the bus route between Paso Robles and Hanford via SR-46 and SR-41, and a bus new route between Gilroy and Merced via SR-152 and SR-59.

An improved Madera Station could be moved to a new or expanded location for a rail to rail connection between future HSR and *San Joaquin* trains and Thruway buses. This is the subject of future study by the Authority and other regional rail agencies.

Reliability

There is no significant change in service reliability under the No-Build Alternative. However, service is likely to deteriorate as freight train frequencies increase causing service disruptions due to congestion. Under the Build Alternatives, passenger and freight rail operations will improve. On-time performance of passenger trains is estimated to be 90 percent. Use of the HSR IOS alleviates potential rail traffic congestion on the BNSF allowing freight trains to operate more reliably, as well.

Frequency

There are no frequency increases in the No-Build Alternative. Under the Build Alternatives, intercity passenger train frequencies would substantially increase from six daily round-trip trains up to 17 on some segments of the San Joaquin routes, especially between Madera and Bakersfield because of the potential use of the new HSR infrastructure. Between Madera and Bakersfield, the *San Joaquin* would operate up to five “shuttle” trains in addition to one through train from Oakland to Bakersfield providing local service to the Hanford, Corcoran and Wasco stations along the BNSF route connecting to other through trains at Madera and Thruway buses at Bakersfield. Up to 11 trains would operate on the HSR first construction section of the IOS.

Two distinct primary operating plans are evaluated in this SDP: A “*conservative*” scenario which would increase the number of trains operating along the trunk between Madera and Bakersfield from six to eight daily round-trips as well as an “*optimistic*” scenario in which the number of trains along this portion of the route would increase to 11 daily round-trips. The *conservative* scenario would utilize agreed to passenger “slots” already negotiated with the freight railroads (in conjunction with corollary track and signaling improvements) whereas the *optimistic* scenario would add more trains along the BNSF portions of the route without increasing passenger traffic along the UPRR Martinez Subdivision between Martinez and Oakland or between Stockton and Sacramento.

The *conservative* scenario was evaluated with either three or six daily round-trips continuing to provide local service between Madera and Bakersfield stopping at the existing Amtrak stations of Hanford, Corcoran and Wasco in addition to the “express” trains operating over the HSR first construction section of the IOS. Between Madera and Bakersfield, the *San Joaquin* would operate up to five “shuttle” trains in addition to one through train from Oakland to Bakersfield.

The *optimistic* scenario included an option to operate more trains to Sacramento by utilizing the Sacramento Subdivision (former WP route) between Stockton and Sacramento as well as an option that would rely upon expanded bus service between Sacramento and Stockton without increasing the number of trains. The use of the UPRR Sacramento Subdivision for increased service between Stockton and

Sacramento is opposed by many Northern California stakeholders. Planning by the Authority and other regional rail agencies will investigate improvements to the UPRR Fresno Subdivision. In addition, the optimistic scenario includes extending service from Port Chicago to Richmond on the BNSF via Franklin Canyon.

However, these optimistic scenarios are not likely to be constructed in time for the 2018 start of blended service and consequently Build Alternatives C and D will not be advanced to more detailed technical analysis in this SDP. However, these scenarios will continue to be evaluated as part of the *Initial Study (2012)*.

Ridership

The prior ridership forecast for the *San Joaquin* service was reported in the *San Joaquin Strategic Plan (2008)* which forecast 1.3 million passengers in 2017. Updated ridership forecasts are included in the California SRP currently in preparation and can be found in Chapter 8.

The 2008 forecast did not anticipate or account for the significant passenger rail improvements now envisioned in the *2012 Business Plan*. The *2012 Business Plan* calls for NCURS providing higher frequencies and faster running times between the San Francisco and Los Angeles markets via the San Joaquin Valley, as early as 2018. As early as 2022, the San Joaquin Valley service operating along the HSR route will be upgraded to electrified HSR providing even higher frequencies and faster running times. As a result, ridership patterns would reflect both the shifting of some longer-distance trips to the HSR line as well as the potential for increased “feeder service” traffic between the HSR stations and existing *San Joaquin* route which would interface with the northern interim terminus of the HSR system at Madera as well as continue to provide some local service to stations to the south.

This potential decrease in end-to-end *San Joaquin* riders are offset by increased ridership on the integrated services provided by regional rail services, because expanded routes, increased frequencies and faster service will make the rail mode more attractive. For example, the NCURS will reduce rail running times in the Central Valley, which will make rail/bus/rail trips between the San Francisco Bay Area and San Joaquin Valley communities faster and more attractive via the San Joaquin Corridor. The connecting rail ACE service between San Jose and Stockton would make rail trips between the San Jose area and the northern San Joaquin Valley more attractive. All the Build Alternatives increase ridership over the No-Build Alternative.

5.2 Technical Feasibility

The following criteria assess the technical feasibility of each alternative, identifying ROW requirements and possible disruptions to railroad operations, state highways, or adjacent property for each alternative. Technical feasibility also includes the timing and constructability of projects prior to service initiation in 2018. Projects not likely to be completed for start of service in 2018 would render a Build Alternative untenable and incapable of being advanced. These projects would be deferred for further detailed technical analysis in future service planning studies by the Authority and other regional rail agencies.

5.2.1 ROW Requirements

The width of railroad right-of-way varies throughout the San Joaquin Corridor. Along most of the alignment, the existing right-of-way is sufficient for completion of the proposed track improvements, with a distance of 15 to 20 feet between track centers. Therefore, no additional ROW would be required for any of the Build Alternatives utilizing existing sections of route segments.

Right-of-way will need to be acquired in the Central Valley between Merced and Bakersfield to construct the first construction section of the IOS. The Authority is responsible for acquiring ROW and constructing

the new infrastructure, track and related systems to allow *San Joaquin* trains to operate between 2018 and until 2022 when the line is electrified and HSR trains commence service.

Conceptual engineering for the IOS project includes layouts for new stations at Fresno and King/Tulare. The Fresno station would be located in Downtown Fresno on vacant UPRR property across from the historic Southern Pacific Depot. The station is outside the operating freight railroad ROW. For implementation of the *San Joaquin* express service, the Authority would construct temporary platforms and shelters similar to commuter or regional rail services. Improvements to the Madera Station may require the purchase of additional right-of-way. However, the purchase of this land is being undertaken by the Authority and is not part of this SDP.

The potential Kings/Tulare HSR Station would be located east of SR-43 (Avenue 8) and north of the Cross Valley Rail Line (San Joaquin Valley Railroad). The entire site would be approximately 27 acres, including eight acres designated for the station, bus transit center, short-term parking, and kiss-and-ride. An additional approximately 19 acres would support a surface parking lot with an estimated 1,600 spaces. The Authority has not yet made a final determination of whether this regional station would be constructed as part of the Initial Operating Segment.

In summary, ROW requirements for all the Build Alternatives within the UPRR and BNSF alignments are minimal relative to the length of the corridor and will not displace residential uses.

The first construction section of the IOS will have considerable impact on land-use. The Authority has prepared an EIR/EIS that includes environmental clearance of the proposed HSR alignment and stations in Fresno and Kings/Tulare. The Authority is undertaking the acquisition of all right-of-way and land necessary to support the first construction section of the IOS subject to future operations modeling analyses which will not be completed prior to the finalization of the SDP.

5.2.2 Disruption to Railroads, Highways or Adjacent Property

In a letter to Caltrans dated March 4, 2010, UPRR indicated that in order to accommodate any additional intercity passenger trains along its track segments from Port Chicago to Oakland and Sacramento to Stockton, one additional track would be required on each of the specified segments. It appears feasible to construct the double track and triple track improvements within the existing UPRR ROW between Port Chicago and Oakland identified in the March 4, 2010 letter. These costs could be avoided by obtaining permission to reroute trains from the UPRR to other routes.

However, to avoid construction of the additional double- and triple-track sections in the UPRR Port Chicago to Oakland segment of the *San Joaquin* route, proposals have been made to extend the San Joaquin Corridor from Port Chicago to Richmond over the BNSF via Franklin Canyon where trains can connect to the *Capitol Corridor* and BART.[(xvi)] It also appears feasible to construct the double track improvements within the existing BNSF ROW between Port Chicago and Bakersfield and between Port Chicago and Richmond identified in BNSFs most recent list of recommended improvements contained in the *BNSF San Joaquin Valley Capacity Analysis* dated October 8, 2010. However, there is very little likelihood that the improvements needed to operate trains between Port Chicago and Richmond over the BNSF route through Franklin Canyon can be environmentally cleared and constructed in time for service initiation in 2018.

Due to an Agreement with UPRR, the added train frequencies between Sacramento and Stockton could be shifted from the UPRR Fresno Subdivision to the Sacramento Subdivision (formerly Western Pacific). However, Sacramento Regional Transit, Sacramento Area Council of Governments, the City of Sacramento, the Central Valley Rail Working Group (a working group comprised of 20 major local and regional agencies between Sacramento and Merced), and other stakeholders have expressed opposition to routing passenger trains over the UPRR Sacramento Subdivision. In addition infrastructure improvements necessary to upgrade and improve the Sacramento Subdivision are not likely to be

approved or constructed by the 2018 start of blended service. It is not likely that the improvements needed to increase service beyond Port Chicago to Oakland and north of Stockton to Sacramento can be completed in time for service start-up in 2018. Consequently, those improvement projects are being deferred until future planning studies by the Authority and other regional rail agencies are completed. Consequently, Build Alternatives C and D are not being advanced to further detailed analysis.

There are no disruptions to the existing or planned highway network by any of the Build Alternatives for the expanded *San Joaquin* service other than those being mitigated by the Authority for the first construction section of the IOS.

There are no additional requirements for adjacent land acquisition by any of the Build Alternatives for the expanded *San Joaquin* service other than those adjacent parcels being by planned for acquisition by the Authority for the first construction section of the IOS or Madera Station expansion and improvements.

5.3 Economic Feasibility

Intercity passenger rail funding is primarily provided by state sources, but also includes federal, local and private funding sources. The CSRP currently being prepared suggests that funding for many of the conventional intercity passenger rail programs is mostly exhausted and additional funding has not been identified for any of the Build Alternatives and projects listed in the SDP not already funded by the California Transportation Commission. Consequently, criteria that identify capital and operating costs are used as a proxy for the economic feasibility of each alternative. Projects that are extremely costly are deemed untenable because of the uncertainty of funding allocations.

The capital cost estimates from prior studies have limited utility for evaluating the alternatives because they are now out of date. Caltrans DOR and BNSF have acknowledged that the information presented in this SDP is regenerated from the previous studies. However, Caltrans DOR and BNSF have developed new capital cost information to determine that proposed projects are necessary and sufficient to provide the additional rail capacity required to allow operation of the projected rail service levels. The project estimates were updated based on generally accepted inflationary factors and revised project descriptions. It is therefore possible to make some general order of magnitude observations about the relative cost of different types of improvement projects:

- Siding extensions: $10-20 million per mile, plus $5 million per new switch.
- New stations: $5-10 million each.
- Curve realignments: $20-150 million for each five to ten mile segment.
- Second main track: $15-40 million per mile, depending on topography.

Table 5.1 shows the indicative estimates of probable cost for the Build Alternatives and 79 and 90 mph MAS options based on the additional study by Caltrans DOR, BNSF, and others. (Table 4.4 and 4.5 shows the specific projects necessary for each Alternative.)

Table 5.1: Estimates of Probable Capital Costs (CAPEX)

Speed Option	Alternatives				
	No-Build	Build A	Build B	Build C	Build D
CAPEX 79 mph ($millions)	$39.1	$213.4	$213.4	$386.0	$1,614.1
CAPEX 90 mph ($millions)	NA	$237.8	$262.2	$499.8	$1,727.9

Source: Caltrans DOR, BNSF, and AECOM

These cost ranges indicate that increasing travel speeds to 90 mph MAS may be cost prohibitive when considering the incremental ridership and small trip time savings achieved as suggested in Chapter 8. Initial efforts should focus on improvements necessary to begin operating more passenger trains at

current operating speeds on the UPRR and BNSF route segments. Improved trip time savings will be achieved by operating *San Joaquin* express trains on the HSR first construction section of the IOS between Madera and Rosedale just north of Bakersfield, which is where the available federal American Recovery and Reinvestment Act (Stimulus) and Authority funding is being invested. Additional travel time reductions and/or additional trains can be achieved as funding becomes available for additional project improvements for the *San Joaquin* and HSR.

Build Alternatives C and D add substantial capital cost for building the infrastructure needed to increase the number of trains from eight to 11 and will not be advanced to more detailed analysis. The 90 mph MAS option for all the Build Alternatives also adds capital cost for all the Build Alternatives. The 90 mph speed option will not be advanced to more detailed technical analysis. Higher speed options for the San Joaquin can be studied by the Authority and regional rail agencies as part of service development planning for blended service beyond 2022.

5.3.1 Operating Expense (OPEX)

Operating costs were based on existing expenses on the San Joaquin service. They include train crew labor, operations and maintenance, maintenance of way and track access charges and allocated general administrative costs. These expenses do not anticipate any change in operating cost structure as a result of the implementation of the new Amtrak Section 209 pricing structure required under PRIIA that will be initiated in 2013-14. While San Joaquin expenses under Section 209 are not anticipated to increase substantially, some increases in expenses are possible. Incremental expenses associated with maintenance of way for the first construction section of the IOS and access charges for use of the HSR infrastructure have not yet been determined. The estimate of probable overall operating and maintenance expense is based on a rate of $57.94[xvii] per train-mile. The O&M cost rate of $80.76 per revenue-mile for the 90 mph option is based on estimated values for the higher speed option developed for the *Richmond–Hampton Roads Passenger Rail Project Tier 1 Final EIS*. The estimate of probable incremental daily operating and maintenance expenses of running additional trains for each of the Build Alternatives and speed option is shown in Table 5.2.

Table 5.2: Indicative Estimate of Probable Operating Cost (OPEX)

Annual Train Miles	Alternatives				
	No-Build	Build A	Build B	Build C	Build D
San Joaquin Service (mi.)	1,331,520	1,921,360	2,221,390	3,103,230	3,203,970
OPEX 79 mph	$77,161,584	$111,342,812	$128,729,551	$179,832,179	$185,670,062
OPEX 90 mph	$107,533,555	$155,169,034	$179,399,456	$250,616,855	$258,752,617

Notes:
- "NA" indicates not available or not applicable.

Build Alternatives A and B add approximately $35 - $55 million in expenses for operating 7 and 8 round trip trains while Build Alternatives C and D add substantial expenditures for operating and maintaining 11 trains. As it is unlikely the infrastructure improvements necessary to support the 11 train *optimistic* scenarios will be constructed for commencement of blended service in 2018, these alternatives will not be advanced to more detailed technical analysis in later chapters of the SDP. The 90 mph MAS option adds substantial operating expense to each of the Build Alternatives and will not be advanced to more detailed technical analysis. Higher speed options for the San Joaquin can be studied by the Authority and regional rail agencies as part service development planning for blended service beyond 2022.

Table 5.3 and Chapter 12 include more information on operating expenses, revenue and state operating costs.

5.3.2 Independent Utility

Build Alternatives A and B are usable and reasonable expenditures, even if no additional transportation improvements are made in the area. Double-tracking sections of the *San Joaquin* route along both the UPRR and BNSF route segments would benefit all trains operating in the corridor, both freight and passenger, improving their reliability and decreasing running time. The faster trip times achieved by operating *San Joaquin* express trains on the HSR tracks between Madera and Bakersfield will result in a 40-minute travel time savings over existing schedules and would retain utility even if the Authority does not complete the IOS or the entire 800-mile HSR network.

5.3.3 Phasing Potential

The program of projects for Build Alternatives A and B that facilitate service expansion on the *San Joaquin* will be timed for the completion of the first construction section of the IOS of the HSR project, which will be ready for train operation in 2018. Prioritization of individual projects within the program of project improvements has not been completed.

5.4 Environmental Resources and Quality

A Programmatic EIR for the San Joaquin Corridor is being undertaken to examine the environmental impacts including cumulative effects of the program of projects identified for the preferred service alternatives. Each individual element of the program of projects will require individual project level environmental study.

The following criteria assess major environmental concerns with respect to the improvements identified in the *San Joaquin* rail service improvement program.

5.4.1 Geologic Constraints

Some of the improvements defined above appear to have geologic constraints, such as fault crossings, coastal areas, and known areas of high landslide susceptibility.

5.4.2 Wetlands / Nature Preserves / Environmentally Sensitive Areas

Some of the improvements cross over the San Joaquin River and its branches and tributaries and other bodies of water. These improvements would require the following permits, certifications, agreements and plans:

- Section 404 permit from the United States Army Corps of Engineers (Corps).
- California Regional Water Quality Control Board (RWQCB) 401 Water Quality Certification.
- California Department of Fish and Game (CDFG) Streambed Alteration Agreement (1601 or 1603 Agreement).
- A construction storm water discharge permit – National Pollution Discharge Elimination System (NPDES) through filing a Notice of Intent (NOI) and compiling a Storm Water Pollution Prevention Plan (SWPPP) with the RWQCB.

It may also be necessary to obtain incidental take permits for listed protected species from the US Fish and Wildlife Service and CDFG. County Drainage Permits may be required from each county through which the proposed secondary segment would traverse for activities affecting watercourses and drainage facilities in unincorporated areas. A Flood Control Encroachment Permit may be required for any temporary or permanent encroachment on County Flood Control and Water Conservation District

properties or rights-of-way. High-level review of the other improvements indicates no other concerns in this category.

5.4.3 Cultural / Parks / Section 4(f) / Farmland or Agricultural Zones

The improvements are within the existing railroad ROW where this criterion is generally not applicable.

5.4.4 Sensitive Receivers

Adding more trains in each direction would add a cumulative noise source, but this would not be a significant impact given the number of trains currently operating and the ambient noise levels near sensitive receptors. High-level review indicates that the improvements defined above would not change visual/scenic resources, or affect built-up areas with institutional, medical, school and/or residential properties adjacent to the ROW.

5.5 Summary and Conclusions

Key performance indicators and evaluation criteria that address the project goals and objectives are compared and contrasted for each of the Build Alternatives and the No-Build Alternative. The summary matrix is found in Table 5.3.

The alternatives evaluation indicates that Build Alternative A, adding two more daily round-trip trains in each direction operating at current speeds, is the least costly alternative. Besides increasing the frequency of trains in the Corridor between Oakland/Sacramento and Bakersfield, the new express service will allow faster trips between the San Francisco Bay Area and the Central Valley via Thruway bus connections as outlined in the *2012 Business Plan*. Build Alternative A infrastructure improvements can be programmed and constructed before 2018 if funding becomes available.

The alternatives evaluation also indicates that ROW requirements for the Build Alternatives being advanced for more technical analysis are minimal, as are the expected impacts on railroads, state highways and adjacent properties. No significant environmental impacts are expected. Finally, there is good potential for phasing the Build Alternatives by incrementally making improvements to the corridor and operating express trains on the first construction section of the IOS. Opportunities for phasing new services are limited to incremental extensions of existing service, such as extending ACE from Sacramento to Stockton or from Stockton to Madera.

However, further examination is needed of the HSR program's potential impact on the number of riders forecast for the *San Joaquin* service and parallel competing future HSR services in the corridor for the planning years beyond 2022.

Table 5.3: Summary Evaluation Matrix

Evaluation Criteria	Alternatives				
	No-Build	Build A	Build B	Build C	Build D
Round-trips (by segment)	6	10	13	17	17
Oakland–Bakersfield (BNSF & UPRR Martinez Sub)	4	1	1	1	1
Oakland-Stockton	0	5	5	5	5
Richmond–Stockton	0	0	0	4	4
Sacramento–Stockton (UPRR)	2	2	2	2	2
Sacramento–Stockton (WP)	0	0	0	0	3
Stockton–Bakersfield (using first construction section of the IOS)	0	7	7	11	11

Evaluation Criteria	**Alternatives**				
	No-Build	**Build A**	**Build B**	**Build C**	**Build D**
Madera-Bakersfield (first construction section of the IOS)	0	6	6	10	10
Madera–Bakersfield (BNSF)	0	2	5	5	5
Train service miles	1,477,520	1,994,360	2,294,390	3,176,230	3,276,970
Travel savings (h:min) via IOS	0	0:40	0:40	0:40	0:40
2020 Ridership (79 mph)	1,388,000	2,060,000	2,160,000	2,470,000	2,640,000
Change from No-Build	NA	672,000	772,000	1,082,000	1,252,000
OPEX 90 mph ($thousands)	$107,533.6	$155,169.0	$179,399.4	$250,616.8	$258,752.6
OPEX 79 mph ($thousands)	$77,161.6	$111,342.8	$128,729.5	$179,832.2	$185,670.1
Revenue 79 mph($ thousands)	*$46,970.0*	*$76,400.0*	*$79,500.0*	*$90,900.0*	*$97,700.0*
Operating surplus (loss) ($thousands)	($30,191.6)	($34,942.8)	($49,229.5)	($88,932.2)	($87,970.1)
Subsidy per rider (79 mph option)	*($21.75)*	*($16.96)*	*($22.79)*	*($36.00)*	*($33.32)*
CAPEX 79 mph MAS ($millions)	$39.1	$213.4	$213.4	$386.0	$1,614.1
CAPEX 90 mph MAS($millions)	NA	$237.8	$262.2	$499.8	$1,727.9
Constructability	NA	Yes	Yes	No	No
Alternative advanced	Yes	Yes	No	No	No

Notes:

- NA indicates not available or not applicable.
- * indicates trains that are joined and split at Stockton in each direction but counted only once for total train frequency. See diagrams in Chapter 4.

6.0 Planning Methodologies

This chapter describes the basic elements of the methodology used in developing the SDP. The chapter also addresses the planning horizons utilized and the major overall assumptions employed throughout the SDP.

6.1 Planning Horizons

The planning horizon for the San Joaquin Corridor reflects the short duration and interim nature of this SDP. The SDP is based on implementing improved services and increased train frequencies coinciding with completion of the first construction section of the IOS of the HSR project in 2018. Consequently, the planning horizon examines service commencing in 2018 with a 2020 forecast year.

6.1.1 Year 2020 (Near-Term)

The near-term horizon reflects an initial level of operation to increase corridor service between Oakland/Sacramento and Bakersfield meeting ridership demand in the corridor through 2020. Improvements needed to accommodate new daily northbound and southbound trains operating on both the existing route alignment and first construction section of the IOS, with forecast 2020 freight traffic levels, are considered within this planning horizon.

This SDP provides a “Blended Service” plan to address use of the first construction section of the IOS and that the target date for revenue operations on the first construction section of the IOS is 2018. However, Ridership forecasting for the initiation of blended service is being prepared for the 2020 horizon year. Accordingly, the 2020 ridership estimates for all intercity corridors statewide will reflect the impact of blended service to the extent that such impacts are discernible. Blended service and operations refers to sharing tracks with HSR infrastructure and to the integration of high-speed trains with existing intercity and commuter/regional rail services by coordinating infrastructure investments, scheduling, ticketing and other means.

6.1.2 Year 2040 (Long-Term)

Improvements needed to accommodate additional trains beyond 2020 are not considered in this service planning horizon.

The Year 2040 Long-Term ridership forecasts would need to include the effects of the completion of the Phase 1 HSR system statewide. The Phase 1 high-speed rail network includes HSR service from San Francisco to Anaheim, utilizing blended operations on the Caltrain segment between San Francisco and San Jose as well as on the Los Angeles to Anaheim segment, and dedicated HSR tracks between San Jose and Los Angeles. This is not the subject of this SDP.

6.2 Major Overall Assumptions

The major overall assumptions used in the SDP with regard to socioeconomic data, freight rail forecasting, market analysis, Geographic Information Systems (GIS), and screening of alternatives are presented in this section.

6.2.1 Socioeconomic Data

Passenger and freight demand forecasting, market analysis, and subsequent planning analysis rely upon a future year statewide socioeconomic forecast encompassing households, population, jobs, workers, household incomes, and other variables. Moody’s 2011 Economy.Com socioeconomic data (SED) was

selected for use in all planning and forecasting efforts on this SDP. These forecasts have a number of advantages, including:

- Economy.com SED forecasts are currently being used for both the Amtrak/California Intercity Passenger Rail Forecasting Model (Amtrak/Caltrans Model) and the High-Speed Rail Ridership and Revenue Model (HSR R&R Model).[xviii]
- Economy.com SED forecasts were developed in 2011 and represent the most up-to-date forecasts that best reflect the continued economic slowdown (prior SED forecasts anticipated a shorter recession and more robust upturn in the California economy).
- Economy.com also produces a consistent set of economic output data used in the freight rail forecasts.

6.2.2 Forecasting Assumptions

Base values or methodologies are presented for the following planning assumption categories:

- Cost Assumptions, including automobile operating costs, bridge tolls, airfares, intercity conventional rail fares, high-speed rail fares, and station parking costs.
- Travel Times for automobile and air.
- Headways for air.
- Wait Times for airports and rail stations.
- Terminal Processing Times for airports and rail stations.

These values are derived in large part from assumptions supporting modeling activities for the Authority; however, some assumptions such as conventional rail fares and parking costs are based on assumptions in the Amtrak/Caltrans Model. Travel times and headways for high-speed rail and conventional rail routes are not reported here as planning assumptions, since they were defined through the scenario development process.

Cost Assumptions

Relevant cost assumptions include automobile operating costs; fares for conventional rail, high-speed rail, and air travel; and access/egress costs such as parking charges at airports and stations. All costs, except conventional rail fares, are reported in 2005 dollars. Costs were inflated to a common dollar year for the purposes of modeling.

Automobile Operating Costs – Automobile operating costs are comprised of actual fuel and nonfuel operating costs. Automobile ownership costs, including purchase costs and insurance, are not included in operating costs since under standard demand forecasting procedures they do not factor into the day-to-day decisions of whether to use the vehicle for a particular trip. As of June 2011, the high-speed rail analysis assumes fuel operating costs of 15.625 cents per vehicle per mile.[xix] Nonfuel operating costs include maintenance and repair, motor oil, parts, and accessories. Nonfuel costs are assumed fixed at 60 percent of gas operating costs, or 9.375 cents per mile. Estimated total automobile operating costs are therefore equivalent to 25 cents per mile, and are assumed constant in real dollars for all analysis years. These automobile operating cost base assumptions are consistent with those specified by the Metropolitan Transportation Commission for use in the HSR R&R Model.

Bridge Tolls – Bay Area bridge tolls are assumed at current levels set by the Bay Area Toll Authority (BATA). The tolls are:

- Bay Bridge: Weekday Peak $6.00 (5:00 a.m. to 10:00 a.m. and 3:00 p.m. to 7:00 p.m.)

  - Weekday Other Times $4
  - Weekend $5
- Golden Gate:
  - Cash $6
  - Fastrak $5
- Other bridges: $5

Airfares – Market-to-market airfare assumptions are based on year 2009 observed airfare data use in high-speed rail modeling.[xx]

Conventional Rail Fares – The most recent conventional rail market-to-market base fare assumptions are used in the analysis. The *San Joaquin* will share the same route and stations of the *Capitol Corridor* between Oakland and Martinez. Conventional rail fares are assumed constant in real dollars for all analysis years.

Station Parking Costs – Parking costs are identified by mode:

- Air. Airport daily parking cost assumptions (in 2005 dollars) range from $25.50 at Oakland to $9.50 at Sacramento, while costs at minor airports range from $3.00 at Modesto to $10.00 at Fresno and $7.50 at Bakersfield. The model uses the daily airport parking rate when calculating trip costs, irrespective of trip duration.

  Base airport parking cost assumptions were derived from data collections performed by MTC staff for San Francisco and Oakland Airports and by Cambridge Systematics staff for Los Angeles Airport. These values reflect current airport parking costs used in high-speed rail modeling as of August 2011. Costs are assumed constant in real dollars for all analysis years.

- Conventional Rail. Conventional rail station parking cost assumptions (per trip) are as follows:
  - $6 – Los Angeles Union Station, Sacramento.
  - $3 – Bakersfield, Fresno, Merced, Modesto, Stockton.
  - $0 – All other stations.

  This pricing mechanism was adopted based on market cost assumptions developed by the program management team for high-speed rail analysis, and used for scenario runs conducted after 2007.

- High-Speed Rail. High-speed rail station parking cost assumptions currently assumed for modeling purposes range from $36 at San Francisco to $32 at Los Angeles, while costs at minor stations range from $16.00 at Fresno to $11.00 at Merced. Parking costs (in 2005 dollars) are assumed constant in real dollars for all analysis years. In the case of joint conventional rail and high-speed rail stations, the high-speed rail prices will be used.

Travel Times

Base travel time assumptions for auto and air travel between market pairs are fixed variables. Conventional and high-speed rail travel times are subject to level of service scenario assumptions. The following proposed levels are consistent with the most recent model run assumptions used by the Authority.

- Automobile. Peak-period region-to-region automobile travel time assumptions for year 2030 are based on the average auto speed and travel time assumptions used by the HSR R&R Model, which assumes a maximum annual decrease in automobile speeds of 0.5 miles per hour.

- Air. Air travel times are based on existing HSR R&R Model assumptions, which utilize FAA data samples from years 2000 and 2005. Market-to-market air travel time assumptions are assumed constant for all analysis years.

Headways

Air travel service headways are assumed constant for all analysis years. Service headways for conventional rail were established for each operating scenario used in the service planning analysis.

Wait Times

Wait time refers to the average time spent between arriving at the airline gate or train platform and the closing of the airplane or train door after passengers have boarded. Air wait times are assumed to be held constant at 55 minutes based on a review of surveys conducted in support of the HSR R&R Model.

Rail travel wait times are lower than air travel wait times for a variety of reasons, including multiple train boarding points, proof-of-purchase ticketing, baggage-related delays, etc. The HSR R&R Model assumes wait times of 15 minutes on both high-speed and conventional rail modes.

Terminal Processing Times

Both airports and rail terminals are subject to terminal processing times, or the amount of time passengers must endure from the time they arrive at the terminal via their access mode to the point they reach the gate. This includes time spent walking between access points and the terminal; time spent receiving a ticket and checking baggage, security, and other factors. In the HSR R&R Model, terminal processing times are determined from a combination of peer review recommendations and subsequent refinements, and vary based on the characteristics of the airport or terminal.

Airports:

- At LAX and SFO – 24 minutes for non-business/commute trips and 22 minutes for business/ commute trips.
- At other airports – 20 minutes for non-business/commute trips and 18 minutes for business/ commute trips.

Conventional Rail:

- At stations that serve only conventional rail – 3 minutes.
- At stations that serve local and express trains – 10 minutes.

6.2.3 Freight Rail Forecasting Methodology

A key element in the SDP is an examination of the impact of future train volume changes on the rail system. Changes from present train traffic volumes will affect the performance of the system, its capital needs, and potential shifts in mode share between rail and other competing modes. Since train volume changes are not uniform across the entire network, some sections may be subject to substantial volume gains, others could face stable demand, while yet others could face declines.

Economists classify the movement of goods (i.e., transportation) as a “derived” demand, by providing the necessary linkage between locations where goods are produced and where they are consumed. The act of transporting a good between two locations has no value per se; it creates value when there is an economic need for that good at the destination, and the combined cost of production at origin and its transportation to the destination is less than that for any other geographic source or material substitute. These linkages between production and consumption are indicated through an examination of freight flows moving between geographic origins and destinations.

Data Sources

Two different data sources were used for this effort:

1. The Federal Highway Administration's Freight Analysis Framework (FAF3) database – which contains aggregated annual volume summaries by origin-destination geography, mode, and commodity – provides this information on a historical basis, using a combination of actual data and modeled behavior; and
2. The Surface Transportation Board's (STB) Confidential Carload Waybill Sample also provides freight flow data for the rail mode only and is used as an input to the FAF.

These two data sources, used in combination, provide most of the information needed to produce a base year commodity flow database and forecast. The commodity flow database is then used to estimate daily train flows at the line level for base year and forecast years in addition to identifying flows by other modes that may represent potential markets for diversion to rail.

Approach

The freight forecasting process was structured in a series of five tasks discussed below, following an accepted and commonly used approach. While the first four steps are fixed, the last step entails some adjustment, depending on the availability of actual train counts.

Step 1 – Aggregate STB Waybill data by commodity, shipment type (carload rail and mixed mode, e.g., intermodal), and FAF3 geographic zones.

Step 2 – Using FAF3, calculate multiplier (growth rate) for change in rail traffic volumes (tonnage and value) between 2007 and 2035 by commodity, shipment type, and FAF3 zones.

Step 3 – For the container traffic associated with the ports of Los Angeles, Long Beach, and Oakland, utilize current long-range forecasts to create growth rate tonnage multipliers for 2007 to 2035. Port-related traffic is segregated in the waybill by examining the container initials, equipment type, and service lanes in which it appears. A base year adjustment is made for transshipped traffic (i.e., containers that are unloaded in the port region and then reloaded into domestic containers and trailers for movement inland) by using available data.tep 4 – Apply the tonnage multiplier calculated in the previous steps against each row in the STB Carload Waybill Sample. Since the geographic and commodity information in the FAF is not consistent with the STB Waybill Sample, two cross-reference tables must be created. The first associates each Standard Point Location Code (SPLC) found in the Waybill Sample with the appropriate FAF3 zone, and the second associates the Standard Classification of Transported Goods (SCTG) found in the FAF with Standard Transportation Commodity Code (STCC) utilized by the Waybill Sample. The net result is an STB waybill with a forecast showing tonnage, number of carloads, and value for each extant origin, destination, carrier (route), and commodity combination. In some instances, the regional tonnage and carload totals are adjusted to avoid introducing distortions in volume growth.

Step 5 – Generate trains. Using the base case and forecast waybills from Step 3, estimate train volumes using the methodology that was developed in the Association of American Railroads' 2007 *National Rail Freight Infrastructure Capacity and Investment Study*. This methodology entailed the estimation of the number of carloads moving over the network on a representative day, with volumes allocated among four types of train service based on the commodity being carried and the type of operation:

- Auto. For assembled motor vehicles moving in multilevel cars.
- Unit Train. For grain, coal, and other bulk commodities usually moving as a single train between origin and destination.
- Intermodal. For commodities moving in containers or truck trailers.

- General Merchandise. All other carload rail shipments, including commodities moved in box and tank cars.

The number of trains of each type needed to move the cars are estimated using information on the typical number of cars hauled by train service type, obtained from available industry and STB reports. The number of intermodal trains needed is based on the number of intermodal units (e.g., container-on-flat-car (COFC) units and trailer-on-flat-car (TOFC) units). Train counts are calibrated against existing train count data wherever possible.

The base year train count data developed from the freight forecasting methodology was compared against current train count data assembled from the Class 1 railroads and other sources such as the BNSF Railway capacity analysis as well as prior data on existing conditions. Adjustments were made to minimize disparities. All freight train counts and movements are discussed in more detail in Chapter 9.

6.2.4 Market Analysis

This section outlines the methodology used to estimate current and future travel market trends in the passenger sector. Market analysis defines the magnitude and nature of travel (the number of people that travel; their income and travel needs; origins and destinations, etc.), as well as the underlying drivers of this travel (population, employment, income growth, etc.). Market analysis is critical since these assumptions affect other aspects of SDP development such as the number and timing of trains, pricing strategies, infrastructure location (tracks, sidings, terminals, stations), and resulting ridership, revenue and public/private benefits.

The market analysis was primarily developed using the Authority's Ridership and Revenue Model (R&R Model) which consists of separate, yet integrated, components for forecasting long-distance interregional travel and intraregional travel within urban areas. Interregional travel is forecast using a new set of models, derived from survey data collected for the HSR project combined with other relevant survey data sources. The model forecasts all interregional trips by purpose and length (trip frequency), identifies which region the interregional trips will be going to (destination choice), and then estimates which access, egress, and line-haul mode the interregional trip will use (mode choice). Intraregional models are based on trip tables generated from the MPO models, with customized mode choice models for the Bay Area and Los Angeles metropolitan regions. Trips by mode from the interregional and intraregional models are aggregated prior to the assignment step. The interregional trip frequency models allow forecasting of induced travel based on improved accessibilities due to new modes and faster options.

For the SRP effort, the socioeconomic assumptions in the R&R Model were updated. Population and Employment figures are derived from the Moody's 2011 Economy.com dataset. Figures were obtained and aggregated at the county level for both statewide and corridor analysis. Employment North American Industry Classification System (NAICS) codes were grouped into four categories: wholesale, retail, professional services, and other employment.

Population and Employment Density was estimated using land area information obtained via the 2010 U.S. Census as interpreted by Moody's Analytics, which is the source for population and employment forecasts.

Underlying trip tables for travel within the LA Basin were provided by the Southern California Association of Governments (SCAG), while travel within San Francisco Bay Area zones was provided by MTC. These tables were adjusted based on Moody's Economy.com (2011) data. All trip tables reflect "No-Build" conditions, without high-speed rail service. The interregional model is based on trip frequency and destination choice models that utilize socioeconomic data directly and are influenced by accessibility between zones through logsums[(xxi)] reported under the R&R Model's mode choice model. Origin/destination information contained in R&R Model transportation analysis zones (TAZs) was aggregated to the county (and subcounty) level.

As the last step of the market analysis process, County-To-County Travel Market Trip Tables (all modes) for years 2000 and 2030 were derived from the HSR R&R Model for all trips within the San Joaquin Valley.[xxii]. For the purposes of corridor-level analysis, trip origin/destination pairs are aggregated at the county level. The San Joaquin Corridor is divided into several markets:

- Bay Area including Alameda and Contra Costa.
- Sacramento County.
- San Joaquin Valley including Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare Counties.

Amtrak Station Boardings and Station-To-Station Trips are observed station-to-station ticket sales figures reported by the Amtrak Data Warehouse (2011).

6.2.5 GIS Methodology

This section summarizes the methodology and approach taken to develop the GIS information used in developing the SDP. As a starting basis, Caltrans and the Authority provided existing relevant data from CT Earth, the Caltrans Statewide Travel Demand Model, the Statewide Freight Model, and Caltrans and the Authority GIS geospatial data and files for the statewide rail system. Building upon existing GIS information, a geospatial library for the existing and future rail system and rail services and facilities was developed in ArcGIS 9.3+.

A comparative analysis of the best available source of rail line data was conducted to determine which base layer provided the most efficient starting point for the GIS network update. To develop the data layers and attributes, an existing conditions inventory was constructed and built on the 2008 California State Rail Plan. Features of the passenger rail inventory include state-supported intercity passenger rail lines (Amtrak California state and national lines), and Amtrak long-distance lines, connecting bus service routes and station locations, intercity passenger rail station locations, proposed high-speed rail corridors and station locations, commuter rail systems and station locations, location of at-grade crossings, and passenger rail maintenance facilities.

A GIS database design was developed to store the data layers deemed feasible for data development. Data layers were reviewed against current ortho imagery such as that available in Google Earth. Attributes and features were populated and verified, route-by-route, to ensure the physical characteristics of the existing passenger rail system were accurate and could be used for GIS-spatial and other analysis. This included characteristics such as shared corridor rail owner, rail operator, service frequency, condition, and station-level statistics. Corridors that are currently out of service were also noted.

6.2.6 Alternatives Analysis Methodology

This section presents the methodology developed for the Alternatives Analysis (Chapters 1-5) component of the SDP. The alternatives analysis approach presented below includes the identification of alternatives analysis criteria and the methodology for preliminary service development planning.

The alternatives analysis evaluation was based on prior studies of the San Joaquin and related corridors, including:

- San Joaquin Corridor Strategic Plan (January 2008)
- Amtrak California Passenger Rail System: 20-Year Improvement Plan Technical Report (March 2001)
- UPRR letter to Caltrans (March 2010)

- BNSF San Joaquin Valley Capacity Analysis (October 2010)
- State Route 99 Corridor System Management Plan (2008)
- State Route 99 Corridor Enhancement Master Plan (2012)
- State Route 99 Corridor Business Plan (2005)
- State Route 99 Transportation Concept Report (2003)
- Current planning for Northern California Unified Rail Service
- San Joaquin Passenger Rail Corridor Programmatic EIR 2035 Vision – Initial Study (2012).

These studies identified a wide range of improvement projects including siding extensions, signaling upgrades, curve realignments, new stations, and enhancements to existing stations. At this point in the development of the SDP, it was appropriate to provide an evaluation of candidate corridor-level improvements to focus further work and refine the concepts. Therefore, the alternatives analysis methodology was designed to assemble and evaluate service plans and improvement lists that have been under development and/or implementation for some time, in order to create a foundation for further refinement.

The alternatives analysis criteria address how alternatives are determined to be reasonable and feasible, in order to be carried forward into further analysis. The criteria assess how well each alternative meets the following:

- The Purpose and Need for the action.
- Technical feasibility (physical route characteristics, ROW and engineering constraints, constructability, capacity-constrained existing facilities or infrastructure, and safety impacts).
- Economic feasibility (market potential and/or ridership, capital and operating costs and cost-effectiveness).
- Major environmental concerns. These concerns include impacts to traffic requiring grade-separations. The number of grade-crossing separations would be a differentiator.
- The alternatives analysis describes and evaluates two alternatives: 1) No-Build/No-Action Alternative; and 2) Build/Improved Passenger Services Alternative. The analysis was primarily based on the following information from prior studies, program environmental documents prepared by Caltrans, and recent rail corridor improvement projects. Each scenario was evaluated based on the categories of information described below. The determination of which scenario should be included in the Build Alternative was made by analyzing the data and determining which scenario: could be built by 2018, could reasonably be expected to be funded in the required time period, and was the most cost effective. Purpose and Need Statements were identified from previous and on-going studies and Program Environmental Impact Report and Environmental Impact Statement (Program EIR/EIS) efforts.
- Infrastructure improvements and conceptual order-of-magnitude capital cost estimates were assembled based on conceptual planning and/or engineering from previous studies and similar recent projects and the costs were escalated based on generally accepted cost estimating practices.
- Infrastructure improvements were determined to be feasible if they could be environmentally cleared, permitted, funded and constructed by the 2018 start of revenue service.
- Operating assumptions were based on prior strategic improvement plans, service development plans, and operational analyses for this SDP.

- Operating and maintenance cost estimates for an initial operations period were estimated based on the train requirements identified as part of the operating assumptions analytical work and then on per train mile / hour operating and maintenance cost factors as provided in prior studies or similar recent projects.
- Travel demand and ridership forecasts for each Build Alternative were estimated.
- Cost-effectiveness of the 90 mph speed option was examined by calculating the incremental operating cost per new rider attracted by the 90 mph speed.

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7.0 Outreach Efforts

This section describes the public/agency involvement in developing the San Joaquin Corridor SDP as well as the California State Rail Plan (CSRP) statewide outreach effort as described in Chapter 4 of the CSRP.

At the time of developing the San Joaquin Corridor SDP, separate environmental studies were ongoing or completed along the San Joaquin Corridor including the legally required outreach providing information on the project alternatives, potential impacts and proposed mitigation. These include the Merced – Fresno and Fresno – Bakersfield project level Environmental Impact Report/Environmental Impact Statement (EIR/EIS) currently being prepared by the CHSRA. Outreach efforts for the CSRP and San Joaquin Corridor were coordinated with these various ongoing environmental studies.

General outreach for the CSRP included the project website, advisory committee meetings, collateral materials and stakeholder outreach briefings. These outreach efforts also involved San Joaquin Corridor specific information as it relates to the overall SDP development process. The following outlines the specific outreach efforts and coordination for the San Joaquin Corridor SDP. The final San Joaquin Corridor SDP report was vetted through Caltrans and other appropriate state agencies and other committees in early 2013.

7.1 Stakeholder Meetings

Presentations summarizing the goals, process, and schedule for the San Joaquin Corridor SDP were provided to Caltrans and various agencies, stakeholders, rail corridor committees and railroads during 2012 to ensure that key decision makers and executive staff were well informed and updated on the status of the SDP process prior to submittal of the administrative draft SDP.

7.1.1 California State Rail Plan Advisory Committee

A CSRP Advisory Committee was formed by Caltrans Division of Rail to provide input and expertise in the development of the CSRP and service development plans throughout the state including San Joaquin Corridor. Representatives from federal, state, and regional agencies and freight and passenger rail agencies comprised the committee to ensure a broad and diverse group of interests were represented. Participant groups included:

- National Passenger Rail Corporation (Amtrak)
- BNSF Railway
- California High-Speed Rail Authority (Authority)
- California Shortline Rail Association (CSLRA)
- California Transportation Commission (CTC)
- Capitol Corridor Joint Powers Authority (CCJPA)
- Coast Rail Coordinating Council (CRCC)
- Federal Railroad Administration (FRA)
- Los Angeles–San Diego–San Luis Obispo Rail Corridor Agency – North Corridor (LOSSAN North)
- Los Angeles–San Diego–San Luis Obispo Rail Corridor Agency – South Corridor (LOSSAN South)

- San Joaquin Valley Rail Committee (SJVRC)
- State of California Business, Transportation and Housing Agency (BT&H)
- Union Pacific Railroad (UPRR)

7.1.2 Caltrans Internal Coordination

San Joaquin Corridor information, as part of the overall SDP development effort was presented to Caltrans Management and related agency groups including: BT&H, CTC and others. Specific SDP information was also part of the five public CSRP meetings held throughout the state in early 2013.

A collaborative effort was also established with Caltrans District 3, 4, 5, 6, 7, and 10 Public Information Officers (PIOs) and Planning Deputies to assist with reaching out to corridor district stakeholders. PIOs were provided an information packet (fact sheet, frequently asked questions (FAQs), and website links and other CSRP materials) including a "Meeting-in-a-Box" PowerPoint presentation containing information on the San Joaquin Corridor. They were also asked to help in getting the CSRP/SDP message out to stakeholders. Administrative Draft chapters of the San Joaquin Corridor were also sent to PIOs and Planning Deputies for their review and comments. The packet of information was used to educate the Districts on the CSRP and SDP process and to provide adequate reference materials should stakeholders inquire about the San Joaquin Corridor study and outreach process.

7.1.3 State Agencies/Regional Agencies

Status and updates were provided to state agencies and regional agencies (MPOs, RTPAs and Councils of Governments (COGs)) related to the San Joaquin Corridor including distribution of the same CSRP information packets discussed above. The agencies listed below were encouraged to review the materials and participate in the five public meetings held throughout the state in early 2013 regarding the California SRP and SDP. The following organizations were provided a presentation on the status and process of developing the SDP's including San Joaquin Corridor:

- State Agencies. The following agencies received overview CSRP briefings including general SDP information only.
    - Native American Advisory Committee (NAAC)
    - California Association of Councils of Governments (CALCOG)
    - Active Transportation and Livable Communities (ATLC)
    - Rural Counties Task Force (RCTF)
    - Air Resources Board (ARB)
- The California Energy Commission (CEC) and Strategic Growth Council received an information packet but did not receive a briefing.
- MPOs, RTPAs and COGs. Representatives from the following agencies participated in at least one of the following rail committees: San Joaquin Valley Rail Committee, Coast Rail Coordinating Council or Capitol Corridor Joint Powers Authority where they were informed of, and/or received draft San Joaquin Corridor documents:
    - Santa Clara Valley Transportation Authority (SCVTA)
    - Santa Cruz County Regional Transportation Commission (SCCRTC)
    - Transportation Agency for Monterey County (TAMC)
    - Peninsula Corridor Joint Powers Board (PCJPB)
    - San Joaquin Council of Governments (SJCOG)

- Metropolitan Transportation Commission (MTC)
- Sacramento Area Council of Governments (SACOG)
- San Diego Association of Governments (SANDAG)
- Stanislaus Council of Governments (StanCOG)
- San Luis Obispo Council of Governments (SLOCOG)
- Santa Barbara County Association of Governments (SBCAG)

7.1.4 SDP Rail Corridor Committees and Railroads

As part of the CSRP Advisory Committee the SJVRC, CRCC, CCJPA, freight, and passenger, rail representatives received the draft *San Joaquin* Corridor SDP to review and provide comments. In addition, each member was tasked with coordinating the input needed to inform the SDP development process prior to the submittal of the Administrative Draft. Status reports and updates on the SDP and interim deliverables were also provided through specific presentations to the Advisory Committee. However, briefings were not scheduled to individual passenger and commuter rail owners and operators. Each of the agencies below received the draft San Joaquin Corridor SDP for review and comment:

- Rail Corridor Board and Committees:
  - Federal Railroad Administration
  - LOSSAN Joint Powers Authority (JPA) Board of Directors
  - LOSSAN Technical Advisory Committee (TAC)
  - San Joaquin Valley Rail Committee
- Freight Railroads, Class 1/Shortline Railroads:
  - Union Pacific Railroad
  - BNSF Railway
  - California Shortline Railroad Association
- Passenger Railroads (Owners and Operators):
  - Caltrain
  - Los Angeles County Metropolitan Transportation Authority
  - Ventura County Transportation Commission (VCTC)
  - Southern California Regional Rail Authority
  - Amtrak
  - Peninsula Corridor Joint Powers Board
  - San Joaquin Regional Rail Commission (SJRRC)
  - Altamont Corridor Express
  - San Mateo County Transit District (SamTrans)
  - San Diego Metropolitan Transit System (SDMTS) – Coaster
  - North County Transit District (NCTD) – Coaster
  - Orange County Transportation Authority (OCTA) – Metrolink
  - Santa Cruz Regional Transportation Commission
  - Santa Clara Valley Transportation Authority (SCVTA)
  - Transportation Agency for Monterey County (TAMC)

- Metropolitan Planning Organizations
    - San Joaquin Council of Governments (SJCOG)
    - Santa Barbara County Association of Governments (SBCAG)
    - San Luis Obispo Council of Governments (SLOCOG)
    - Southern California Association of Governments (SCAG)

7.2 Public Meetings

One round of five public meetings was held throughout the state in February 2013 to discuss the CSRP and SDP areas including the San Joaquin Corridor. These public meetings garnered stakeholder input and supported the San Joaquin Corridor environmental outreach efforts. Meetings were held in the following cities/locations:

- Sacramento (February 12, 2013)
- Oakland (February 14, 2013)
- San Diego (February 19, 2013)
- Los Angeles (February 20, 2013)
- Fresno (February 21, 2013)

Table 7.1: Stakeholder Meetings Involving San Joaquin Corridor

Date	Meeting	Location
February 15, 2012	CSRP Advisory Committee	Caltrans Headquarters, Sacramento
June 6, 2012	CSRP Advisory Committee	Caltrans Headquarters, Sacramento
September 19, 2012	CSRP Advisory Committee	Caltrans Headquarters, Sacramento
December 19, 2012	CSRP Advisory Committee	Caltrans Headquarters, Sacramento
September 14, 2012	BT&H	Caltrans Headquarters, Sacramento
September 14, 2012	CTC Staff	Caltrans Headquarters, Sacramento
November 2012	BT&H	Caltrans Headquarters, Sacramento
January 2013	BT&H	Caltrans Headquarters, Sacramento
October 30, 2012	CALCOG	SACOG Board Room, Sacramento
November 15, 2012	ATLC	Sacramento
November 16, 2012	RCTF	Caltrans Headquarters, Sacramento
January 14, 2013	RCTF	Caltrans Headquarters, Sacramento
November 14, 2013	CCJPA	Suisun City Hall, Suisun City, CA
April 20, 2012	CRCC	SBCAG, Santa Barbara
July 13, 2012	CRCC	Amtrak Office, Oakland
November 30, 2012	SJVRC	Bakersfield, CA
February 28, 2013	SJVRC	Fresno, CA

8.0 Ridership Demand and Revenue Forecast

This section of the Service Development Plan addresses the methods, assumptions and outputs for travel demand forecasts, and the expected revenue from the proposed services.

8.1 Passenger Rail Forecast

Passenger rail ridership (and revenue) forecasts were prepared for baseline and several San Joaquin Valley service options, using a 2020 forecast year. An overview of the methodology and approach, study area, data sources and assumptions, travel demand model, and resulting ridership forecasts is provided below.

8.1.1 Methodology and Approach

The 2020 ridership forecasts were prepared using the Amtrak/Caltrans Model, a forecasting model developed by AECOM for Caltrans and Amtrak to provide consistent ridership and ticket revenue forecasts in support of short-term and long-term rail passenger service planning in California. The Amtrak/Caltrans Model is based on extensive market and traveler behavior research throughout California, and nationwide, historical rail ridership and revenue data and trends, and demographic data. It provides coverage across the three existing California state-supported passenger rail corridors, including major Thruway bus connections to/from rail, and addresses travel by intercity passenger rail, auto, and air (for trips between Northern and Southern California).

The Amtrak/California ridership forecasting model (Amtrak/Caltrans Model) utilizes a two-stage model system. The first stage forecasts the growth in the total number of person trips in each market and the second stage predicts the market share captured by each available mode in each market. Both stages are dependent on the service characteristics of each mode and the characteristics of the corridor population. The key market segments addressed in the forecasting model system are defined and evaluated by origin-destination market pair and trip purpose (commute, business, recreation, and other).

The first stage of the model addresses the growth in the total intercity person travel volumes and includes natural growth and induced demand. California Department of Finance population forecasts are used in combination with Moody's Economy.com forecasts of population, employment, and income to estimate natural growth. The induced demand is new travel that occurs because service characteristics, like travel time, have improved. The Amtrak/Caltrans model estimates induced demand using relationships based on existing data showing different travel volumes among different travel markets. Through statistical analysis of these data, these volume differences have been attributed to differences in market size and service characteristics provided in markets.

The second stage of the model is the mode share component that forecasts the percentage of the total person travel by auto, intercity rail, and air modes. The key variables in the mode share model include:

- Line-haul travel time for all modes;
- Access/egress time for intercity rail and air;
- Travel cost or fare; and
- Frequency of service, taking account of the departure/arrival times of day and spacing of train services, for intercity rail and air.

The Amtrak/California Model is regularly updated to reflect Amtrak's latest actual ridership and ticket revenues. The Amtrak/Caltrans Model was expanded and updated in 2011 to include:

- A “capacity constraint” feature so that ridership forecasts for trains can be limited to a specified train capacity;
- Revised time-of-day sensitivities based on recent actual train performance in California; and
- All remaining Thruway bus connections.

The California HSR Ridership and Revenue (R&R) Model, including new runs and existing output, provides a source of expected market sensitivities to key high-speed service characteristics – travel time, fare, and frequency – that are outside of the range of those typically tested using the Amtrak/Caltrans ridership forecasting model. These results will be used, as needed to augment the Amtrak/Caltrans model results, specifically for integrated high-speed and conventional rail service scenarios. As needed, both models will be used as secondary sources to benchmark forecast results.

However, because there is no HSR service between 2018 and 2022, the Amtrak/Caltrans Model, augmented/updated as appropriate, is the primary source of forecasts that address the conventional rail service scenarios that utilize the first construction section of the IOS and connections to Thruway buses and other intercity or regional rail services.

8.1.2 Study Area Definition

The overall study area addressed by the Amtrak/Caltrans Model is illustrated by Exhibit 8.1. The existing ACE, *Capitol Corridor*, and San Joaquin rail service are also shown in this exhibit along with key connecting bus services. Regions of particular importance to the San Joaquin Corridor are San Francisco, San Jose, and Oakland/East Bay at the western end; Sacramento at the northern end; Stockton/Modesto/Merced, Fresno and South San Joaquin Valley/Bakersfield; and Los Angeles at the southern end as well as connecting bus services. As shown in the study area map (Exhibit 8.1) these connecting bus services link *San Joaquin* trains to many markets in Southern California, the Central Coast, Las Vegas, Tahoe and Reno, North Sacramento Valley, Wine Country, and the North Coast.

8.1.3 Data Sources and Assumptions

The Amtrak/Caltrans Model is based on extensive travel survey data collected between 2005 and 2008 from existing automobile and rail users at key locations within California.

Modal service characteristics represent the key independent variables in forecasting the shares of travel captured by each mode of travel. These characteristics, often referred to as impedances, include:

- Travel time (minutes).
- Travel cost (dollars).
- Frequency of service (departures per day).

Exhibit 8.1: Study Area Map

Future growth estimates are based on socio-economic data and forecasts developed by Moody's Economy.com. Key measures include forecasts of population, employment and income.

8.1.4 Travel Demand Model

Structure

As discussed, the Amtrak/Caltrans Model utilizes a two-stage model system. The first stage forecasts the growth in the total number of person trips in each market and the second stage predicts the market share captured by each available mode in each market. Both stages are dependent on the service characteristics of each mode and the characteristics of the corridor population. The key market segments

addressed in the forecasting model system are defined and evaluated by origin-destination market pair and trip purpose (commute, business, recreation, and other).

The first stage of the Amtrak/Caltrans Model addresses the growth in the total intercity person travel volumes and includes “natural” growth and “induced” demand. The second stage of the Amtrak/Caltrans Model is the mode share component, which estimates the percentage of the total person travel by the following three different modes of intercity travel (auto, intercity rail, and air). The key variables in the mode share model include:

- Line-haul travel time for all modes.
- Access/egress time for intercity rail and air.
- Travel cost or fare.

Network and Service Characteristics

The specific baseline assumptions that were used for competing (non-rail) modes of travel are detailed in the *Forecasting Assumptions Memorandum* prepared in September 2011. Detailed rail service inputs were developed for baseline conditions and four future service scenarios. The “Baseline” is defined by the current service levels, which include:

- A total of six *San Joaquin* train round-trips on the BNSF in the San Joaquin Valley – four between Oakland and Bakersfield and two between Sacramento and Bakersfield.
- *Capitol Corridor* service consisting of 15 weekday and 11 weekend round-trips between Sacramento and Oakland; seven of these round-trips extend to San Jose.
- Altamont Corridor Express service consisting of four weekday round-trips between Stockton and San Jose via Altamont Pass.

The future service scenarios extend four more weekday *Capitol Corridor* round-trips to San Jose, for a total of 11 round-trips on weekdays, and add a sixteenth weekday *Capitol Corridor* round-trip between Sacramento and Martinez, with a transfer to/from a *San Joaquin* train. The future service scenarios also add two daily ACE round-trips between Stockton and San Jose, for a total of six weekday and two weekend round-trips.

The four future Build Alternatives are described in detail in Chapter 4. Table 8.1 summarizes the train frequencies provided by each of the scenarios.

Table 8.1: Summary of Round-trip Train Frequencies by Build Alternative and Operating Scenario

	Daily Train Frequencies (round-trips)				
	Baseline	**Build A**	**Build B**	**Build C**	**Build D**
ACE Service Stockton–San Jose	4 weekday	4 weekday 2 weekend	4 weekday 2 weekend	4 weekday 2 weekend	4 weekday 2 weekend
Capitol Corridor Auburn–Roseville	1 daily	2 daily	2 daily	2 daily	2 daily
Roseville–Sacramento	1 daily	5 daily	5 daily	5 daily	5 daily
Sacramento–Oakland	15 weekday 11 weekend	15 weekday 11 weekend	15 weekday 11 weekend	15 weekday 11 weekend	15 weekday 11 weekend
Sacramento–Martinez connect	NA	1 weekday	1 weekday	1 weekday	1 weekday
Oakland–San Jose	7 weekday 7 weekend	11 weekday 7 weekend	11 weekday 7 weekend	11 weekday 7 weekend	11 weekday 7 weekend
San Joaquin Oakland–Bakersfield (via BNSF)	4 daily	1 daily	1 daily	1 daily	1 daily
Sac–Bakersfield (via BNSF)	2 daily	NA	NA	NA	NA
Oak(RIC)–Bakersfield (via the first construction section of the IOS)	NA	4 daily	4 daily	8 daily (3 RIC-BFD)	5 daily
Sac–Bakersfield (via the first construction section of the IOS)	NA	1 daily	1 daily	1 daily	1 daily
Oak(RIC)/Sac–Bakersfield (split train via the first construction section of the IOS)	NA	1 daily	1 daily	1 daily (RIC-BFD)	4 daily (RIC-BFD; 3 SAC on WP)
Madera–Bakersfield (via the first construction section of the IOS)	NA	1 daily	1 daily	1 daily	1 daily
Madera–Bakersfield (via BNSF)	NA	2 daily	5 daily	5 daily	5 daily

Notes:
- "NA" indicates not applicable.

The summary provided in Table 8.2 provides a sense of how the mix of services provided on the BNSF and first construction section of the IOS in the San Joaquin Valley perform across the scenarios. Ridership and ticket revenue increase as frequency of service increase, as expected. For example, local ridership/revenue south of Madera on the BNSF is the lowest in Scenario A, which provides only three round-trips instead of six in Scenarios B, C, and D. Similarly, local ridership south of Madera, on the first construction section of the IOS, increases in Scenarios C and D since 11 round-trips are provided instead of only seven in Scenarios A and B. Both of these results also show the diminishing impact of adding frequency, particularly when one also considers that the first construction section of the IOS and BNSF trains also serve some common markets.

Note that the "Thru Madera" ridership/revenue not using the first construction section of the IOS increases much less in Scenarios B, C, and D relative to Scenario A. This occurs because most of the demand in this market is on the single round-trip that provides a "one seat ride" thru Madera in all four options. Scenario A provides two additional round-trips that operate as local shuttles and connect to/from the first construction section of the IOS trains at Madera. Scenarios B, C, and D provide a total of five shuttles with a connection to/from the first construction section of the IOS trains at Madera – all of the added service on the BNSF is provided by shuttles.

8.1.5 Baseline and Future Scenarios Forecasted Ridership 79 mph

Using the Amtrak/Caltrans Model, ridership and ticket revenue forecasts were prepared for 2020 baseline and future service scenarios for the 79 mph MAS option for trains operating on the BNSF and UPRR segments of the route. All trains operating on the first construction section of the IOS have a 125 mph MAS. Table 8.2 summarizes these results by type of service.

The results show growth in ACE ridership/revenue, reflecting the new daily round-trips in the future scenarios, increases in *Capitol Corridor* ridership/revenue resulting from the additional service to San Jose, and increasing *San Joaquin* ridership/revenue as service is improved across the future scenarios. In general, as expected, ridership and ticket revenue increase with increasing service frequency. These trends are perhaps best shown by the more detailed *San Joaquin* forecast summaries that follow. Tables 8.2 and 8.3 provide two different summaries of these future *San Joaquin* ridership/revenue forecasts by market relative to key geographic locations.

Table 8.3 provides a summary around Madera, distinguishing between ridership/revenue for:

- The first construction section of the IOS south of Madera (for example, a trip on a first construction section of the IOS train from Bakersfield to Fresno).
- The BNSF south of Madera (for example, a trip on a BNSF train from Hanford to Fresno).
- The first construction section of the IOS through Madera (for example, a trip on a first construction section of the IOS train from Bakersfield to Stockton).
- The BNSF through Madera (for example, a trip on a BNSF train from Hanford to Stockton).
- North of Madera (for example, a trip from Modesto to Stockton).

Table 8.2: 2020 Annual Forecasts for San Joaquin Valley Service Options

	Baseline	Scenario A	Scenario B	Scenario C	Scenario D
Annual Ridership					
ACE Service	1,079,000	1,412,000	1,412,000	1,408,000	1,408,000
Capitol Corridor(1)	2,114,000	2,400,000	2,400,000	2,400,000	2,400,000
San Joaquin(2)	1,388,000	2,060,000	2,160,000	2,470,000	2,640,000
Total	*4,581,000*	*5,872,000*	*5,972,000*	*6,278,000*	*6,448,000*
Ticket Revenue (2012 dollars)					
ACE Service	$5,930,000	$7,770,000	$7,770,000	$7,740,000	$7,740,000
Capitol Corridor(1)	$34,140,000	$39,100,000	$39,100,000	$39,100,000	$39,100,000
San Joaquin(2)	$46,970,000	$76,400,000	$79,500,000	$90,900,000	$97,700,000
Total	*$87,040,000*	*$123,270,000*	*$126,370,000*	*$137,740,000*	*$144,540,000*

Notes:
(1) Includes Martinez connecting ridership/revenue associated with sixteenth weekday frequency.
(2) Includes associated connecting ACE and Bus revenue.

Table 8.3: Summary of 2020 San Joaquin Forecasts Relative to Madera

	Baseline	Scenario A	Scenario B	Scenario C	Scenario D
Annual Ridership					
South of Madera on the first construction section of the IOS	0	474,000	473,000	562,000	561,000
South of Madera on BNSF	335,000	78,000	123,000	123,000	123,000
Thru Madera using the first construction section of the IOS	0	1,013,000	1,026,000	1,200,000	1,329,000
Thru Madera not using the first construction section of the IOS	714,000	72,000	84,000	84,000	87,000
North of Madera	339,000	423,000	454,000	501,000	540,000
Total	*1,388,000*	*2,060,000*	*2,160,000*	*2,470,000*	*2,640,000*
Ticket Revenue (2012 dollars)					
South of Madera on the first construction section of the IOS	$0	$16,070,000	$16,030,000	$18,960,000	$18,960,000
South of Madera on BNSF	$7,330,000	$1,850,000	$2,810,000	$2,810,000	$2,810,000
Thru Madera using the first construction section of the IOS	$0	$46,670,000	$47,380,000	$55,000,000	$60,940,000
Thru Madera not using the first construction section of the IOS	$32,240,000	$2,930,000	$3,400,000	$3,350,000	$3,490,000
North of Madera	$7,400,000	$8,880,000	$9,880,000	$10,780,000	$11,500,000
Total	*$46,970,000*	*$76,400,000*	*$79,500,000*	*$90,900,000*	*$97,700,000*

Demand in markets thru Madera is impacted by service differences north and south of Madera. Many of these important differences between scenarios are better illustrated by breaking the markets at Stockton instead of Madera. Table 8.4 provides a summary around Stockton, distinguishing between ridership/revenue for:

- North of Stockton (for example, a trip from Sacramento to Stockton).
- West of Stockton (for example, a trip from Oakland to Stockton).
- Thru Stockton to/from North (for example, a trip from Sacramento to Fresno).
- Thru Stockton to/from South (for example, a trip from Oakland to Fresno).
- South of Stockton (for example, a trip from Modesto to Fresno).

The summary provided in Table 8.4 provides a sense of how the mix of services provided to/from the Bay Area and Sacramento, either as single or split trains, perform across the scenarios. Again, ridership and ticket revenue increase as frequency of service increase, as expected. For example, local ridership/revenue north of Stockton is the lowest in Scenarios A, B, and C where only two round-trips are provided by a thru train and a split train at Stockton. Scenario D increases this frequency to five round-trips by adding three round-trips on the UPRR Sacramento Subdivision (former WP) route to Sacramento.

Table 8.4: Summary of 2020 San Joaquin Forecasts Relative to Stockton

	Baseline	Scenario A	Scenario B	Scenario C	Scenario D
Annual Ridership					
North of Stockton	12,000	11,000	11,000	11,000	25,000
West of Stockton	165,000	209,000	227,000	241,000	241,000
Thru Stockton to/from North	284,000	367,000	367,000	407,000	567,000
Thru Stockton to/from West	319,000	487,000	532,000	602,000	597,000
South of Stockton	608,000	986,000	1,023,000	1,209,000	1,210,000
Total	*1,388,000*	*2,060,000*	*2,160,000*	*2,470,000*	*2,640,000*
Ticket Revenue (2012 dollars)					
North of Stockton	$170,000	$160,000	$160,000	$160,000	$350,000
West of Stockton	$3,290,000	$3,780,000	$4,370,000	$4,490,000	$4,490,000
Thru Stockton to/from North	$11,650,000	$15,760,000	$15,760,000	$17,450,000	$24,240,000
Thru Stockton to/from West	$14,300,000	$22,180,000	$24,140,000	$27,160,000	$26,980,000
South of Stockton	$17,560,000	$34,520,000	$35,070,000	$41,640,000	$41,640,000
Total	*$46,970,000*	*$76,400,000*	*$79,500,000*	*$90,900,000*	*$97,700,000*

Another interesting forecasting trend can be noted in the "Thru Stockton to/from West" market, where ridership/revenue increases from Scenario A to B, largely because of the ACE connection, and increases further in Scenarios C and D as a result of the additional round-trips to Richmond on the BNSF via Franklin Canyon.

8.1.6 Baseline and Future Scenarios Estimated Ridership 90 mph

The demand estimates for the proposed 90 mph *San Joaquin* service is based on a forecast of the existing service with the current six round trips. The summary of the existing service (2010 baseline) forecast using the Amtrak/Caltrans model is outlined in Table 8.5 Summary of San Joaquin Forecasts Relative to Speed.

Table 8.5: Summary of San Joaquin Forecasts Relative to Speed (2010 baseline)

Service	Ridership		Revenue	
	79 mph	90 mph	79 mph	90 mph
San Joaquin	1,067,400	1,153,100	$35,704,000	$38,976,000
Capitol Corridor	1,708,600	1,708,000	$25,720,000	$25,711,000
Total	2,776,000	2,861,100	$61,424,000	$64,687,000
Incremental change	*NA*	*85,100*	*NA*	*$3,263,000*

Notes:
- "NA" indicates not applicable.

The incremental annual revenue gain is estimated at about $3.3 million and an incremental gain of 85,100 annual riders, which is about 108 percent of the baseline speed option. The ridership for the 90 mph speed options for Build Alternatives were estimated based on the ratio of incremental change in the

forecast for the existing service based on the 2010 baseline. These forecast estimates are presented in Table 8.6.

Table 8.6: San Joaquin Build Alternatives Estimated Ridership Relative to Speed

	Baseline	Scenario A	Scenario B	Scenario C	Scenario D
Annual Ridership					
San Joaquin[(2)] (79 mph)	1,388,000	2,060,000	2,160,000	2,470,000	2,640,000
San Joaquin (90 mph)	1,499,441	2,225,394	2,333,423	2,668,313	2,851,962

Notes:
(1) Includes Martinez connecting ridership/revenue associated with sixteenth weekday frequency.
(2) Includes associated connecting ACE and Bus revenue.

Build Alternative A estimate of ridership for the 90 mph MAS option is 2.2 million when compared to the No-Build of 1.5 million. Build Alternative B is slightly higher at 2.3 million annual riders. Build Alternative D has the highest estimate of ridership at 2.8 million. However, Build Alternatives C and D also have the highest capital and operating costs as noted in Chapter 5.

8.2 Revenue Forecast

Revenue includes ticket revenue associated with fares paid by train rides and auxiliary revenue associated with on-board food and beverage service.

8.2.1 Ticket Revenue Forecast

Ticket revenue forecasts are simply the product of the ridership forecasts, described above, and the average fares by station pair market. The tables above also summarize the forecasted ticket revenue. All ticket revenue forecasts are expressed in 2012 dollars and are consistent with the latest near-term forecasts developed by Amtrak and Caltrans for current state-supported intercity passenger rail services within California.

8.2.2 Auxiliary Revenue Forecast

Typically, where detailed revenue sources are unavailable, the forecasting of auxiliary revenue is represented as a percentage of the total operation revenue. Auxiliary revenue is not substantial for the current network. Since there currently are no programs in place to increase auxiliary revenue sources in the future year scenarios, auxiliary revenue forecasts are not expected to be considerable and were not forecast.

8.3 Summary

Although Build Alternatives C and D have higher ridership forecasts at 79 mph and the highest estimate of ridership for the 90 mph speed option when compared to Build Alternatives A and B, these alternatives were dismissed from further consideration due to an inability to obtain environmental clearance and complete construction in time for service initiation in 2018. As indicated in Chapter 5, the 90 mph speed option is not cost effective adding about $100 per new rider in operating costs on average. In addition, Alternative B was not advanced because it is more costly to operate than Alternative A.

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9.0 Operations Modeling

The San Joaquin Corridor refers to the 365-mile corridor between Oakland/Sacramento and Bakersfield and is described in Chapter 1. The Corridor consists of three route segments owned by two Class I railroads – the BNSF Railway (BNSF) and Union Pacific Railroad (UPRR). The BNSF owns the tracks between Bakersfield and Port Chicago and the UPRR owns the route segments between Port Chicago and Oakland combined with its Fresno Subdivision between Stockton and Sacramento.

To conserve study resources, for operations modeling this SDP relies on the on-going planning process and related analysis being conducted by the BNSF and UPRR in cooperation with Caltrans DOR. As part of prior planning efforts, Caltrans DOR focused on passenger demand growth over the next 25-year planning period. Prior studies determined how many passenger trains will be required to meet this demand; established an objective of increasing passenger train speeds to 90 mph where possible; and identified the track and facility infrastructure improvements required to support the proposed future passenger train operations. These prior studies still have relevance for examining the infrastructure needed to support increased train frequencies and higher speeds on segments of the *San Joaquin* route not impacted by the parallel first construction section of the IOS. This chapter of the SDP describes rail operation planning and simulations for the San Joaquin Corridor to date.

9.1 BNSF Modeling

BNSF Railway conducted simulation analysis of its portion of the San Joaquin Corridor in 2010[(xxiii)] using Rail Traffic Controller (RTC model) and has been working with Caltrans DOR continuously since then. The analysis included proposed future operations for years 2020 and 2035 based on differing levels of passenger train service and speed options. The purpose of BNSF's work was to identify future capacity needs within segments of the San Joaquin corridor owned by them in order to prepare required planning, environmental, permitting, and engineering design work. Other BNSF modeling is being done for the Authority but that modeling will not be completed in time to be included in this SDP.

Using the passenger demand data, BNSF proceeded with line capacity modeling to identify the track modifications between Port Chicago and Bakersfield that the railroad considered necessary to support the proposed 2020 operating scenario (eight round trip trains) and the 2035 operating scenario (11 round trip trains). Port Chicago is the location where intercity passenger trains operating between Oakland and Bakersfield transition between the BNSF and UPRR tracks and is east of Martinez, which is on the UPRR owned segment of the *San Joaquin*. The following passenger train scenarios were modeled by BNSF:

- Base Case (2010). the current (in 2010) San Joaquin plan of six passenger trains per day in each direction from Bakersfield to Stockton, and four passenger trains per day in each direction from Stockton to Port Chicago.
- 5/10 Year 79 mph Plan. Eight passenger trains per day in each direction on the Bakersfield – Port Chicago segment (16 total); passenger trains operate at a maximum speed of 79 mph.
- 25 Year 79 mph Plan. 11 passenger trains per day in each direction on the Bakersfield – Port Chicago segment (22 total); passenger trains operate at a maximum speed of 79 mph.
- 5/10 Year 90 mph Plan. Eight passenger trains per day in each direction on the Bakersfield – Port Chicago segment (16 total); passenger trains operate at a maximum speed of 90 mph.
- 25 Year 90 mph Plan. 11 passenger trains per day in each direction on the Bakersfield – Port Chicago segment (22 total); passenger trains operate at a maximum speed of 90 mph.

BNSF modeled 320 weekly freight trains in the Base Case, while the 5/10 Year and 25 Year scenarios have 14 additional weekly freight trains beyond the Base Case level, yielding 334 total weekly freight trains for each future scenario.

Both of the 5/10 Year cases also have an additional scenario in which one daily round trip is operated in 'express' mode, with stops at only Stockton, Modesto, Fresno, and Hanford; the other 5/10 Year cases have all trains stopping at all stations.

Exhibit 9.1 is a graph from a BNSF simulation report showing the weekly trains included in their simulation analysis in each case. Train types Z8 and Z9 are UPS freight trains with dispatch priority just under passenger trains. Z1-7 refers to other types of freight trains with dispatch priorities just under Z8 and Z9 trains. The remaining types of freight trains (Other Intermodal, Other Freight) have the lowest dispatch priority.

9.1.1 Modeling Methodology

BNSF's modeling work was completed using RTC. Each of the five scenarios modeled included proposed passenger and freight train levels. Modeled infrastructure included current infrastructure along with additional infrastructure projects expected to be in place for each scenario, such as additional double tracking and sidings.

9.1.2 Service Network Analysis

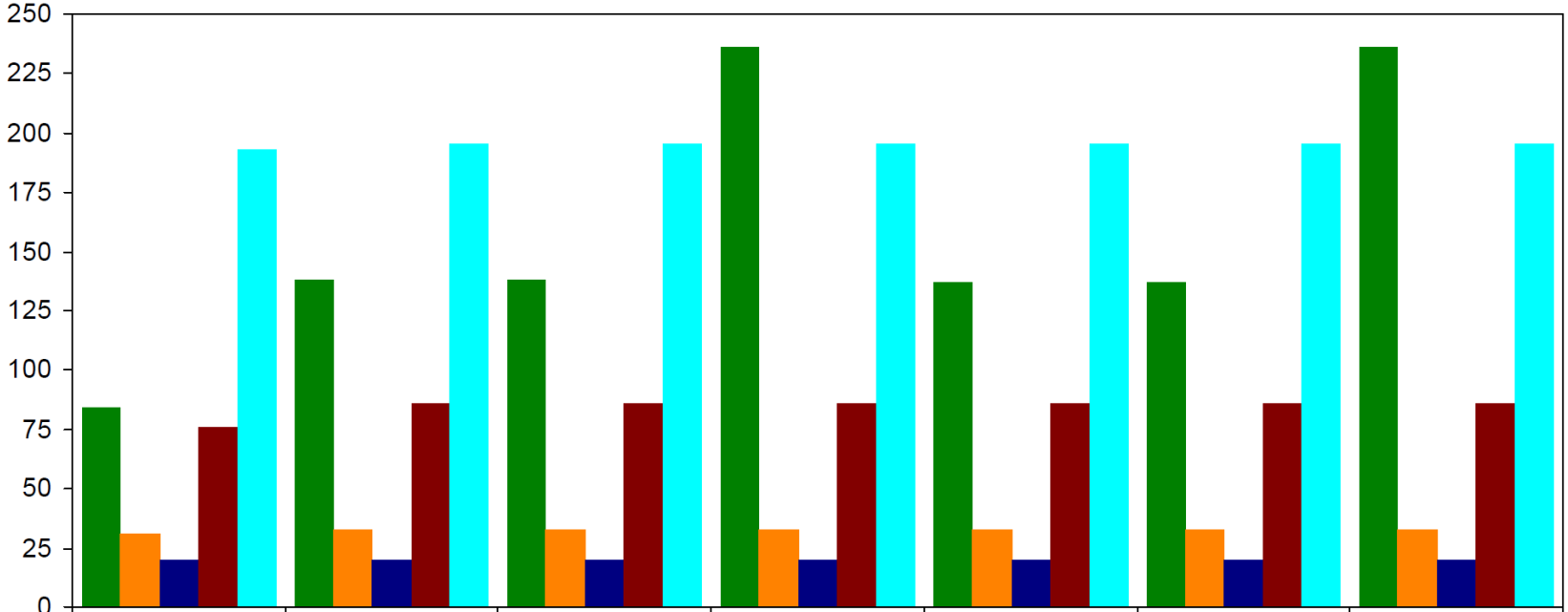
BNSF's RTC modeling methodology included the following steps:

- Passenger performance records were checked against actual on-time records and reviewed internally by BNSF for consistency.
- Passenger trains are given dispatch priority over all types of freight cargo. After passenger trains, UPS freight trains (Z8 and Z9) have the highest dispatch priority, followed by all other freight train types and local freight trains.
- A vetted Base Case freight delay hours and freight delay ratio (minutes of delay per 100 train miles) were developed as the standard against which all future case performance was matched. No decay in these values in the future scenarios was accepted.
- Improvements were identified by starting with an initial list of proposed capital improvements determined by BNSF. Each improvement was tested independently in RTC to rank their relative impact on delay performance. Next, cases were run iteratively starting with the most beneficial projects until performance matched at minimum the Base Case delay levels. In some cases, the original list of proposed projects was insufficient to match Base Case delay, so additional improvements were identified and modeled in regions with the most delay until Base Case delay records were matched.

9.1.3 Operational, Equipment, and Infrastructure Reliability

Train reliability is crucial to operators in meeting OTP goals. On the San Joaquin Corridor network, there are some elements of infrastructure which may impede reliability. The San Joaquin Corridor handles a large volume of freight traffic, with 320 weekly freight trains included in the 2010 BNSF Base Case, compared to 84 weekly passenger trains. Many sections of the Corridor are single tracked or have sidings of insufficient length to accommodate freight trains, leading to conflicts and train delays due to congestion within the region. BNSF's RTC simulation effort identified improvements which enable train delay performance to remain steady at 2010 levels or better in future years as train traffic increases. Most of the recommended improvements include significantly increased levels of double tracking across the San Joaquin Corridor, which reduces train conflicts and improves train delay levels.

Exhibit 9.1: BNSF Trains per Week in RTC Simulations [(1)]



	Base case	5/10 year 79 mph plan (1 express schedule)	5/10 year 79 mph plan (no express schedules)	25 year 79 mph plan	5/10 year 90 mph plan (1 express schedule)	5/10 year 90 mph plan (no express schedules)	25 year 90 mph plan
Passenger	84	138	138	236	137	137	236
Z1-7	31	33	33	33	33	33	33
Z8-9	20	20	20	20	20	20	20
Other lmdl	76	86	86	86	86	86	86
Other freight	193	195	195	195	195	195	195

Notes:

(3) *San Joaquin Valley Capacity Analysis: Summary of RTC Simulations*, BNSF Railway, October 8, 2010.

The San Joaquin Corridor already includes modern features such as Centralized Traffic Control across the entire corridor, which allows centralized control of train dispatching, switching and signaling decisions. With existing infrastructure, the maximum authorized speed any passenger train may travel is 79 mph. Two of the four future year scenarios include analysis of a maximum authorized speed of 90 mph. Higher speeds would result in faster trip time resulting in increased travel time savings benefits for passengers.

9.2 Union Pacific Operations Planning

UPRR did not model its segments of the San Joaquin Corridor, which includes the Fresno Subdivision between Sacramento and Stockton and the Martinez Subdivision between Martinez and Oakland or the Tracy Subdivision between Port Chicago and Martinez. Instead of modeling the proposed service increases as listed in Section 9.1, the UPRR requested specific modifications to their railroad infrastructure they claimed would be needed to support the proposed increases in passenger train operations. According to UPRR, the Martinez subdivision is among the most dense and constrained routes in their system, handling both passenger and freight trains. While no simulation analysis was included for the Martinez Subdivision, Jerry Wilmoth, General Manager of Network Infrastructure of UPRR, indicated in a 2010 letter[(xxiv)] to Caltrans that they see a need for improvements in the region, including:

- Double-tracking between Port Chicago and Martinez.
- Full triple tracking between Martinez and Oakland with universal crossovers every six to eight miles.
- Upgraded station designs to allow unimpeded flow of trains on all tracks at track speed while passenger trains load and unload at stations.

In order to evaluate an actual improvement scenario for the UPPR track segments from Stockton to Sacramento, Caltrans contracted a railroad engineering firm to examine this alignment and identify the scope of improvements that could reasonably be installed within this segment of the San Joaquin Corridor. There are two UPRR track alignments between Stockton and Sacramento. The first is the Fresno Subdivision, which is the current route of the existing *San Joaquin* service; the second is the Sacramento Subdivision (former Western Pacific) on the west. Although UPRR did not model the route, there is an assumed need for an additional track to be installed on each alignment, resulting in two tracks on the route selected for the Stockton to Sacramento corridor.

Based upon field surveys and a review of existing track charts, J.L. Patterson and Associates determined that it is possible to add the required track improvements to each of the UPPR corridors. With the exception of a small segment near Lodi, where it was judged infeasible to construct a second track, the entire Fresno Subdivision could receive a second track, either through upgrade of an existing siding to mainline status or through installation of a new second track. Approximately 43 miles of new track would be constructed. If the Sacramento Subdivision is selected for improvement, a second track could be installed along the entire alignment, either through upgrading existing sidings or installation of a second track, resulting in approximately 42 miles of new track. However there is considerable apprehension and opposition to the use of the Sacramento Subdivision from the local and regional agencies between Sacramento and Merced, including Sacramento RT, SACOG, the City of Sacramento, San Joaquin Regional Rail Commission and the Central Valley Rail Working Group).

Scenario A which is chosen as the Build Scenario, doesn't require any increases in service on UP track, therefore no analysis of UP track was necessary for the Build scenario. However, AECOM recommends that simulation of the complete San Joaquin corridor be performed, as that will analyze the effects of network infrastructure improvements in UPRR segments on the BNSF segments and vice versa. One of the possible outcomes of this simulation study would be that some of the suggested network

infrastructure improvements suggested by the railroads may not be considered to be needed based on the simulation results.

9.3 Integrated Operating Timetables

Operating timetables were developed for the San Joaquin Valley Capacity Analysis: Summary of RTC Simulations (2010). These timetables can be found as an attachment to the Vision Study 2012.

Caltrans DOR developed *pro forma* operating timetables for Build Alternative A to determine equipment requirements. These timetables conform to the BNSF capacity analysis timetables for train scheduling.

9.4 Equipment Consists

This section summarizes the type of equipment used for train services operating on the San Joaquin Corridor, including locomotive, engine, and car types, where available. Amtrak's *California Zephyr*, *Coast Starlight* and *Capital Corridor* passenger services all run on a small segment of the San Joaquin Corridor between Martinez and Emeryville, but these were not included in BNSF's RTC analysis as that segment of the corridor is owned by the UPRR.

9.4.1 Intercity Passenger Rail Services

The *San Joaquin* service primarily operates using two types of locomotives: the EMD F59PHI, and the GE P32-8WH. The EMD F59PH locomotives used on the *San Joaquin* service are owned by Caltrans.

Like most Amtrak services, *San Joaquin* service operates the California variant of the Superliner double-decked passenger car. Several types of passenger cars are included in each train consist: a coach-baggage car, a café car, coach cars, a cab car, and cab-baggage car. The cab car is identical to the coach car but also includes the engineer's operating cab, while the cab-baggage car includes the engineer's operating cab and additional space for luggage. This configuration allows the train to be operated in push-pull mode to eliminate the need to turn the train. While each train will have at least one of each of these types of cars, in some situations more than one of certain car types will be present. For instance, it is assumed that some combined trains will operate south of Stockton, resulting in trains with two café cars, two cab-baggage cars, and a locomotive on each end.[xxv]

All trains will have a cab/baggage and café-lounge car, including both sections of trains that split or combine at Stockton (thus, combined trains operating south of Stockton will have two café-lounge cars, two cab/baggage cars coupled face-to-face, and a locomotive on each end). This is required to meet the requirements of set interchangeability, passenger service and equipment maintenance.

9.4.2 Freight Rail Services

Unlike passenger service, freight train consists across the network are not uniform. Train length, railcar type, and number of locomotives will vary depending on the type of cargo and distance to be traveled.

9.5 Rail Infrastructure Characteristics

This section describes the significant characteristics of the San Joaquin Corridor network, including: locations where CTC has been implemented, locations with potentially insufficient sidings, and the number of main tracks available across the network.

9.5.1 Rail Infrastructure Network Background

The San Joaquin Corridor is defined as operating between Bakersfield and Oakland, as well as along the Fresno Subdivision between Stockton and Sacramento. The infrastructure within the Corridor is generally designed to modern standards, including CTC implemented across the entire Corridor.

The number of available main tracks varies across the San Joaquin Corridor, but generally includes either one or two tracks. There are brief segments with three tracks available, such as near Martinez.

9.5.2 Infrastructure-related Assumptions

Each scenario modeled by BNSF included a list of projects in addition to existing infrastructure, intended to allow growth in train traffic volumes in future years while maintaining Base Case delay levels without degradation in performance if possible. BNSF modeling did not assume operation of trains on the first construction section of the IOS. On-going BNSF operations modeling being conducted for the Authority will include that assumption. But that operations simulation modeling will not be completed prior to publication of this SDP.

In the Base Case, infrastructure projects included in the model in addition to existing infrastructure are given in Table 9.1.

Table 9.1: Infrastructure Projects Included in Base Case

Infrastructure Project Description
Double-track Guernsey–Hanford, with crossovers in between; retains Shirley siding (six miles)
Convert Gregg siding to double-track – segment MP 1008.9 to 1013.9 (five miles)
Double-track LeGrand–Planada with crossovers in between (nine miles)
Double-track MP 1107.0 to Walnut with associated crossover and power turnout work (nine miles)
Convert Pittsburg siding to double-track and extend east to MP 1152.7 (five miles)

For future years, infrastructure projects are categorized according to the year in which they are recommended for implementation. Tables 9.2 – 9.5 summarize the infrastructure projects included in the future year scenarios. Red projects indicate those included in the Base Case, while green is used for 5/10 Year projects and blue for 25 Year projects.

Table 9.2: Infrastructure Projects Included in 5/10 Year 79 mph Plan (Eight trains)

Infrastructure Project Description	Project Category
Double-track Guernsey–Hanford, with crossovers in between; retains Shirley siding (six miles)	Red
Convert Gregg siding to double track – segment MP 1008.9 to 1013.9 (five miles)	Red
Double-track LeGrand to Planada with crossovers in between (nine miles)	Red
Double-track MP 1107.0 to Walnut with associated crossover and power turnout work (nine miles)	Red
Convert Pittsburg siding to double-track and extend east to MP 1152.7 (five miles)	Red

Table 9.3: Infrastructure Projects Included in 25 Year 79 mph Plan (11 trains)

Infrastructure Project Description	Project Category
Double-track Guernsey–Hanford, with crossovers in between; retains Shirley siding (six miles)	Red
Convert Gregg siding to double-track – segment MP 1008.9 to 1013.9 (five miles)	Red
Double-track LeGrand–Planada with crossovers in between (nine miles)	Red
Double-track MP 1107.0 to Walnut with associated crossover and power turnout work (nine miles)	Red
Convert Pittsburg siding to double-track and extend east to MP 1152.7 (five miles)	Red
Conejo drill track	Green
Double-track Jastro–Shafter; retains Una siding (13 miles)	Blue
Double-track Angiola–Corcoran; retains Corcoran siding (12 miles)	Blue
Double-track Fig Garden to MP 1008.6 (five miles)	Blue
Double-track MP1013.9 – Madera, retains Madera siding (six miles)	Blue
Double-track Planada–Merced (eight miles)	Blue
Double-track Escalon–Duffy (nine miles)	Blue
Double-track Pittsburg–Port Chicago (8eight miles)	Blue

Table 9.4: Infrastructure Projects Included in 5/10 Year 90 mph Plan (Eight trains)

Infrastructure Project Description	Project Category
Double-track Guernsey–Hanford, with crossovers in between; retains Shirley siding (six miles)	Red
Convert Gregg siding to double-track – segment MP1008.9 to 1013.9 (5five miles)	Red
Double-track LeGrand to Planada with crossovers in between (9 miles)	Red
Double-track MP 1107.0 to Walnut with associated crossover and power turnout work (nine miles)	Red
Convert Pittsburg siding to double-track and extend east to MP1152.7 (five miles)	Red
Conejo drill track	Green
Double-track Jastro–Una, retains Una siding (13 miles)	Green
Double-track Planada–Merced (eight miles)	Green
Double-track Escalon–Duffy (nine miles)	Green

Table 9.5: Infrastructure Projects Included in 25 Year 90 mph Plan (11 trains)

Infrastructure Project Description	Project Category
Double-track Guernsey–Hanford, with crossovers in between; retains Shirley siding (six miles)	Red
Convert Gregg siding to double-track – segment MP 1008.9 to 1013.9 (five miles)	Red
Double-track LeGrand–Planada with crossovers in between (nine miles)	Red
Double-track MP 1107.0 to Walnut with associated crossover and power turnout work (nine miles)	Red
Convert Pittsburg siding to double-track and extend east to MP 1152.7 (five miles)	Red
Conejo drill track	Green
Double-track Jastro–Una, retains Una siding (13 miles)	Green

Infrastructure Project Description	Project Category
Double-track Planada–Merced (eight miles)	Green
Double-track Escalon–Duffy (nine miles)	Green
Double-track Una–Shafter (eight miles)	Blue
Wasco siding extended	Blue
Double-track Elmo–Sandrini (eight miles)	Blue
Double-track Allensworth–Angiola–Corcoran; retains Corcoran siding (22 miles)	Blue
Double-track Fig Garden to MP 1008.6 (five miles)	Blue
Double-track MP 1013.9 – Madera; retains Madera siding (six miles)	Blue
Double-track Fluhr–Ballico (11 miles)	Blue
Double-track Pittsburg–Port Chicago (eight miles)	Blue

Exhibit 9.2 is a representation of the current track structure as of BNSFs 2010 analysis, showing locations of sidings and single- versus double-tracking. This representation does not include any planned upgrades, including those assumed for the Base Case scenario. Exhibits 9.3 – 9.6 show the recommended infrastructure configurations for each future year scenario. The track colors in Exhibits 9.3 – 9.6 correspond to the color categories in Tables 9.1 – 9.5. Exhibit 9.7 is a graph comparing the percentage of double-tracking between Bakersfield and Port Chicago included in each scenario based on existing infrastructure plus the recommended improvement projects from Tables 9.1 – 9.5.

9.6 BNSF Model Outputs

This section summarizes RTC model outputs used for analysis by BNSF. The metrics used by BNSF include average train speed, minutes of delay per 100 train miles, and on-time performance for passenger trains. The overall performance goal for each future year scenario was to at least match Base Case performance for each metric for each type of train; this was achieved in most, but not all situations.

Table 9.6 summarizes where future year freight train performance degraded compared to the Base Case.

Table 9.6: Future Year Freight Performance Metrics versus Base Case

Type	Metric	5/10 Year 79 mph with express	5/10 Year 79 mph No express	25 Year 79 mph	5/10 Year 90 mph with express	5/10 Year 90 mph No express	25 Year 90 mph
Z1-Z7	Speed	xxx	xxx	xxx	xxx	xxx	xxx
Z1-Z7	Delay / 100	xxx	xxx	xxx	xxx		xxx
Z8-Z9	Speed						
Z8-Z9	Delay / 100						
Other Intermodal	Speed						
Other Intermodal	Delay / 100	xxx	xxx	xxx		xxx	
Other Freight	Speed						
Other Freight	Delay / 100		xxx				xxx

Notes:

- "xxx" indicates degradation in performance compared to the Base Case.

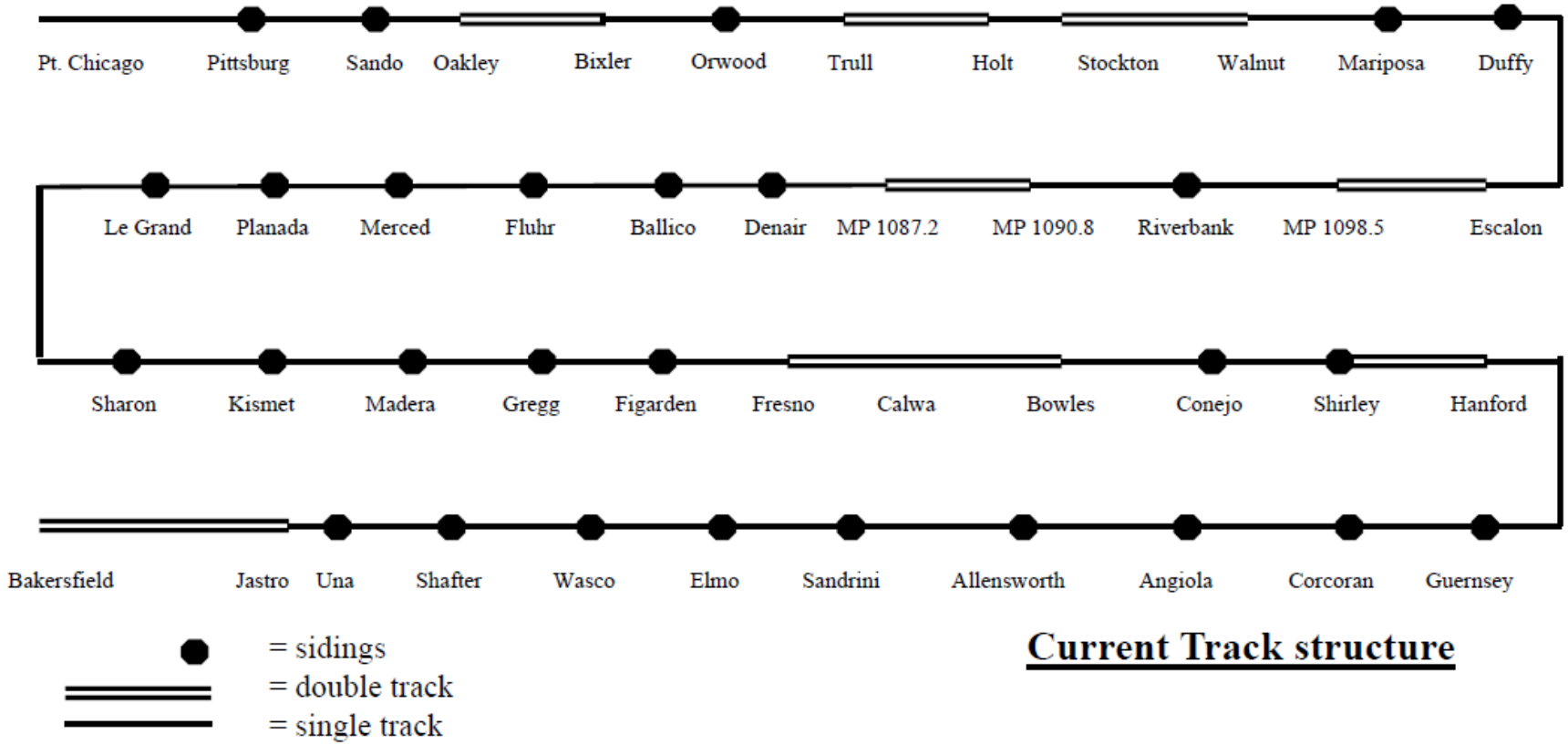
BNSF's RTC model results had freight trains of type Z1 – Z7 degrading modestly in each case. The Base Case speed was 34.3 mph, while the lowest average speed in any future scenario was 32.5 mph. Delay per 100 train miles also degrades in all but one future year scenario for type Z1 – Z7 trains from the Base Case level of 27.11 minutes. The 5/10 Year 79 mph scenario with express schedule has the highest delay level 34.55 minutes. According to BNSF, this represents about 17 minutes of additional delay per train between Mariposa and Bakersfield.

Other Intermodal type trains had RTC model results indicating degradation in delay per 100 train miles in four of six scenarios, from the Base Case delay level of 41.18 minutes. The highest level of delay occurred in the 5/10 Year 79 mph scenario with no express schedule at 45.07 minutes, an increase of 3.89 minutes per 100 train miles. BNSF indicated that the other scenarios with degraded metrics range from 2.29 to 3.65 additional delay minutes per 100 train miles, equating to five to eight minutes of additional delay per train operated.

Other Freight type trains also had degraded delay per 100 train miles performance in two cases. The Base Case RTC simulation for this train type resulted in 60.50 minutes of delay per 100 train miles. The 5/10 Year 79 mph scenario with no express schedule had the highest level of delay at 65.94 minutes, or an additional 5.44 minutes compared to the Base Case. This results in about 13 minutes of added delay per train operated between Stockton and Bakersfield. The 25 Year 79 mph scenario degraded similarly, with 5.01 minutes of additional delay per 100 train miles compared to the Base Case, or about 12 additional minutes per train operated.

Exhibits 9.8 through 9.10 are graphs of BNSF's RTC outputs. Exhibit 9.8 presents average train speed, while Exhibit 9.9 shows minutes of delay per 100 train miles, and Exhibit 9.10 presents passenger train OTP.

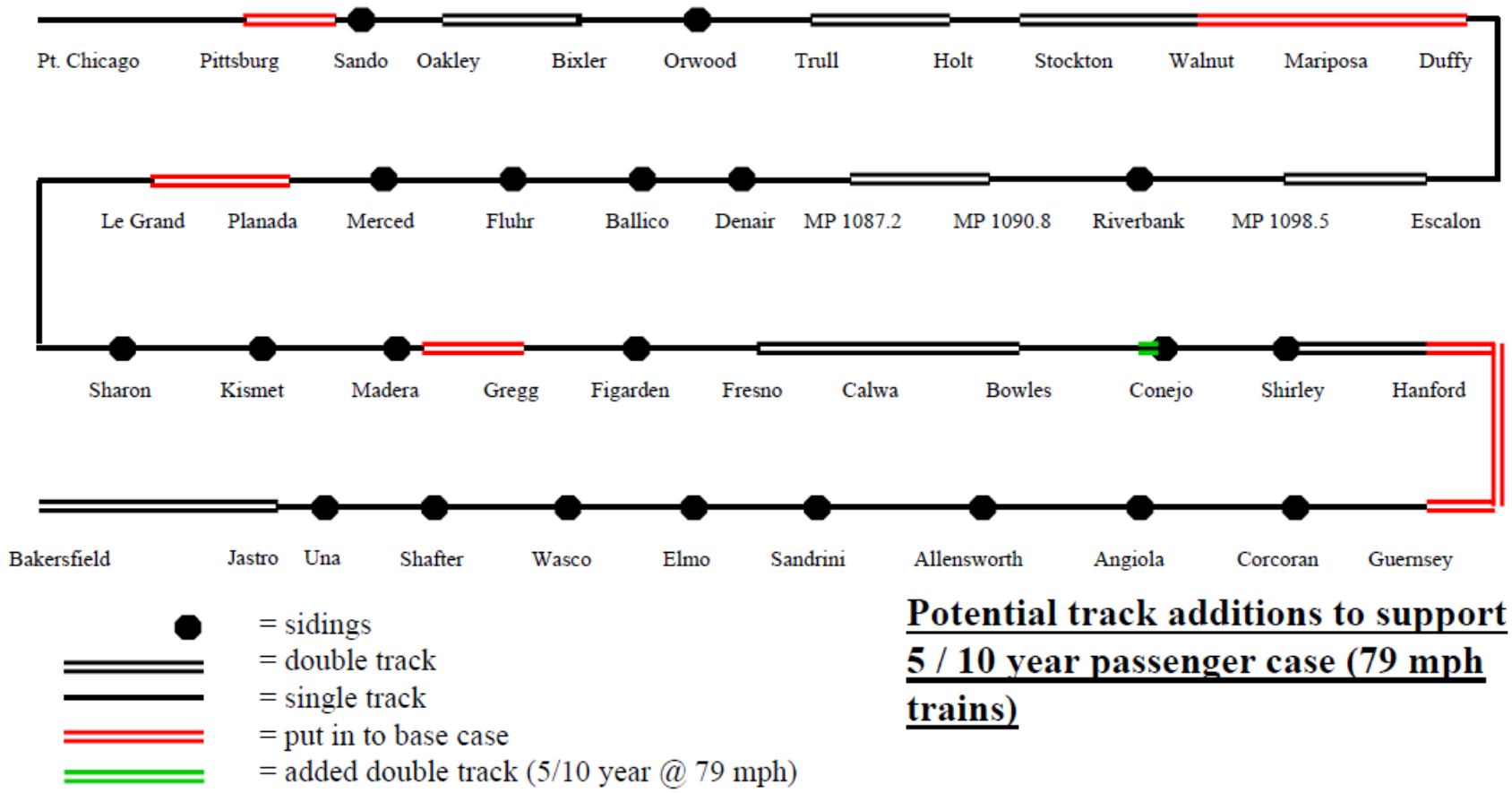
Exhibit 9.2: Current Track Structure as of 2010 BNSF Analysis [(1)]



Notes:

(1) *San Joaquin Valley Capacity Analysis: Summary of RTC Simulations*, BNSF Railway, October 8, 2010.

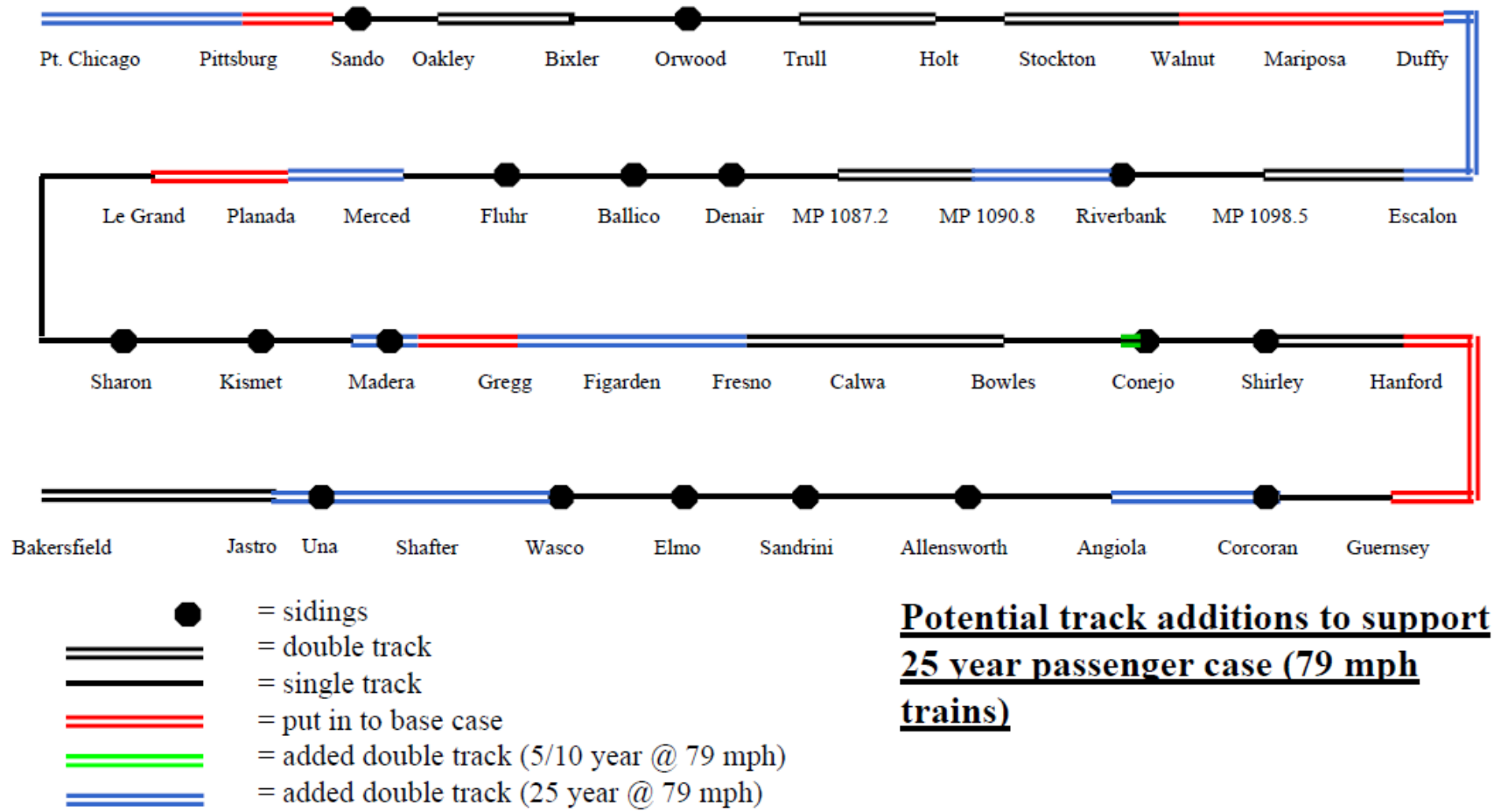
Exhibit 9.3: 5/10 Year 79 mph Track Structure Plan [1]



Notes:

(1) *San Joaquin Valley Capacity Analysis: Summary of RTC Simulations*, BNSF Railway, October 8, 2010.

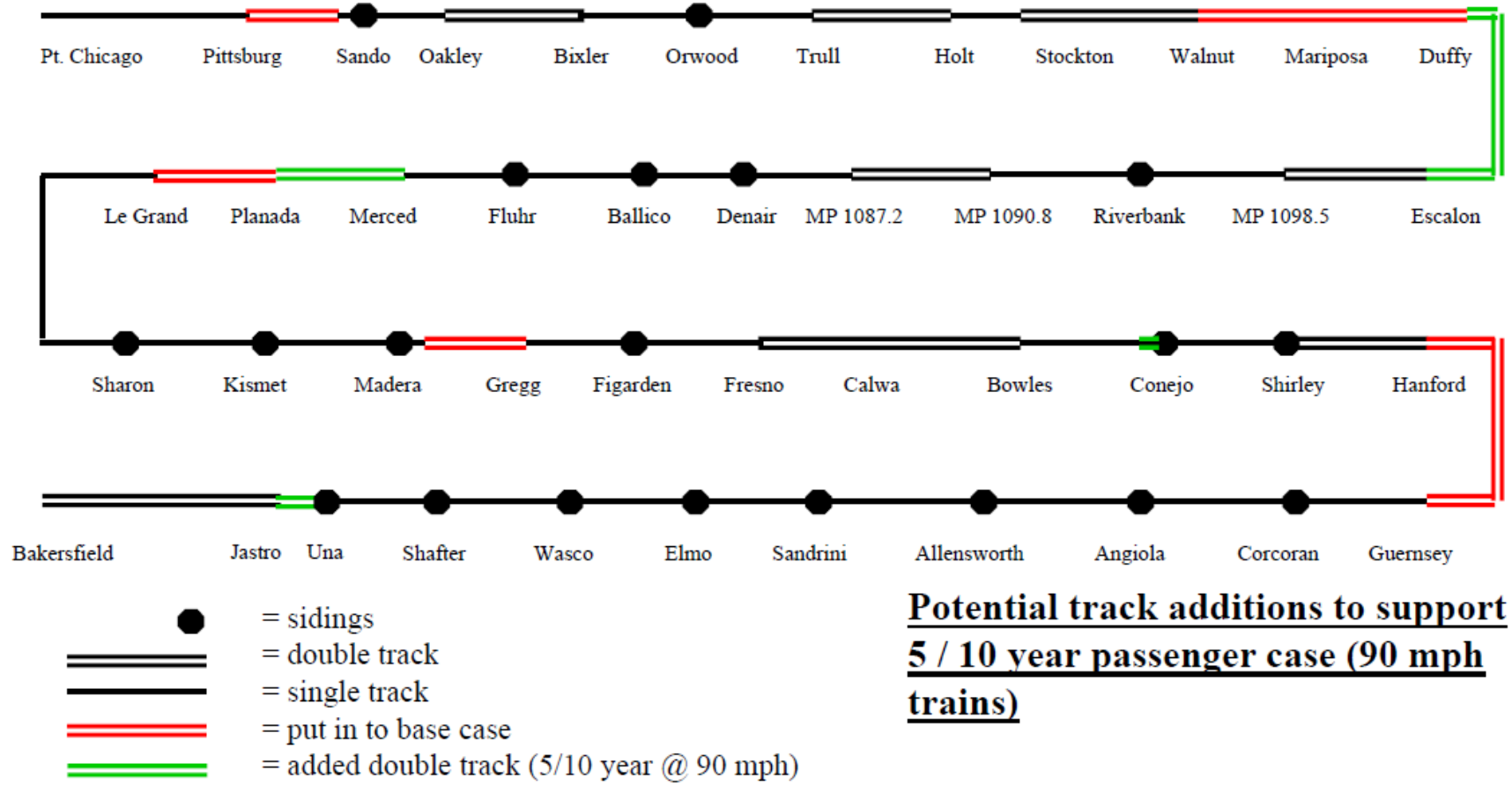
Exhibit 9.4: 25 Year 79 mph Track Structure Plan [(1)]



Notes:

(1) *San Joaquin Valley Capacity Analysis: Summary of RTC Simulations*, BNSF Railway, October 8, 2010.

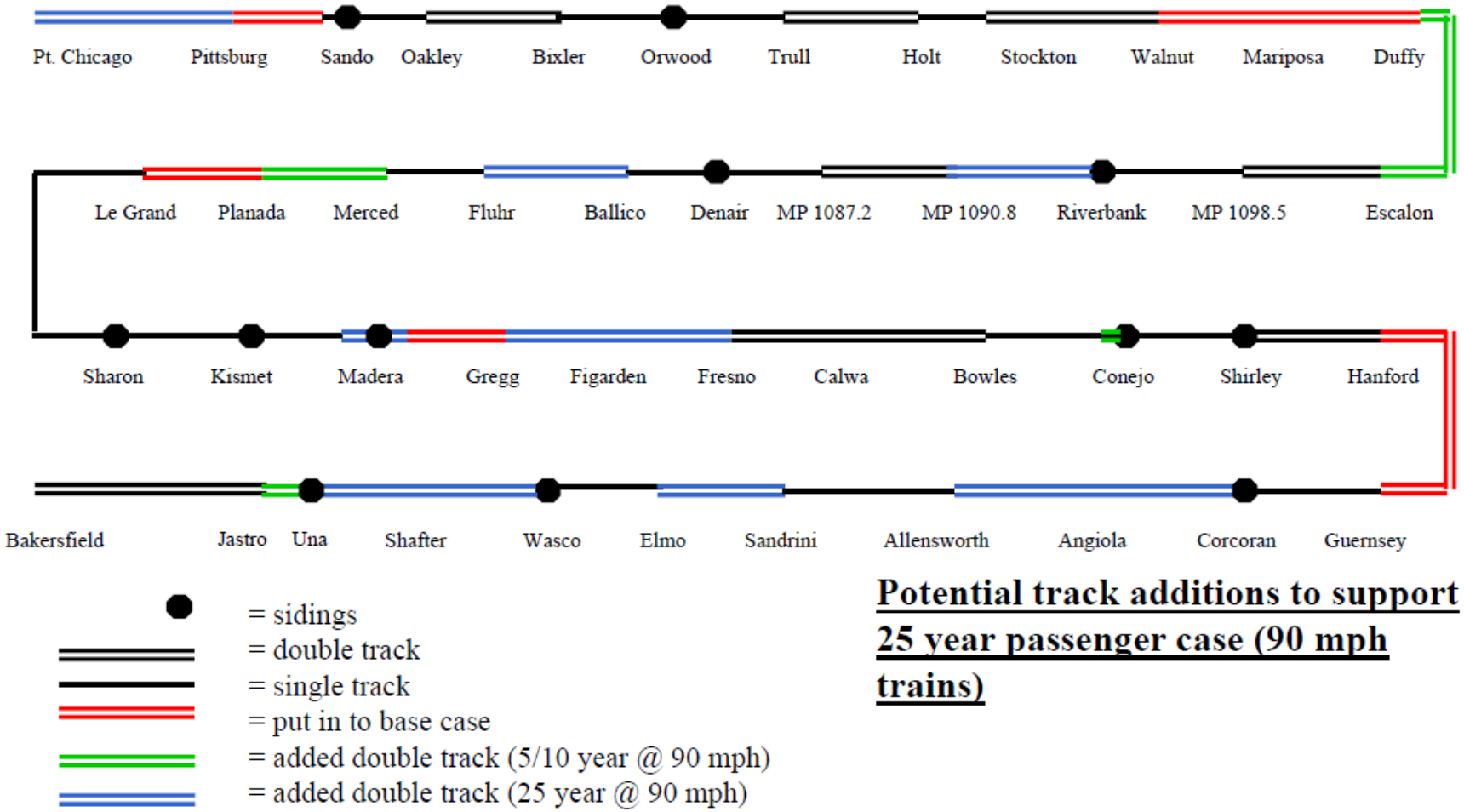
Exhibit 9.5: 5/10 Year 90 mph Track Structure Plan [1]



Notes:

(1) *San Joaquin Valley Capacity Analysis: Summary of RTC Simulations*, BNSF Railway, October 8, 2010.

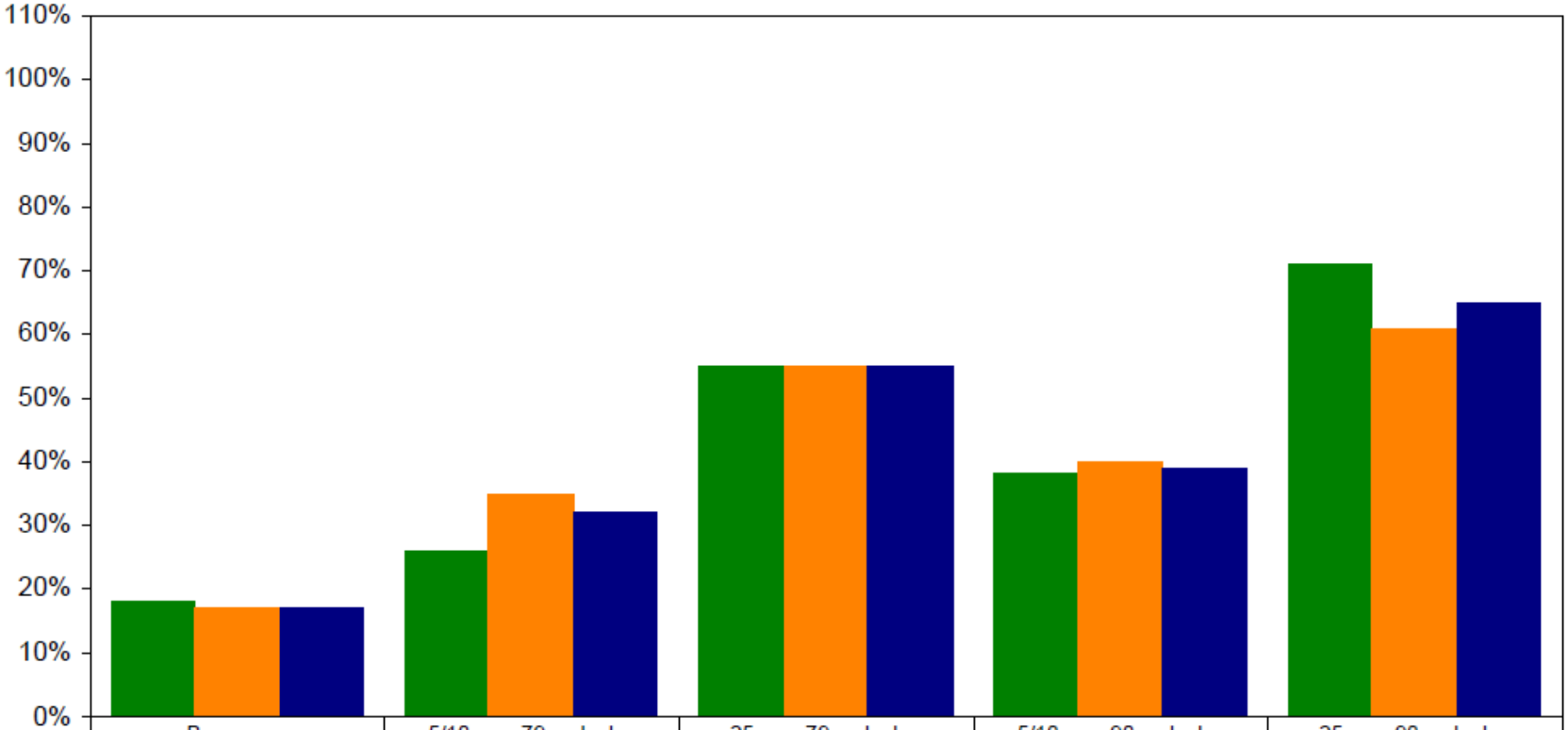
Exhibit 9.6: 25 Year 90 mph Track Structure Plan [1]



Notes:

(1) *San Joaquin Valley Capacity Analysis: Summary of RTC Simulations*, BNSF Railway, October 8, 2010.

Exhibit 9.7: Percentage of Double Tracking in Each Scenario [1]

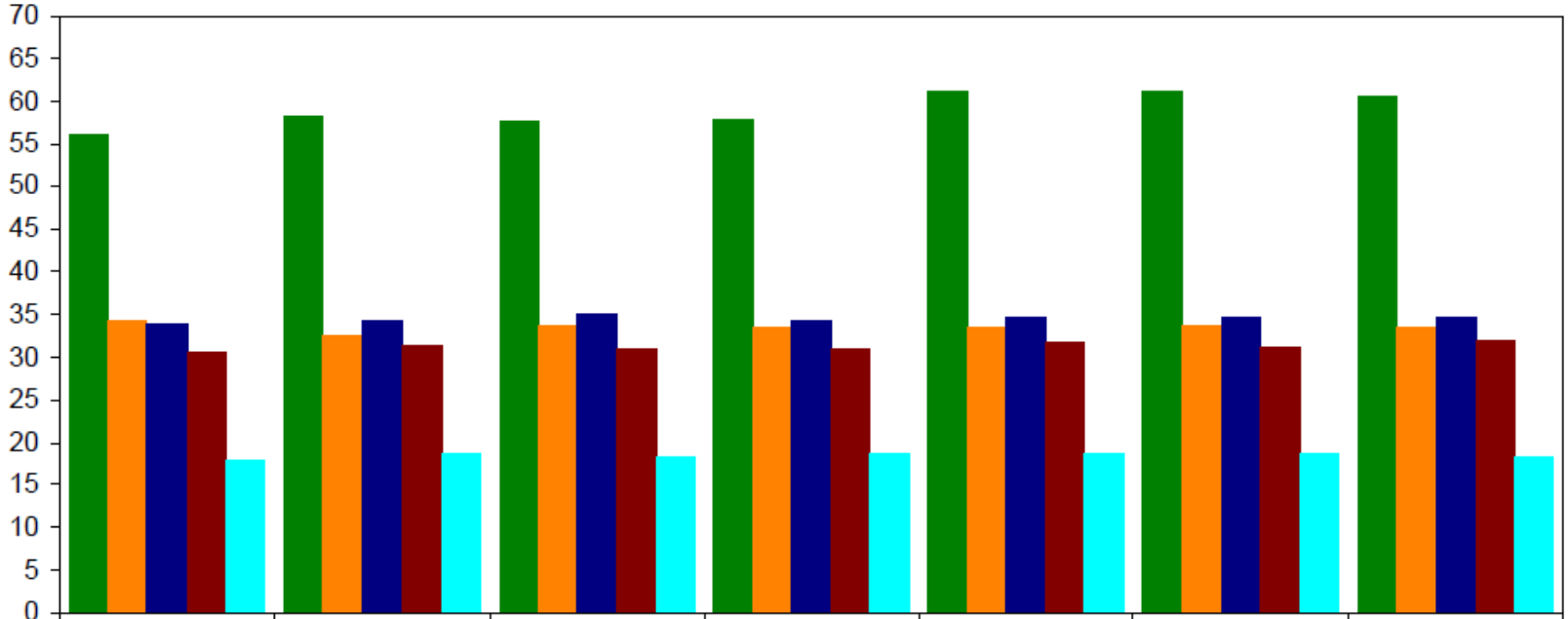


	Base case	5/10 year 79 mph plan	25 year 79 mph plan	5/10 year 90 mph plan	25 year 90 mph plan
Bakersfield	18%	26%	55%	38%	71%
Stockton	17%	35%	55%	40%	61%
Combined	17%	32%	55%	39%	65%

Notes:

(1) *San Joaquin Valley Capacity Analysis: Summary of RTC Simulations*, BNSF Railway, October 8, 2010.

Exhibit 9.8: RTC Results – Average Speed [1]



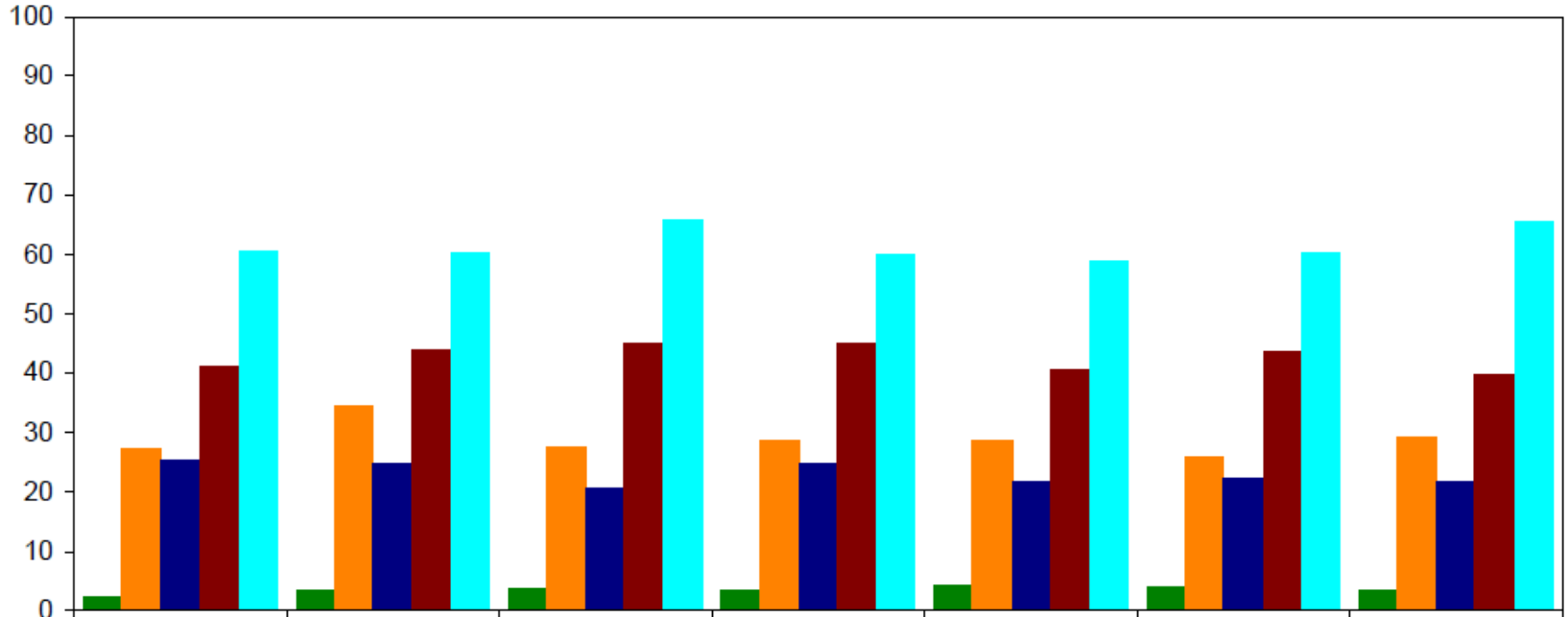
	Base case	5/10 year 79 mph plan (1 express schedule)	5/10 year 79 mph plan (no express schedules)	25 year 79 mph plan	5/10 year 90 mph plan (1 express schedule)	5/10 year 90 mph plan (no express schedules)	25 year 90 mph plan
Passenger	56.1	58.2	57.7	57.8	61.2	61.1	60.6
Z1-7	34.3	32.5	33.7	33.6	33.5	33.7	33.4
Z8-9	33.8	34.2	35.0	34.2	34.7	34.6	34.6
Other lmdl	30.4	31.2	31.0	31.0	31.7	31.1	31.9
Other freight	17.9	18.6	18.3	18.7	18.7	18.7	18.3

Notes:

(1) *San Joaquin Valley Capacity Analysis: Summary of RTC Simulations*, BNSF Railway, October 8, 2010.

- Average speed in miles per hour.

Exhibit 9.9: RTC Results – Minutes of Delay per 100 Train Miles [(1)]

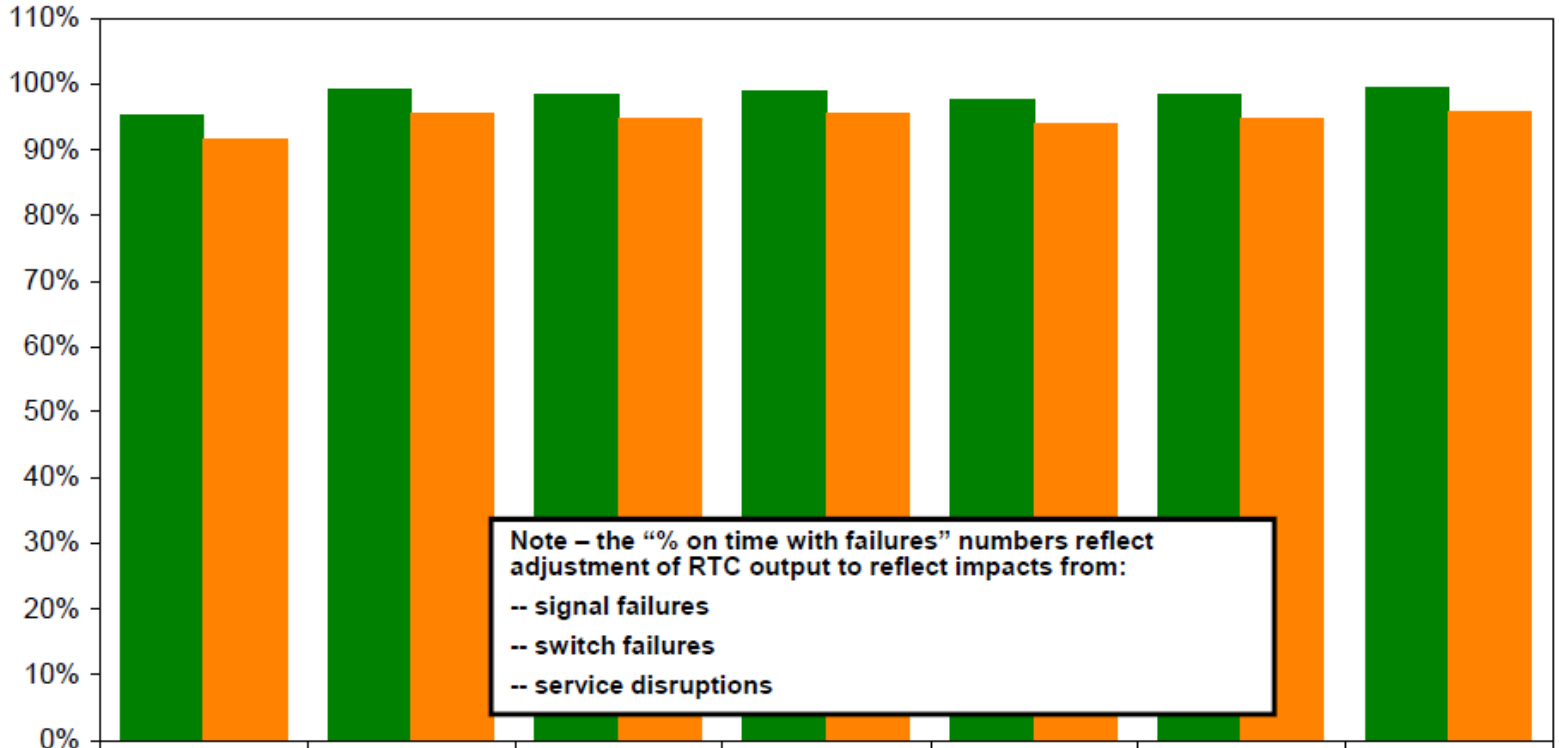


	Base case	5/10 year 79 mph plan (1 express schedule)	5/10 year 79 mph plan (no express schedules)	25 year 79 mph plan	5/10 year 90 mph plan (1 express schedule)	5/10 year 90 mph plan (no express schedules)	25 year 90 mph plan
Passenger	2.23	3.51	3.77	3.57	4.29	3.82	3.50
Z1-7	27.11	34.55	27.69	28.72	28.55	25.89	29.22
Z8-9	25.28	24.79	20.81	24.81	21.72	22.36	21.74
Other lmdl	41.18	44.07	45.07	44.83	40.44	43.47	39.52
Other freight	60.50	60.38	65.94	60.00	58.66	60.08	65.51

Notes:

(1) *San Joaquin Valley Capacity Analysis: Summary of RTC Simulations*, BNSF Railway, October 8, 2010.

Exhibit 9.10: Passenger Train On-Time Performance [1]



	Base case	5/10 year 79 mph plan (1 express schedule)	5/10 year 79 mph plan (no express schedules)	25 year 79 mph plan	5/10 year 90 mph plan (1 express schedule)	5/10 year 90 mph plan (no express schedules)	25 year 90 mph plan
% on time - no failures	95.2%	99.2%	98.4%	99.0%	97.6%	98.4%	99.5%
% on time with failures	91.5%	95.5%	94.7%	95.3%	93.9%	94.7%	95.8%

Notes:

(1) *San Joaquin Valley Capacity Analysis: Summary of RTC Simulations*, BNSF Railway, October 8, 2010.

9.7 Equipment and Train Crew Scheduling

Typical Amtrak train staffing varies depending on the types of railcars available and passenger levels. Based on typical *San Joaquin* service consists, a typical train will include at least: an engineer, a conductor, an assistant conductor, and a Café-Car attendant.

Employee shift scheduling is dependent on a number of factors, including employee seniority, length of the train's route, and type of employee (i.e. whether they are an operating employee or train attendant). Operating employees (engineers, conductors, and assistant conductors) have shift lengths determined by crew base locations and Federal Hours of Service requirements, such as a maximum of 12 work hours per day. An Amtrak crew change point is located in Sacramento for operating employees. On-board employees (primarily train attendants) typically remain with a train for the entire run.

The current *San Joaquin* service requires seven trainsets daily for operation of six round trips – four between Bakersfield and Oakland, and two between Bakersfield and Sacramento. These seven trainsets utilize a total of 42 cars and 9 locomotives, including maintenance spares as indicated in the first row of Table 9.7, which summarizes the fleet size requirements for the Baseline Alternative and each horizon year and speed option examined in the BNSF capacity analysis, including maintenance spare and additional equipment needs due to retirement or relocation of existing equipment.

Table 9.7: Future Equipment Forecast

	Cab-Baggage	Coach	Café	Loco-motive	Total # of Cars	Total # of Trainsets
Current revenue requirements	9	24	9	9	42	7
2020 79/90 mph total revenue operating requirement	11	32	11	11	54	9
New revenue equipment required (increase over current)	2	8	2	2	12	2
Equipment due for replacement by 2020	0	4	0	2	4	NA
Total new & replacement equipment for 2020 79/90mph	*2*	*12*	*2*	*4*	*16*	*2*
2035 90mph total revenue operating requirement	20	70	20	20	110	17
New revenue equipment required (increase over 2020)	9	38	9	9	56	NA
New revenue equipment required (increase over current)	11	46	11	11	68	10
Equipment due for replacement by 2035	9	20	9	7	38	NA
Total new revenue & replacement equipment for 2035 90mph	*18*	*58*	*18*	*16*	*94*	*NA*
Total new revenue equipment (2020 and 2035)	*11*	*46*	*11*	*11*	*68*	*NA*
Total replacement equipment (2020 and 2035)	*9*	*24*	*9*	*9*	*42*	*NA*

Source: San Joaquin Corridor Intercity Passenger Rail: Programmatic Environmental Impact Review / Environmental Impact Statement, October 28, 2011, p. 20.

Notes:

- "NA" indicates not applicable.

As indicated, Caltrans DOR reviewed the operating scenarios for the San Joaquin prepared for the BNSF capacity analysis and developed operating schedules to support the generalized operating scenarios for

the blended service program commencing in 2018. The equipment requirements for the 2018 blended system operating schedule for Build Alternative A require a total of ten trainsets with a total of 96 cars and 25 locomotives (Three F59PHI and 22 125 mph-capable high-speed NGEC locomotives), including maintenance spares. A detailed equipment rotation and consist size summary is provided in Table 9.8. This represents an increase of 54 cars and 22 NGEC 125-mph locomotives over current operating requirements.

Table 9.8: Blended Service Equipment Forecast

	Cab-Baggage	Coach	Café	Loco-motive	Total # of Cars	Total # of Trainsets
Current schedule requirements	9	24	9	9 [a]	42	7
2018 schedule requirement (79/125 mph)	16	65	15	25	96	10
Increase over current schedule	7	41	6	22 [b]	54	3
Equipment due for replacement by 2020	0	4	0	2	4	NA
Total new & replacement equipment for 2020 (79/125 mph)	*7*	*45*	*6*	*24*	*58*	*3*

Source: Caltrans DOR, October 17, 2012.
Notes:
(1) Older locomotives will be retired or reassigned to other conventional services.
(2) [b] Next Generation 125 mph locomotives

The equipment needs assessment has been performed using the 2018 "BNSF 79 mph" schedule as provided, and with the following assumptions:

- There are no shared trainsets between the *San Joaquin* and *Capitol Corridor* or with other commuter and regional rail operators such as Caltrain or ACE. All equipment shown operates exclusively on the *San Joaquin* corridor.
- The ability of layover facilities in Bakersfield, Oakland or Sacramento to accommodate these operating scenarios has not been assessed as part of this equipment needs summary.
- All trains will have a café-lounge car, including both sections of trains that split or combine at Stockton (thus, combined trains operating south of Stockton will have two café-lounge cars, two cab/baggage cars coupled face-to-face, and a locomotive on each end). Each trainset will include at least one cab-baggage car to provide checked baggage handling capability.
- All equipment will rotate through a primary maintenance facility (Oakland or Sacramento) for inspection, maintenance and servicing at least once during its rotational cycle.
- This scenario assumes that all equipment will be able to operate in this service without the need to be turned at any end point.
- The eight trainsets operating on the ICS will be separate from the two trainsets operating entirely on the BNSF, for the purposes of utilizing existing F59PHI locomotives as much as possible. All trains operating on the ICS will have two NGEC locomotives for 125 mph operation to provide propulsion for both sections of the train that split or combine in Stockton. The six additional locomotives are spares for scheduled maintenance and schedule protection.

9.8 Terminal, Yard, and Support Operations

Amtrak owns a yard facility in Los Angeles which is used to provide support for Amtrak trains and equipment system-wide. This includes system-wide fleet repairs and overhauls. Amtrak switching locomotives are located at the Los Angeles and Oakland facilities. The ability of layover facilities in Bakersfield, Oakland or Sacramento to accommodate these operating scenarios has not been fully

assessed as part of the equipment needs summary. The *San Joaquin* mid-route layover facility has not been fully addressed in this SDP as on-going studies for future blended service being conducted by the Authority and other regional rail agencies is not yet complete.

The amount of time required for maintenance of rolling stock varies depends on a number of variables, including scheduled equipment turns, availability of specific fleet and equipment types, and equipment mileage, manufacturer, and repair history. There are local maintenance facilities for rolling maintenance of Amtrak equipment in both Oakland and Sacramento.

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10.0 Station and Access Analysis

This chapter addresses the location of the stations to be served by the expanded San Joaquin services, how stations will accommodate the proposed services, how passengers will access stations, and how intermodal connections will be integrated at the stations.

The chapter identifies existing stations and considers new or expanded stations along the San Joaquin Corridor, characterizing existing and planned service integration and coordination. Current intermodal connectivity is analyzed, and key capital projects that would improve multimodal connectivity are presented. A typology of station types is developed, reflecting that stations sharing certain key characteristics would ideally be developed with common features.

The analysis is focused on identifying necessary safety, capacity and operational improvements in the stations themselves or in connecting bus and rail transit service. Key land use considerations such as Transit-Oriented Development (TOD) potential, Complete Streets and Sustainable Communities Strategies (SCS) are evaluated.

10.1 Station Location Analysis

10.1.1 Methodology

The methodology was limited to the identification of existing stations and future stations planned by applicable agencies in the corridor (i.e., cities and the Authority). Since the *San Joaquin* is not planned to be expanded outside of its existing corridor, a quantitative methodology for identifying location and need for new stations was not considered necessary. The methodology employed to evaluate the station locations includes a review of the existing stations along the Corridor and will be used to determine potential locations for station improvements or the addition of new stations. Available station services (i.e., staffing and ticketing machines) and multimodal access (i.e., transit connections, parking, taxi service, rental car services, and bicycle facilities) were studied, as were potential station improvements. As well, the possible locations of new stations that would be required under the proposed expanded service in the Corridor were investigated.

Criteria addressing station location include:

- The extent to which the station location capitalizes on and serves existing communities.
- The level of convenience provided to the passenger in accessing important destinations in the station area or nearby.
- The potential for the station to complement and enhance the building fabric and streetscape in the station area.

Executive Order 13514 – Federal Leadership in Environmental, Energy, and Economic Performance has become federal policy to ensure that federally planned facilities, such as Corridor rail stations, include consideration of sites that are pedestrian friendly, near existing employment centers, accessible to public transit, and emphasize existing central cities.[(xxvi)] Such policy aligns with California state law SB 375 (Steinberg 2008), which requires the linking of transportation and land use in SCSs.

10.1.2 Potential Station Locations

The *San Joaquin* route connects Bakersfield with the Sacramento/San Francisco Bay regions of Northern California. The route is shown in Exhibit 1.1, which depicts the route and station locations. Through the Central Valley, the route roughly follows SR-99, branching in Stockton to terminate in Oakland and

Sacramento. Of the 18 existing stations, five are also served by *Capitol Corridor* trains, and one is served ACE.

Stockton is unique in that it has two Corridor stations, one for each branch of the route that splits in Stockton. The station south of Downtown is commonly referred to as the Stockton Amtrak station, and it serves the four round-trips of the San Joaquin service that connects Stockton to Oakland and the San Francisco Bay Area. The station east of Downtown is commonly referred to as the ACE station, because it serves as the eastern terminal for the ACE regional rail trains operating between Stockton and San Jose. In addition to ACE trains, this station also serves the two round-trips of the San Joaquin service that operate between Stockton and Sacramento. The two stations are located 1.5 miles apart and Amtrak operates a shuttle bus between them. The BNSF, UPRR, Caltrans DOR and local agencies are investigating the possibility of a joint station to serve future high-speed rail and both commuter and intercity passengers through a single terminal to improve interconnectivity between the two services because the bifurcation of service between the two stations often confuses passengers.[xxvii]

Passenger access to San Joaquin service is considered appropriate with the current station locations and spacing. However, there is local and regional interest in pursuing additional San Joaquin stations at Berkeley, Hercules, Elk Grove and 65th Street in Sacramento. Moreover, local and regional agencies have requested that the state investigate additional stations between Madera and Bakersfield (in particular West Bakersfield and North Fresno) which may increase the viability of continued service along the existing BNSF route. Additionally, three stations are proposed in the Corridor along the IOS of the California High-Speed Rail project, which may be used by San Joaquin trains before the full implementation of HSR. These stations include Fresno, a potential station at Kings/Tulare, and Bakersfield. The San Joaquin trains operating on the first construction section of the IOS would stop at these stations. A new HSR station is also planned for Merced and environmental studies for this station are currently underway. Additionally, the Madera station may be relocated if the existing station is bypassed by the connection between the first construction section of the IOS and the BNSF Stockton Subdivision currently used by San Joaquin service.

10.1.3 Transit-Oriented Development, Joint Use, and Joint Development Opportunities

Ideally, stations are located in proximity to complementary land uses. Locations near existing commercial and residential areas maximize ridership potential and function as a gateway to a city's major activity centers. Appropriate to the size of the community, TOD and SCS initiatives also factor in to station area planning. Smaller communities may not support high density TOD, but downtown stations like Wasco and Corcoran are good examples of long established TODs and support smart growth goals. Stations in larger communities such as Fresno, Bakersfield, Stockton (ACE), Oakland and Sacramento and those along the *Capitol Corridor* are potential candidates for higher density station-oriented infill development.

Table 10.1 provides a preliminary assessment of TOD potential at Corridor stations. Stations in the core urban area of the San Francisco Bay Area as well as Sacramento have the highest potential, as these stations host multiple transit services and have a greater market for higher-density, mixed-use development. Stations on the periphery of the San Francisco Bay Area and in the larger communities of the Central Valley offer medium potential, with moderate levels of transit service and a more limited market for TOD-style residences, offices and retail. Smaller communities in the Central Valley exhibit lower new TOD potential, lacking both frequent connecting services and a demand for compact, mixed-use development at scale.

TOD at stations furthers Caltrans policy to promote integrated land use and transportation. Such policy depends on, as well as supports, the efforts of local jurisdictions to maintain and redevelop their station-area districts and increase housing and employment opportunities for their residents. As a key stakeholder, Caltrans will support the station area planning efforts of local jurisdictions. Caltrans and

Corridor committees can build upon initiatives such as the transit village plan for Emeryville and Sacramento Valley stations in Northern California, as they engage local planners in TOD-related efforts.

Transit-oriented joint use and joint development add value to stations by placing additional uses and activity in station buildings or surrounding properties. Businesses and offices can profit from close proximity to rail service, and passengers can benefit from convenient access to these uses. Typical examples appropriate to the Corridor include cafés, newsstands, and other vendors that cater to rail passengers. Complementary retail uses can draw upon the non-passenger market of the surrounding area, enlivening the station and addressing security issues. Retailers can also fill the role of providing basic information about train services and local transportation options at unstaffed stations or outside of staffed hours.

Table 10.1 presents the existing amenities and staffing at Corridor stations, as well as a preliminary assessment of their joint use/joint development potential. Opportunities for joint use and joint development are on par with TOD potential at most stations, but are lower in cases where the station's function as an origin or destination is less important than the station's location in the surrounding region. So while the area around Richmond station is a prime infill site, the station's primary roles is in facilitating intermodal connections (and thus have a medium joint use/development potential). Additionally, joint development opportunities are also considered low at platform-only stations, while the surrounding area may have moderate TOD potential, as at Antioch station.

Table 10.1: Station Joint Development and New TOD Potential

Station	Existing Amenities	Joint Use/ Development Potential	New TOD Potential
Sacramento	Enclosed waiting room, ticket office, ticket machine, restrooms, phone, ATM	High	High
Lodi	Enclosed waiting room, ticket machine, phone	Low	Low
Stockton–ACE	Enclosed waiting room, ticket machine, phone	Medium	Medium
Oakland–Jack London Square	Enclosed waiting room, ticket office, ticket machine, restrooms, phone, ATM	High	High
Emeryville	Enclosed waiting room, ticket office, ticket machine, restrooms, phone, ATM	High	High
Richmond	Platform with shelter, ticket machine, phone	Medium	High
Martinez	Enclosed waiting room, ticket office, ticket machine, restrooms, phone	Medium	Medium
Antioch	Platform with shelter, ticket machine	Low	Medium
Stockton–Amtrak	Enclosed waiting room, ticket office, ticket machine, restrooms, phone	Low	Low
Modesto	Enclosed waiting room, ticket office, ticket machine, restrooms, phone	Low	Low
Denair/Turlock	Platform with shelter, ticket machine	Low	Low
Merced	Enclosed waiting room, ticket office, ticket machine, restrooms, phone	Medium	Medium
Madera	Platform only, ticket machine	Low	Low
Fresno	Enclosed waiting room, ticket office, ticket machine, restrooms, phone	High	High

Station	Existing Amenities	Joint Use/ Development Potential	New TOD Potential
Hanford	Enclosed waiting room, ticket office, ticket machine, restrooms, phone	Medium	Medium
Corcoran	Enclosed waiting room, ticket machine, restrooms, phone	Low	Low
Wasco	Platform with shelter, ticket machine	Low	Low
Bakersfield	Enclosed waiting room, ticket office, ticket machine, restrooms, phone, ATM	High	High
Kings/Tulare	This is a potential new HSR station for interim use.	Medium	Medium

Joint development may not be possible if suitable property surrounding Corridor stations is not available. Demand for joint use around stations in the Corridor is greatest in the San Francisco Bay Area and in Sacramento, but may be constrained by existing development adjacent to the station and limited room for expansion. More frequent services in these areas, such as the *Capitol Corridor*, represent a greater driver of joint development than San Joaquin service.

At intermediate stations along the Corridor, sufficient property may be available for joint development, but lower ridership levels may not be sufficient to spur joint use and joint development alone. However, provided the location would support the business with or without the presence of rail service, joint development may still be viable. Neighboring parcels may provide better opportunities for integrating complementary businesses, as is the case for a car rental agency at Emeryville station.

10.2 Station Operations Analysis

Station operations include a number of considerations related to the needs of Corridor passengers (ticketing, baggage handling, and information) and other supporting functions. Station operations also facilitate access by various modes and promote intermodal connections. Operational analysis of Corridor stations includes the identification of existing services and amenities provided at the stations, their track and platform configuration, and surrounding land uses. Stations are classified based on their relative importance: statewide, regional, or local.

Table 10.2 differentiates stations still further, defining five station categories based on the physical characteristics of stations: the density and type of urban form of the station area; auto access, as indicated by parking cost; and intermodal access, as represented by connecting rail and passenger services. These five station prototypes capture the wide range of station contexts and connectivity functions found throughout the state in an easily-applied framework.

Table 10.2: Station Prototypes

Station Category	Density and Urban Form	Auto Access	Typical Intermodal Access Modes
Statewide Significance			
"Major Metropolitan Downtown" • Sacramento Oakland–Jack London Square	High density; mixed-use, grid-based primary downtown in major metropolitan area	• High parking cost • Taxi	• Amtrak long-distance service • Amtrak Corridor service • Amtrak Thruway bus • Rail transit • Local transit • Shuttles (e.g., hotels)
Regional Significance			
"Developed Urban Area" • Emeryville • Richmond • Fresno(2) Bakersfield	Middle density; mixed-use, grid-based secondary downtown in major metropolitan area	• Moderate parking cost • Taxi	• Amtrak long-distance service at Emeryville and Richmond • Amtrak Corridor service • Amtrak Thruway bus • Rail Transit (BART at Richmond) • Local transit • Shuttles
"Minor Downtown or Activity Center" • Stockton–ACE • Martinez Stockton–Amtrak Merced(4)	Middle to low density; grid-based downtown in low-density suburban area or outside major metropolitan area	• Moderate to low parking cost • Taxi	• Amtrak long-distance service at Martinez • Amtrak Corridor service • Amtrak Thruway bus • ACE regional rail at Stockton • Local transit • Shuttles
Local Significance			
"Exurban or Outlying Area with Moderate Transit Connectivity" • Hanford Kings/Tulare(1)	Low density; exurban or outlying	• Low parking cost /free parking	• Amtrak Corridor service • Amtrak Thruway bus • Local transit • Shuttles
"Small Town with Limited Transit Connectivity" • Lodi • Antioch • Modesto • Denair/Turlock	Low density; exurban or outlying	• Free parking	• Amtrak Corridor service • Local transit • Shuttles

Station Category	Density and Urban Form	Auto Access	Typical Intermodal Access Modes
• Madera(7) • Corcoran • Wasco			

Notes:

(1) While the *Capitol Corridor* is classified as an intercity route due to its length and station spacing. It connects two major urban centers, and in some cases its service frequency and ridership are comparable to some Metrolink commuter rail services. In southern California, intercity rail (Pacific Surfliner) and commuter rail (Metrolink) operate in some of the same corridors and are interchangeable for many trips. Along the *Capitol Corridor*, this layering of intercity and commuter rail is not provided, but instead the needs of both markets are addressed through a single service.

(2) Station will be relocated in conjunction with the first construction section of the IOS.

(3) Long-distance and commuter rail service is typical for regionally-significant stations in the polycentric urban areas of northern and southern California. Fresno and Bakersfield are also considered major cities with regional significance, yet are bypassed by Amtrak's long-distance route network and represent "stand-alone" metropolitan areas without commuter rail service.

(4) Station may be relocated with in conjunction with the IOS, pending current studies.

(5) Statewide, most "minor downtown or activity centers" are in the major metropolitan areas of Los Angeles or the San Francisco Bay Area and have commuter rail service. The two Stockton stations are similar with respect to location and services; however, only Stockton – ACE is actually a commuter rail stop. Martinez receives commuter-like service provided by the *Capitol Corridor*, see Note 1. Merced represents a "stand-alone" metropolitan area without commuter rail service.

(6) Proposed new station.

(7) Station may be relocated in conjunction with the first construction section of the IOS, pending current studies.

- Statewide Significance. The "Major Metropolitan Downtown" station prototype has statewide significance. These stations are located in the high-density, mixed-use primary downtowns of major metropolitan areas. Auto access, while important, is not dominant and parking costs are high. All types of connecting passenger services are typically represented at these stations. Amtrak long-distance services (e.g. *California Zephyr*) as well as corridor services stop at these stations, and by virtue of the fact that these stations are located in major cities, a broad range of regional and local transit services are also represented. Trains serve the station throughout the day, often at regular intervals. The number of daily passengers and trains warrants a broad spectrum of amenities, including staffed ticketing offices, restrooms, phones, and vendors.

  Sacramento and Oakland–Jack London Square represent "Major Metropolitan Downtown" stations in the Corridor.

- Regional Significance. Stations with regional significance may be "Developed Urban Area" prototypes if in an area of middle density in a major metropolitan area; or "Minor Downtown or Activity Center" prototypes if in a lower-density suburban area, or outside of a major metropolitan area. The areas around these stations feature middle to lower-density development in grid-based downtowns, with moderate to low parking costs. Stations with regional importance typically host both long-distance as well as Corridor trains; within metropolitan regions they may have commuter rail or rail transit options. Several trains may serve the station throughout the day, but not necessarily at regular intervals. Regionally-significant stations may feature amenities such as staffed ticketing offices, restrooms, phones, and vendors, especially if outside the major metropolitan areas.

  Emeryville, Richmond, Fresno, and Bakersfield represent "Developed Urban Area" stations in the Corridor. "Minor Downtown or Activity Center" stations in the Corridor include Stockton – ACE, Martinez, Stockton–Amtrak, and Merced.

- Local significance. Stations with local significance are "Exurban or Outlying Area" prototypes, with moderate or limited transit connectivity. A station with moderate transit connectivity is a connection point for Amtrak Thruway buses, while a station with limited transit connectivity is served only by local buses. The areas around these stations are outlying or exurban in character,

with a dominant focus on auto access and low cost or free parking. Stations with local significance typically will not serve long-distance trains, only Corridor trains. Trains may be limited to only a few services in each direction throughout the day. Amenities are typically limited at locally-significant stations, and most are unstaffed.

Among "Small Town" stations, Hanford has moderate transit connectivity, while Lodi, Antioch, Modesto, Denair/Turlock, Madera, Corcoran, and Wasco have limited transit connectivity. The potential new Kings/Tulare HSR station is planned in an exurban, outlying area and is expected to have moderate transit connectivity.

The above classifications of the stations proposed for relocation from the BNSF Stockton Subdivision to the first construction section of the IOS and its later extension –from Madera to Merced – are not expected to change. The Fresno HSR station will be located less than one mile southeast in the same general area as the existing Amtrak station, while the Merced HSR station location is currently under study. Authority policy prefers station locations in established downtown areas, where existing development and infrastructure can support the station and redevelopment goals. Thus, the intermodal access and density and urban form surrounding the relocated Merced station would remain largely the same as the existing station. Madera is not designated as a HSR station, and would only serve as a regional station. If relocated, the station would also be located in a low-density setting and would have the same access options as the existing facility.

10.3 Intermodal Connectivity

10.3.1 Integration of Non-Program Operations and Services

Expanding passenger rail service between the San Francisco Bay Area/Sacramento and the Central Valley would open up new travel markets in the intermediate regions, requiring integration with existing and future transportation modes. These other modes are crucial to the effectiveness of Corridor rail service, and include Amtrak long-distance services, Amtrak Thruway buses, commuter rail (e.g., ACE), and taxi/car rental services.

The particular mode or modes that would be used in combination with a Corridor rail trip depends on trip purpose and length, among other factors. The available intermodal connections available at each station are presented in Table 10.4 at the end of the chapter.

A segment of the San Joaquin route is shared with Amtrak's long-distance trains. The California Zephyr travels between the San Francisco Bay Area and Chicago via Reno, Salt Lake City, Denver and Omaha, and the Coast Starlight provides service between Los Angeles and Seattle via Portland. Transfers to and from the San Joaquin can be made at Emeryville, Martinez, and Sacramento. In addition, Richmond is a common stop for the Coast Starlight and San Joaquin.

The *Capitol Corridor* also provides a similar "feeder" role for the San Joaquin Corridor service along its route between San Jose and Sacramento. *Capitol Corridor* passengers originating from, or destined to, stations south of Oakland, or conceivably Berkeley, Suisun/Fairfield, or Davis, can transfer at the common stations of Oakland – Jack London Square, Emeryville, Richmond, Martinez, and Sacramento.

Similarly, Amtrak Thruway buses extend origin and destinations to off-Corridor points such as Eureka, Redding, South Lake Tahoe, Yosemite National Park, San Luis Obispo, Visalia, and Barstow, and connect to the Los Angeles Basin and the Pacific Surfliner service. Transfers can be made at intermodal rail/Thruway bus stations such as Martinez, Sacramento, Merced, Fresno, Hanford, and Bakersfield.

To facilitate access between other off-Corridor points, taxi service is available at Corridor stations and many are also in proximity of rental car agencies, as indicated in Table 10.4.

Local rail transit, as operated by BART and Sacramento Regional Transit (SacRT), also provides intermodal connections in the major metropolitan areas at the two northern ends of the Corridor. Throughout the Corridor, local bus systems, vans and shuttles round out local transit options. The particular services available at each station are presented in Table 10.4.

Madera is the northern terminal of the San Joaquin local service between 2018 and 2022. However, future intermodal integration will be required with implementation of HSR. Merced is expected to be the northern terminal of the IOS starting in 2022. At this interim HSR terminus, both operational and physical intermodal integration measures will be required to facilitate transfers between the San Joaquin service operated with conventional equipment, and HSR service operated with electrified equipment. Seamless connections at this station will be necessary to accommodate expected passenger volumes and to ensure the success of the phased implementation of HSR. However, the re-routing of the *San Joaquin* service from the BNSF alignment to the Merced HSR Station is likely to be not cost effective. It is suggested that the Authority consider building a temporary/interim HSR station in Madera to facilitate cross platform transfers with connecting *San Joaquin* local services. Ridership studies by the Authority will inform the decision to provide a station stop at Madera.

10.3.2 Intermodal Integration Measures

Intermodal integration consists of measures and improvements to coordinate the modes outlined in the previous section with Corridor service and with each other. Intermodal connections are facilitated by two major types of considerations: operational characteristics and physical characteristics.

Operational Characteristics

Operational characteristics of stations contribute to their function and value as intermodal connections. Passenger connections are preferably “cross platform”, or at a minimum a common concourse connection, for direct rail to rail connections. Equally important as the physical layout of the station and platforms is the scheduling required for the necessary connectivity, as discussed further below.

Schedule Coordination

Schedule coordination refers to efforts to minimize delay for passengers transferring between modes. Each service operates according to a schedule reflecting travel speed, stops, and service frequency, which differ from service to service. In general, schedule coordination is organized by hierarchy of service; for example, faster trains serving intercity and regional destinations arrive last at a connectivity station and are the first to leave. Slower trains serving local destinations arrive first and leave last, which permits passengers transferring to or from faster trains to make connections. The same principle applies for the local transportation system, whether consisting of light rail, buses, shuttles, or vans.

Schedule coordination requires a high level of reliability and on-time performance. Existing rail services often do not operate at their full potential of speed and reliability, largely due to the shared infrastructure of the passenger/ freight network. The improvements described in Chapter 4 are designed to address these issues, and will contribute to the opportunity to implement schedule coordination among services in the Corridor.

Schedule coordination is most important when a connection is being made to a less frequent service, during off-peak periods, or to the last trip offered during the service day. Conversely, schedule coordination is relatively unimportant for major origin and destination stations that have very frequent service.

Three schedule coordination strategies can be implemented, depending on the services involved: pulse schedules, directional schedule coordination, and dependent linked schedules.

- Pulse Schedules. At a station with a pulse schedule, services converge at regular intervals at a hub and depart after a short interval during which transfers can be made. Pulse schedules would be implemented at rail stations that serve as hubs of Amtrak Thruway buses or local transit services. Thruway buses would either terminate at these stations, or observe a period of several minutes to allow transfers to be completed.
- Directional Schedule Coordination. In this variation of a pulsed schedule, Thruway or local transit services operating forward in the peak direction of travel would "pulse" directly following train arrivals. This type of schedule coordination has the advantage of not requiring the services involved to be held for each other, as in the case of pulse schedules. However, it affords convenient transfers only in one direction of travel – transferring passengers in the opposite direction of the coordinated schedule would face longer waits.
- Dependent Linked Schedules. Transfer times can be reduced to an absolute minimum with dependent linked schedules. When a train arrives, a Thruway bus or vehicle of another feeder service can be scheduled to be having a layover and can immediately receive transferring passengers. However, this requires high reliability on the part of both services, as delays on one line would affect service along the other line in the forward direction of travel.

A dependent linked schedule will be necessary at the interim HSR terminus in Merced to ensure seamless service in 2022. Southbound HSR trains would be scheduled to depart only after a southbound San Joaquin has arrived and passengers have had adequate time to transfer between trains. By the same token, northbound *San Joaquin's* would only depart after northbound HSR passengers have been able to transfer. Since *San Joaquin* service is subject to greater service reliability issues than HSR will be, it may be necessary to schedule southbound HSR trains at a somewhat lower operating speed; if there is a delay on the *San Joaquin*, the forward-operating HSR train could operate at greater speed and recover its schedule. These service integration issues are the subject of additional study by the Authority in coordination with Caltrans DOR and others.

Fare Integration

Fare integration addresses the cost and inconvenience of paying a second fare when transferring between services. Caltrans has implemented fare integration with its "Free Transit Transfer Program", which offers passengers of Corridor services free transfer passes to the services of local transit authorities, subject to annual renewals. This successful program can be enhanced and offered on a more permanent basis.

Similarly, discounted BART tickets are sold on the *Capitol Corridor* as a type of fare integration. Because *San Joaquin* trains also share the Richmond station with BART, this program has applicability for the San Joaquin service as well.

The phased implementation of HSR calls for an integrated ticketing system with *San Joaquin* service. A transfer between *San Joaquin* service and HSR would be no different than a trip involving another Amtrak service, such as the *Capitol Corridor*, and vice versa. For example, a trip between Bakersfield and Sacramento would require only a single ticket, even if a passenger must transfer from a HSR to a *San Joaquin* train in Merced. These service integration issues are the subject of additional study by the Authority in coordination with Caltrans DOR, Amtrak and others.

Physical Characteristics

Just as operational characteristics contribute to a station's function and value as an intermodal connection, so do physical characteristics. They involve the station's location within the urban fabric of the communities it serves, as well as the functional layout of station facilities.

Station Configurations

Depending on their size and importance in the statewide network, as well as particular site characteristics and constraints, stations may have a broad range of configurations, with implications for intermodal connectivity.

The simplest station configuration is an at-grade platform alongside a single track. With a second passenger track, two side platforms or a central platform may be used. With additional tracks, combinations of center and side platforms may be employed. As long as tracks are at ground level, passengers may typically cross tracks at grade to reach the outer platform. Various design considerations can improve the safety of such crossings. With more than two platforms and/or greater levels of train traffic, underground or overhead concourses may be implemented to convey passengers to platforms, avoiding at-grade crossings. As space allows, ramps can be used to facilitate movement from ground level to the concourses and avoid the cost of escalators and elevators.

The simplest stations have only a shelter next to the platform, but many have a station building offering an indoor waiting environment and amenities as warranted by the level of station activity. The station building itself will typically be located on one side of the tracks, with intermodal connections facilitated within or through the facility.

Locally-significant stations, as defined in Section 10.2, will typically have a single platform serving both directions, while regionally-significant stations may have a second platform, one for each direction. Multiple-track stations with additional platforms, and above- or below-grade track crossings, are typically limited to stations of statewide importance.

It is essential that the interim HSR terminus in Merced be built as center platform, two-track station to facilitate cross-platform transfers between HSR and *San Joaquin* trains. Since the majority of passengers on any arriving train will be transferring to a waiting train on the opposite side of the platform during the interim operating condition, a wider platform than would otherwise be considered may be necessary. These service integration issues are the subject of additional study by the Authority in coordination with Caltrans DOR and others.

Particularly where the services of different operators converge, the infrastructure may not have been designed with transferring passengers in mind. Thus, transfers may range from a cross-platform situation to those that require changes in level and a substantial walk between platforms and stops. The elderly and passengers with disabilities in particular may face considerable obstacles in transferring from one mode to another.

Regardless of station size or configuration, safety concerns must be addressed as intermodal integration measures are considered. At new stations, UPRR now requires “station tracks” (sidings for passenger trains at stations) along with outside platforms connected by pedestrian bridges. Station tracks improve the efficiency of freight operations by allowing freight trains to bypass passenger trains that are stopped at stations. Although costly, pedestrian bridges greatly reduce the potential for accidents involving trains and pedestrians.

Where pedestrians are permitted to cross tracks, safety can be improved by a number of measures, such as gates that restrict pedestrian flows, devices that provide visual and acoustic warnings of approaching trains, and barriers arranged to slow pedestrians down and face them in the direction of oncoming trains. These measures are especially warranted where passengers may be rushing to make connections between trains and buses.

Key capital projects to improve the safety and capacity of Corridor stations identified in the *San Joaquin* Strategic Plan are presented in Table 10.3. New stations proposed in conjunction with the first construction section of the IOS are included as well.

Table 10.3: Key Capital Projects for Intermodal Integration

Station	Project	Source
Antioch	Platform improvements	*San Joaquin Strategic Plan (2008)*
Modesto	Fenced in parking, bus canopies	*San Joaquin Strategic Plan (2008)*
Merced	New HSR Station	*Merced–Fresno EIR/EIS*, the Authority 2011
Fresno	New HSR station	*Fresno–Bakersfield EIR/EIS*, the Authority 2011
Hanford	Second platform (under const.)	*San Joaquin Strategic Plan (2008)*
Kings/Tulare	New HSR station	*Fresno–Bakersfield EIR/EIS*, the Authority 2011
Wasco	Improved parking	*San Joaquin Strategic Plan (2008)*
Bakersfield	New HSR station	*Fresno–Bakersfield EIR/EIS*, the Authority 2011

Station Access and Wayfinding

Connections between a station and the surrounding land uses are typically provided by the local street system. The grid-based street system of the original settlement area of many California cities and towns often coincides with station locations, and may foster connectivity. Stations in more suburban contexts that developed after widespread adoption of automobile travel may offer fewer routes and points of access. In either case, the railroad itself may act as a barrier, resulting in circuitous routes of access that may be particularly discouraging to pedestrian and bicyclists.

Pedestrian and bicycle access may be enhanced with new grade crossings or overcrossings and undercrossings, as appropriate to the surrounding context. Table 10.4 presents the “Bicycle Facilities” currently available at each station. Three classes of bicycle facilities are defined; Class I (bike path or bike trail separate from motorized traffic), Class II (designated bike lane on a roadway), and Class III (roadway signed or marked for bicycle travel but shared with motor vehicles). Some stations may warrant bicycle lockers, bike share services and other amenities for cyclists.

Consistent and clear signage and wayfinding systems should be integrated into the station property and buildings, orienting transferring passengers. While stations themselves may integrate multiple modes, and facilitate intermodal connections within a single building or property, some connections may depend on the local street system. In such cases, it is important that high standards of sidewalk and streetscape conditions are maintained, and that appropriate wayfinding elements guide passengers to and from the station as they transfer between modes.

As considerations are made for accommodating various modes of access, the following hierarchy should be observed, in order of increasing distance from the immediate station entrance or platform access:

- Passenger pick-up/drop-off and taxi stands and bicycle parking.
- Shuttle bus stops and car share parking.
- Fixed route bus stops and rental auto parking and facilities.
- Auto parking.

Amtrak Thruway bus or local transit access may be provided with a simple stop along the street outside a station, or facilitated with an off-street terminal with multiple bays for different buses, shuttle and van services. Such facilities provide an opportunity for vehicles to lay over at the end of their routes and to organize services for passenger convenience. This is particularly useful for Amtrak Thruway coaches, which require staging areas for luggage loading and unloading.

Auto access is facilitated with designated areas for passenger pick-up and drop-off and taxi stands, as well as parking and rental car facilities. Table 10.4 presents the “Taxi/Rental Car” opportunities currently

available at each station. Appropriate signage along major routes, such as interstate and state highways, is important in guiding motorists to stations and to the various functional components of the station. In addition, the local road system may need to be reviewed to determine if station-area streets are adequate for station-related traffic, particularly in association with service expansion.

Parking facilities serving a station may be publicly or privately operated; provided free or subject to hourly or daily fees; dedicated or shared with adjacent uses; and provided on surface lots or in structures. Parking availability may have a major influence in ridership, while parking provisions may limit the land use potential of the station area. Table 10.4 indicates the amount and distribution of parking at Corridor stations.

10.4 Station Access

This section provides a detailed summary of station access at each station along the Corridor. While all stations have pedestrian access and are Americans with Disabilities (ADA)-accessible, other modes of access to the existing and proposed stations are described, as presented in Table 10.4.

Sacramento

The Sacramento station functions as a multimodal transit hub. Connections to other Amtrak services are provided, including *Capitol Corridor*, *Coast Starlight*, *California Zephyr*, and Thruway Bus Routes 3, 20a, and 20c. SacRT offers light rail and bus connections from this station, and transfers to Placer Commuter Express and e-tran are facilitated. Overnight parking for 165 vehicles is offered, as well as additional short-term parking on-site and in numerous other lots and garages within the immediate vicinity. Rental cars can be obtained within one-half mile, and a taxi zone adjoins the station. Class II and III bikeways are located one-quarter mile away.

Lodi

This station connects with Amtrak Thruway Route 3 and other local and regional bus services provided by Greyhound, the City of Lodi's Lodi Grape Line, South Country Transit (SCT), and San Joaquin Regional Transit District (RTD). A surface parking lot and a multi-level structure serve the station, offering a total of 280 spaces, and car rental services are available approximately one mile away. There are no dedicated bikeways within the immediate vicinity.

Stockton–ACE

This station is the eastern terminus of regional rail service provided by Altamont Corridor Express. Only *San Joaquin* trains that operate to and from Sacramento stop at this Stockton station; trains travelling to and from Oakland utilize the Stockton–Amtrak station. Amtrak offers a shuttle service between the two stations, and Thruway Bus Routes 3 and 34 also stop at the ACE station. Surface lots south of the station offer 143 parking spaces, and rental car services are available approximately one-half mile from the station. A Class III bikeway can be accessed directly from the station.

Oakland–Jack London Square

This station functions as the Bay Area terminus of *San Joaquin* service. Connections to other Amtrak services are provided, including *Capitol Corridor*, *Coast Starlight*, and Thruway Bus Routes 17, 34, and 99. A bus terminal at the station facilitates transfers between rail services and three AC Transit routes, as well as the free Broadway Shuttle circulating through downtown Oakland. A multi-level parking structure offers approximately 500 short-term and 500 long-term spaces adjacent to the station, in addition to a surface lot located across the street. Rental car service is available approximately one-half mile from the station, and Class I, II, and III bikeways are within the immediate vicinity.

Emeryville

The Emeryville station provides service to three connecting Amtrak services (*California Zephyr*, and *Capitol Corridor*, and *Coast Starlight*), as well as three Thruway Buses (Routes 17, 34, and 99). AC Transit and the Emery Go-Round provide local bus service. Automobile connectivity is facilitated by a surface parking lot with approximately 220 spaces, rental car services adjacent to the station, and an adjacent taxi zone. Class I, II, and III bikeways are located within close proximity of the station.

Richmond

The Richmond station operates as a multimodal transit center and facilitates connections between regional and local rail and bus service. Amtrak's C*alifornia Zephyr* and *Capitol Corridor*, trains also stop at the station, which is adjoined by the Richmond BART station. The adjacent bus terminal is served by AC Transit and Golden Gate Transit buses, as well as the Kaiser Richmond and Richmond Circular Shuttles. A surface parking lot with 400 spaces is provided, with an additional parking structure currently under construction. Car rentals are available within two miles. Class II and III bikeways are located within one-quarter mile of the station.

Martinez

This station is shared with Amtrak's *Capitol Corridor*, *Coast Starlight*, and *California Zephyr*, and is the terminus of Thruway Bus Route 7 as well. Regional bus connections are operated by Tri Delta Transit and WestCAT, and local bus service on six routes is offered by County Connection. Parking for 220 vehicles is provided by an adjacent lot, and car rental services are available within two miles. Class II and III bikeways connect directly to the station.

Antioch

The Antioch station offers 43 parking spaces and facilitates connections to local bus service operated by Tri Delta Transit. Car rental is available within one mile of the station. There are no dedicated bikeways within the immediate vicinity.

Stockton–Amtrak

This station serves *San Joaquin* trains travelling to and from Oakland, while the Stockton–ACE station is a stop for trains operating to and from Sacramento. Amtrak Thruway Bus Routes 3, 6, and 34 provide connections, and a shuttle operates between the two Stockton rail stations. Local bus transit is provided by San Joaquin Region Transit District. Parking for 24 vehicles is provided, and car rental is available within one mile of the station. A Class II bikeway connects directly to the station, with Class III bikeways within a one-half mile.

Modesto

The Modesto station is the northernmost station serving all *San Joaquin* trains. North of this station, some trains operate to and from Oakland, while the remaining trains operate to and from Sacramento. Local bus connections are provided by Modesto Area Express. Car rental service is available at Modesto City-

County Airport, located 3.5 miles southwest of the station, where flights to San Francisco International Airport are available. Parking for 122 vehicles is provided at the station, and Class I and II bikeways are located within two miles.

Denair/Turlock

This platform-only station offers eight parking spaces, and transit connections are available through Dial-a-Ride Turlock. Car rental service is located approximately 3.5 miles away. There are no dedicated bikeways within the immediate vicinity.

Merced

The Merced station has a parking lot with 46 spaces (12 short-term and 34 long-term), with car rental services approximately one mile away. Yosemite Area Regional Transportation System and Merced County Transit ("The Bus") operate local bus service to this station. The Bus Route 5X connects this station with Merced Municipal Airport, where flights to Las Vegas, and Los Angeles via Visalia, are available. Class II and III bikeways are located within one-half mile of the station.

Madera

This platform-only station has a parking lot with 19 spaces. Madera Dial-a-Ride offers transit service from this station, and car rental is located approximately three miles away. There are no bikeways within close proximity to this station. This SDP assumes that in 2018, Madera will be used as the terminus for local trains traveling on the BNSF Railway between Bakersfield and Madera. Madera has been suggested as the interim transfer point between HSR and conventional San Joaquin passenger trains in 2022. The Authority has determined that constructing a connection in Merced between the HSR right-of-way and the BNSF right-of-way is neither practical nor cost effective. . Further analysis will be conducted by the Authority.

Fresno

The Fresno station offers connections to Amtrak Thruway Bus Route 1b and local bus service operated by Fresno Area Express. Parking for 109 vehicles (11 short-term and 98 long-term) is available, with additional capacity in surrounding surface lots and on-street parking. Car rental services are located within approximately one mile, and a Class II bikeway connects to the station.

If *San Joaquin* service is operated on the IOS of the HSR project, trains would stop at a new temporary station in Fresno. Amtrak Thruway and local bus service would be expected at this station, as well as parking facilities.

Hanford

The Hanford station is served by Amtrak Thruway Bus Route 1b, Orange Belt Stages, and Kings Area Rural Transit. A surface parking lot with six short-term and 41 long-term spaces is provided at the station, and car rental is available within one-quarter mile. A Class III bikeway is located approximately one mile away.

Corcoran

Access to this station is provided by Kings Area Rural Transit and Corcoran Area Transit through their Dial-a-Ride services. Parking for 90 vehicles is provided. Class II and III bikeways are located within one-quarter mile of the station.

Wasco

Kern Regional Transit and Wasco Dial-a-Ride provide local transit service to this station. Parking for 35 vehicles is provided.

Bakersfield

The Bakersfield station is the southern terminus of the *San Joaquin* service and provides connections to Amtrak Thruway Bus Routes 1a, 1b, 1c, 9, 10, 12, and 19. Local bus service is provided by Golden Empire Transit and Kern Regional Transit. Car rental is available adjacent to the station, and a parking lot with 206 spaces is provided. Class II and III bikeways are located on key streets surrounding the station.

Kings/Tulare

If *San Joaquin* service is operated on the IOS of the HSR project, trains would potentially stop at a new station serving Kings and Tulare Counties. Amtrak Thruway and local bus service would be expected at this station, as well as parking facilities. This station location is being studied by the CHSRA and is not within the scope of this SDP to evaluate.

Table 10.4: Station Access Summary

Station	Parking	Taxi/Rental Car	Transit Connections				Bicycle Facilities	Other Communities Served
			Local & Regional Rail	Local & Regional Bus	Amtrak Services	Airports		
Sacramento	165 overnight spaces with additional short-term parking; numerous other lots and garages with the immediate vicinity	Rental car within 0.5 mile; taxi zone on site	LRT (SacRT Gold Line)	Bus (SacRT), Regional Bus (Amador Transit, E-tran, Placer Commuter Express)	*California Zephyr, Capitol Corridor, Coast Starlight, San Joaquin*; Thruway Bus Route 3 (Redding –Chico–Davis–Sacramento–Stockton), Route 20a (Sparks–Reno–Truckee–Auburn–Roseville–Sacramento), Route 20c (South Lake Tahoe–Placerville–Sacramento)	NA	Class II & III bikeways within 0.25 mile of station	NA
Lodi	380 spaces	Rental car approximately 1 mile away	NA	Bus (Greyhound, Lodi Grape, South County Transit (SCT/LINK), RTD)	*San Joaquin*; Thruway Bus Route 3	NA	No bikeways within immediate vicinity	NA
Stockton–ACE	143 spaces	Rental car approximately 0.5 mile away	Commuter Rail (ACE)	Bus (RTD)	*San Joaquin* (trains to and from Sacramento only); Amtrak shuttle between the Stockton stations; Thruway Bus Route 3 and Route 34 (Stockton–Oakland–San Francisco)	NA	Class III bikeways within immediate vicinity	NA
Oakland–Jack London Square	500 short-term, 500 long-term	Car rental approximately 0.5 mile away; taxi on-call	NA	Bus (AC Transit)	*Capitol Corridor, Coast Starlight, San Joaquin*; Thruway Bus Route 17 (Santa Barbara – Oakland), Route 34, Route 99 (Emeryville – Oakland – San Francisco)	NA	Class I, II, & III bikeways within immediate vicinity	NA
Emeryville	220 spaces	Car rental adjacent to station; taxi zone	NA	Bus (AC Transit, Emery Go-Round)	*California Zephyr, Capitol Corridor, Coast Starlight, San Joaquin*; Thruway Bus Route 17, Route 34, Route 99	NA	Class I, II, & III bikeways within immediate vicinity	Berkeley
Richmond	400 spaces with additional parking structure currently under construction	Car rental within 2 miles; taxi on-call	BART	Bus (AC Transit, Golden Gate Transit, Kaiser Richmond Shuttle, Richmond Circular Shuttle)	*California Zephyr, Capitol Corridor, Coast Starlight, San Joaquin*	NA	Class II & III bikeways within 0.25 mile of station	NA
Martinez	220 spaces	Car rental within 2 miles; taxi on-call	NA	Local Bus (County Connection), Regional Bus (Tri Delta Transit, WestCAT)	*California Zephyr, Capitol Corridor, Coast Starlight, San Joaquins*; Thruway Bus Route 7 (Martinez –McKinleyville)	NA	Class II & III bikeways connect directly to station	Mountain View
Antioch	43 spaces	Car rental within 1 mile	NA	Bus (Tri Delta Transit)	*San Joaquin*	NA	No bikeways within immediate vicinity	Pittsburg
Stockton–Amtrak	24 spaces	Car rental within 1 mile	NA	Bus (RTD)	*San Joaquin*; Thruway Bus Routes 3, 6 (Stockton–San Jose), and 34	NA	Class II leading directly to station, Class III within 0.5 mile	NA
Modesto	122 spaces	Car rental is available at Modesto City-County Airport 3.5 miles SW of station	NA	Bus (Modesto Area Express (MAX))	*San Joaquin*	Modesto City-County Airport (3.5 miles SW, flights to San Francisco)	Class I & II bikeways within 2 miles	NA
Denair/Turlock	8 spaces	Car rental over 3.5 miles away	NA	Dial-a-Ride	*San Joaquin*	NA	No bikeways within immediate vicinity	Turlock

Station	Parking	Taxi/Rental Car	Transit Connections				Bicycle Facilities	Other Communities Served
			Local & Regional Rail	Local & Regional Bus	Amtrak Services	Airports		
Merced	12 short-term, 34 long-term	Car rental 1 mile away	NA	Bus (Merced County Transit ("The Bus"), Yosemite Area Regional Transportation System (YARTS))	*San Joaquin*	Merced Municipal Airport (accessed by "The Bus" Route 5X, flights to Las Vegas, and Los Angeles via Visalia)	Class II & III bikeways within 0.5 mile of station	NA
Madera	19 spaces	Car rental over 3 miles away	NA	Madera Dial-a-Ride	*San Joaquin*	NA	No bikeways within immediate vicinity	NA
Fresno	11 short-term, 98 long-term; numerous other surface lots adjacent to station	Car rental 1 mile away	NA	Bus (Fresno Area Express)	*San Joaquin*; Thruway Bus Route 1b (Bakersfield–Los Angeles–Long Beach–San Pedro)	NA	Class II bikeway connecting on Huntington Boulevard	NA
Hanford	6 short-term, 41 long-term	Car rental within 0.25 mile	NA	Bus (Kings Area Rural Transit, Orange Belt Stages)	*San Joaquin*; Thruway Bus Route 1b	NA	Class III bikeway within 1 mile of station	NA
Corcoran	90 spaces	No car rental; no taxi zones nearby	NA	Bus (Kings Area Rural Transit, Corcoran Area Transit (Dial-a-Ride))	*San Joaquin*	NA	Class II & III bikeways on Sherman Avenue and Flory Avenue	NA
Wasco	35 spaces	No car rental	NA	Bus (Kern Regional Transit, Wasco Dial-a-Ride)	*San Joaquin*	NA	No bikeways within immediate vicinity	NA
Bakersfield	206 spaces	Car rental adjacent to station	NA	Bus (Golden Empire Transit, Kern Regional Transit)	*San Joaquin;* Thruway Bus Routes 1a, 1b, 1c, 9, 10, 12, 19	NA	Class II & III bikeways within 0.5 mile of station	NA

Notes:
- "NA" indicates not applicable.

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11.0 Conceptual Engineering and Capital Programming

11.1 Rail Equipment and Infrastructure Improvements Identification

Improvements for the San Joaquin Corridor were identified based on a variety of sources, including, but not limited to, the following:

- California Passenger Rail System: 20-Year Improvement Plan Technical Report (2001).
- San Joaquin Corridor Strategic Plan (2008).
- BNSF San Joaquin Valley Capacity Analysis (2010)
- San Joaquin Corridor Programmatic Environmental Impact Report (EIR) 2035 Vision – Initial Study
- State and federal grant programs such as California's State Transportation Improvement Program (STIP) or the federal HSIPR program.
- Financially-constrained and unconstrained project lists contained in the RTPs of the respective MPOs, in this case the SACOG, the SJCOG, the StanCOG, the Merced County Association of Governments (MCAG), the Madera County Transportation Commission (MCTC), the Fresno Council of Governments (FCOG), the Kings County Association of Governments (KCAG), the Tulare County Association of Governments (TCAG), and the Kern Council of Governments (KCOG).
- Caltrain Extension to Monterey County: Alternatives Analysis (2007).
- Input from Caltrans, the FRA, SacRT, the Authority, Northern California Rail Partners Working Group, and local host and tenant railroads including: ACE, Caltrain, and the CCJPA.

From these sources a comprehensive list of projects was developed that are shown in Table 4.1. The list of projects that were highlighted in Table 4.1 were reviewed by Caltrans DOR, BNSF and others to screen the projects to only those that are needed to support improved *San Joaquin* blended service utilizing the first construction section of the IOS in 2018 through 2022. This list of projects is shown on Table 11.2. All projects on this table have been developed by BNSF Railway.

As indicated in Chapters 4 and 9, BNSF has been working closely with Caltrans to identify and develop costs for the track projects that would be necessary to implement eight and 11 trains on the *San Joaquin* route at 79 mph and 90 mph. For the most part these projects are the projects that would be necessary for the scenarios studied for 2020 when *San Joaquin* trains are planned to run on the initial construction section of the IOS. Some additional track projects would be necessary in 2018 that were not studied by the BNSF for the San Joaquin service improvements, including the Stockton Hub project. The Stockton Hub project is currently being studied by BNSF on behalf of ACE but is not essential for 2018 *San Joaquin* service.

Preliminary track chart schematic diagrams were prepared by BNSF for the train frequency and speed option improvements modeled by BNSF as described in Chapter 9. These schematic track charts are included as Exhibits 11.1 and 11.2.

The majority of the improvements identified for the San Joaquin Corridor include the following types of projects:

- Extension of existing sidings (or construction of new sidings).

- Construction of second main tracks.
- Realignment of tracks/curves.

In addition to these projects, other identified improvements include new and replacement rolling stock; track and signal upgrades (e.g., Positive Train Control); and a variety of other improvements.

Exhibit 11.1 Northern California Projects at 79 mph

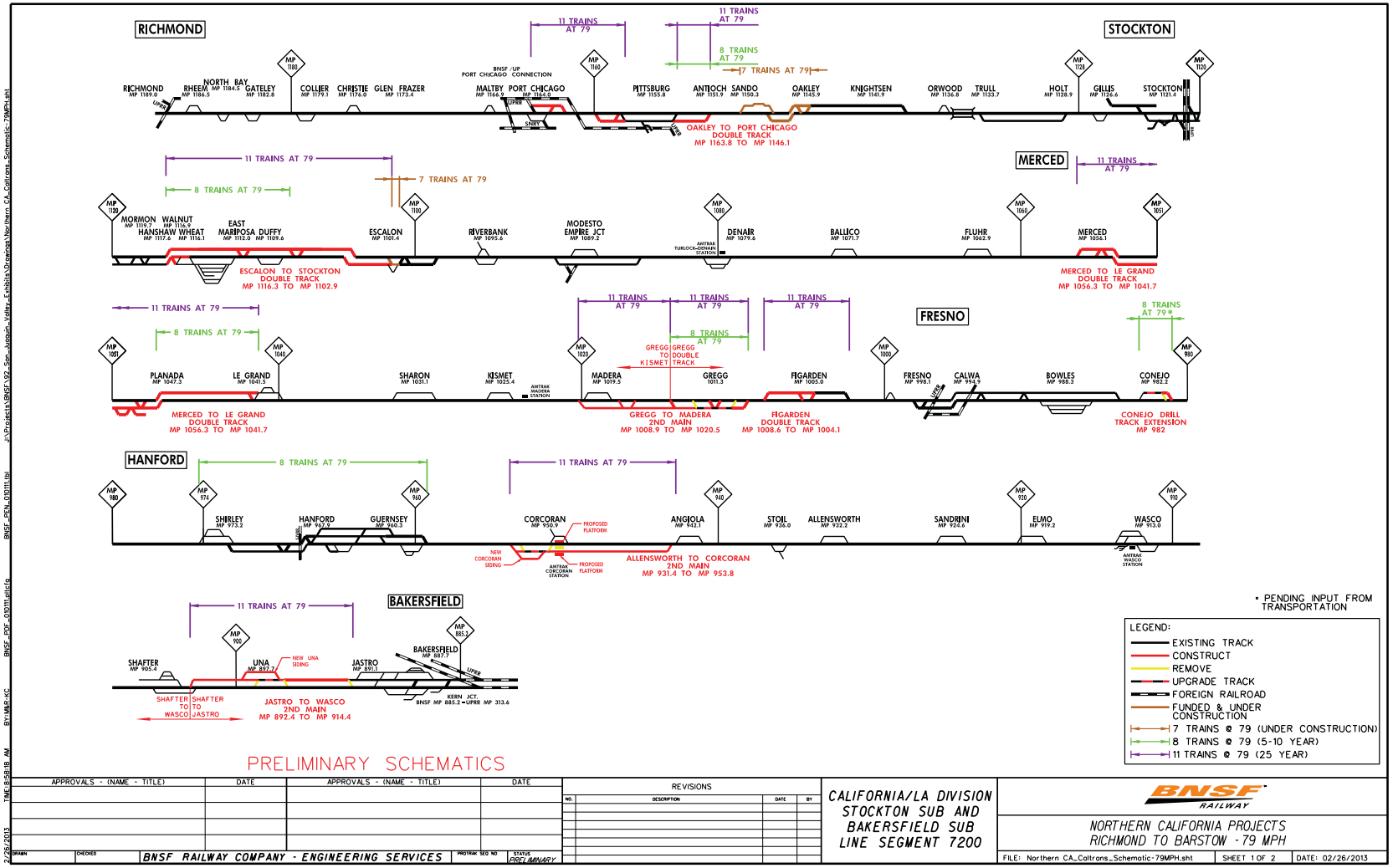
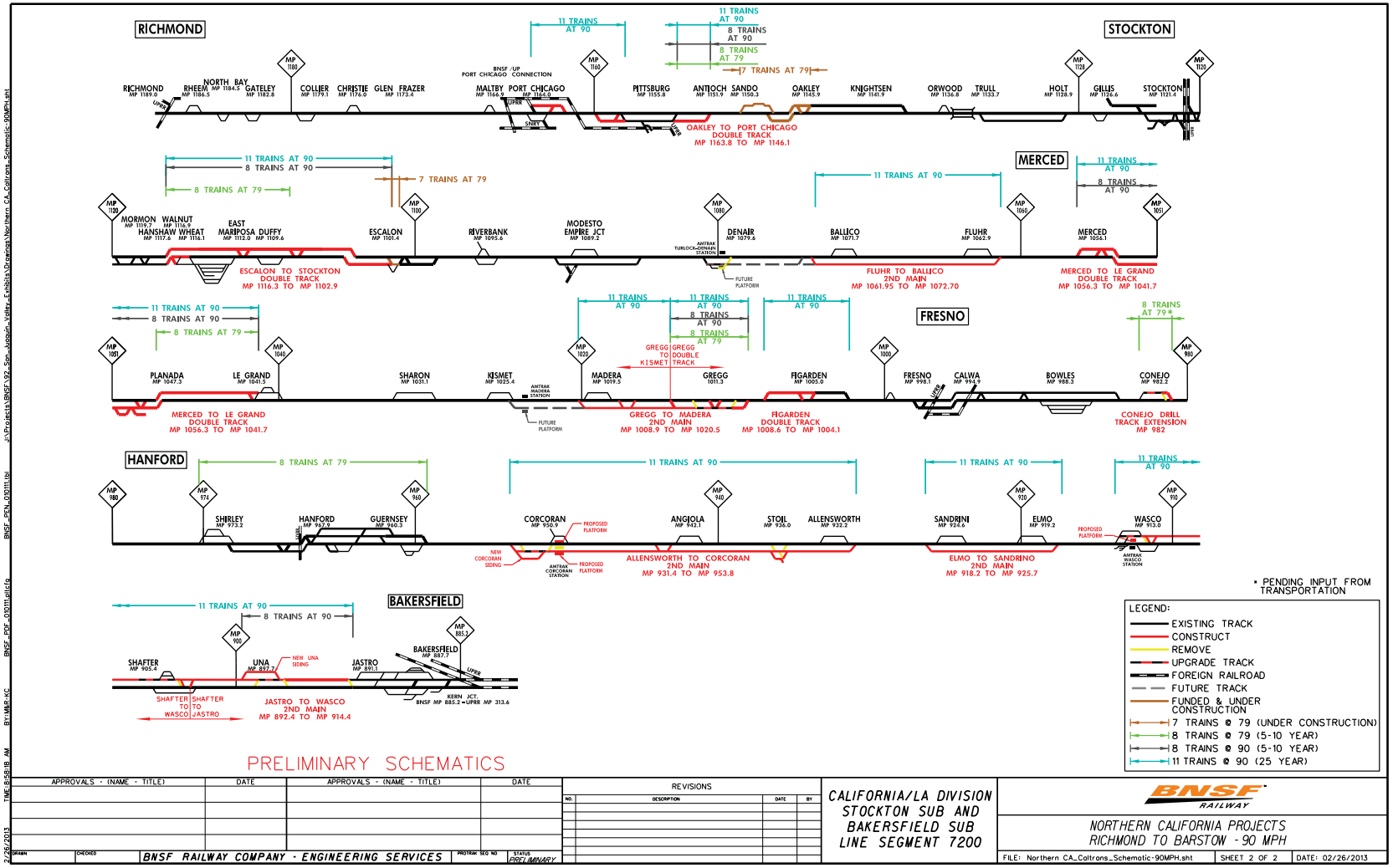


Exhibit 11.2 Northern California Projects at 90 mph



11.2 Project Cost Estimates

11.2.1 Methodology and Assumptions

Planning-level project cost estimates for many of the identified improvement projects have already been developed in the *Amtrak 20-Year Plan (2001)* and the other sources consulted in developing the list of proposed improvements. A systematic review of the projects indicated that these cost estimates were generally reasonable and acceptable for planning purposes, and contained sufficient detail to permit their use in the Service Development Plan. However, many of the cost estimates were developed in previous years and are no longer current. As a result, a cost escalation factor was applied to bring these specific estimates to Year 2012 dollars. The escalation factor was based on the increase in the Engineering News Record Construction Index (ENR Index) evaluated between the time of the prior estimate compared to the current year (2012) values. The ENR Index reflects the cumulative effect of bumps and dips in the economy relative to engineered construction projects and as such is a reasonable basis to adjust cost. This methodology reflects actual cost experience for similar projects over the intervening period of time. New cost estimates were developed for project cost estimates that did not appear reasonable based on the information available regarding project scope. As additional project development activities are accomplished, and/or new information regarding project scope becomes available cost figures should be updated.

In addition, the costs for almost all mid-term projects and some long term projects in Table 4.1 were developed by BNSF as part of the 2010 Capacity Analysis. BNSF developed the cost estimates for the eight train scenarios at 79 mph and 90 mph based on designed and engineered projects with CEQA clearance. The cost estimate for the 11 train projects are based on conceptual engineering for similar projects on the route.

11.2.2 Cost Estimates and Documentation

As part of validating the cost estimates from the various sources, typical Year 2012 unit cost ranges were developed for common improvement projects. These unit cost ranges are summarized in Table 11.1. The development of “low”, “medium”, and “high” estimates of typical project costs allows for flexibility in the cost estimation process to account for project- or location-specific features which may suggest actual costs that are lower or higher than the medium (i.e., “average”) cost for that type of project.

Table 11.1: Typical Unit Cost Ranges for Infrastructure Improvement Projects

Project Type	Unit Costs (Year 2012 dollars)			
	Unit	Low	Medium	High
Siding extension and island CTC	track-foot	$1,300	$1,900	$2,500
Second main track	track-foot	$3,000	$5,500	$8,000
Curve realignments	track-foot	$1,000	$2,500	$4,000

The planning level unit prices and project costs estimates for improvements included in this SDP were also validated against recent cost data from railroad projects that Caltrans has recently funded. It was found that the typical unit cost ranges in Table 11.1 are consistent with recent cost estimates received from BNSF and/or UPRR reflecting more advanced engineering and/or more current base price information. The cost factors for the most typical improvement category – siding extensions/island CTC and double tracking have been validated against current cost estimates reflecting higher levels of engineering (either preliminary or final design) received from the railroads for work on California lines and the evaluation has determined that these factors will provide a substantial contingency to address current and/or near-term implementation.

11.2.3 Infrastructure Improvement Cost Estimates

Caltrans DOR discussed the list of improvements outlined in Chapter 4 with the BNSF and UPRR and examined the capacity improvements outlined in the capacity analysis highlighted in Chapter 9. The project lists were reduced to only those projects required for initiation of "blended" service in 2018 as defined for Build Alternative A at the 79 mph MAS option in Chapter 4 and carried forward from the alternatives analysis outlined in Chapter 5. The projects were also refined by Caltrans DOR as part of the technical review of the BNSF capacity analysis. These improvements would be necessary for any Build Alternative to improve performance and capacity of the existing *San Joaquin* service between Madera and Oakland.

The resulting total costs for each of the identified as essential improvements needed for service initiation in 2018 for Build Alternative A is summarized in Table 11.2.

Table 11.2: Total Costs for Infrastructure Improvement Projects Build Alternative A

Project	Cost (Millions, Year 2012 dollars)	Source(s)
Merced to Le Grand second main track (Segment 1)	$40.4	Proposition 1A, *San Joaquin Corridor Strategic Plan (2008),* Northern California Rail Partners Working Group, BNSF Capacity Analysis
Stockton to Escalon second main track Segments 3 & 4)	$ 54.0	STIP, SJCOG RTP (financially-constrained) *San Joaquin Corridor Strategic Plan* (March 2008), Northern California Rail Partners Working Group, BNSF Capacity Analysis
Port Chicago to Oakley (Segment 2)	$55.0	STIP, TCRP, Proposition 1B (Intercity Rail Improvement), *San Joaquin Corridor Strategic Plan (2008)*, Northern California Rail Partners Working Group, BNSF Capacity Analysis
Jastro to Una (Segment 1)	$42.0	*San Joaquin Corridor Strategic Plan (2008)*, Northern California Rail Partners Working Group BNSF Capacity analysis to support 11 trains at 79 mph
Una to Shafter (Segment 2)	$22.0	*San Joaquin Corridor Strategic Plan (2008)*, Northern California Rail Partners Working Group BNSF Capacity analysis to support 11 trains at 79 mph
TOTAL Infrastructure Cost	$213.4	

Notes:

(1) The projects required for Build Alternative A will support up to eight trains operating on the *San Joaquin* route between Oakland and Madera and up to 11 trains operating between Rosedale to Bakersfield on the BNSF. The total cost of these projects is estimated to be in excess of $193.4 million. Approximately $40 million is allocated by the California Transportation Commission, leaving a capital shortfall of $153.4 million.

11.2.4 Rolling Stock Cost Estimates

The current *San Joaquin* service requires seven trainsets daily for operation of six round trips – four between Bakersfield and Oakland, and two between Bakersfield and Sacramento. These seven trainsets utilize a total of 42 cars and nine locomotives, including maintenance spares. As described in Section 9.7 of the SDP, a total of 16 passenger cars and four locomotives are needed to replace existing equipment and provide the proposed Year 2018 service levels at 79 mph for the No-Build baseline alternative. [xxviii] In terms of capital costs related to rolling stock, Caltrans recently announced a purchase of 42 new bi-level passenger cars, built to Passenger Rail Investment and Improvement Act of 2008 (PRIIA) 305 Next-

Generation Equipment Committee (NGEC) specifications. Of the 42-car order, 11 of the cars will be assigned to the San Joaquin Corridor. Based on a unit cost of approximately $2.7 million per passenger car based on the full 130-car order, the new *San Joaquin* passenger cars represent a capital investment of approximately $29.7 million.[xxix] As a result, an additional five passenger cars (approximately $13.5 million) are needed beyond the 11 cars currently on order for the San Joaquin corridor for the No-Build baseline alternative.

In conjunction with this passenger car order, Caltrans is also purchasing six additional locomotives to replace locomotives whose economic useful life will be expiring. Of these, four would be for the *San Joaquin Corridor*. Based on Metrolink's recent order of 20 Tier 4-compliant EMD F125 locomotives for $129.4 million—suggesting a unit cost of approximately $6.5 million per locomotive—these six locomotives would represent a capital investment of approximately $39 million.[xxx] These locomotives are capable of operating at speeds up to 125 mph.

As indicated in Chapter 9, Caltrans DOR developed operating schedules to support the blended service operations commencing in 2018. The equipment requirements for the 2018 blended system operating schedule for Build Alternative A require a total of 10 trainsets with a total of 96 cars and 25 locomotives (3 F59PHI and 22 125 mph-capable high-speed NGEC locomotives), including maintenance spares. A detailed equipment rotation and consist size summary was provided in Table 9.8. This represents an increase of 54 cars and 22 NGEC 125-mph locomotives over current operating requirements.
The resulting rolling stock cost estimate for Build Alternative A is presented in Table 11.3 below.

Table 11.3: Total Rolling Stock Costs for Build Alternative A

Equipment	Existing Schedule	2018 Schedule	Additional Equipment	Unit Cost	Total Cost ($millions)
Passenger Railcars					
Cab/baggage	9	16	7		
Coach	24	65	41		
Café	9	15	6		
Subtotal	42	96	54	$2,700,000	$145.8
Locomotives					
F59PHI	9	3	0	0	0
NGEC 125	0	22	22	$6,500,000	$143.0
				Total Estimated Cost	*$288.8*

The total incremental rolling stock costs required to operate Build Alternative A are $288.8 million. Funding has been secured by Caltrans for the acquisition of nine new cars (eight coaches and one cab-baggage car) for augmentation of revenue capacity on the San Joaquin corridor, and for six new 125 mph-capable NGEC locomotives to replace Amtrak-owned locomotives currently used on the *San Joaquin* service. Acquisition of the rolling stock that is currently funded will reduce the number of new cars and locomotives that will need to be funded and acquired for the 2018 blended system to 45 cars and 16 NGEC locomotives. The unfunded cost for the additional rolling stock for Build Alternative A is $225.5 million. No funding source for this acquisition has been identified.

11.3 Project Schedule and Prioritization

The *Amtrak 20-Year Plan (2001)* provides some detail on the prioritization and recommended timeline of improvements to the San Joaquin Corridor, classifying improvements into "immediate", "near-term", and

"vision" projects. The *San Joaquin Corridor Strategic Plan (2008)* likewise classifies improvements into "immediate", "short-term", "medium-term", and "long-term" projects.

These prioritization schemes and timelines are partially reflected in the grouping of proposed improvements into the near-term (2013 to 2015), mid-term (2016 to 2018), and long-term (2018 to 2040) timeframes in Table 4.1, supplemented by information regarding the funding status (e.g., programmed or allocated, part of a financially-constrained or unconstrained RTP, etc.) outlined in the California SRP

The projects necessary for the 2018 start of blended service on the first construction section of the IOS have been detailed in Table 11.2 plus the acquisition of rolling stock outlined in Table 11.3. The total cost to implement Build Alternative is $502.2 million for infrastructure and rolling stock in addition to the cost of the existing and committed projects outlined in the No-Build Alternative.

11.4 Conceptual Engineering Design Documentation

The *Amtrak 20-Year Plan (2001)* and other sources provide details on most of the proposed improvements at a conceptual planning level. Those details are summarized for common improvement types.

- Siding extension. Siding extensions generally involve increasing siding length to 10,000 ft to better accommodate passing movements (either between freight and passenger trains or between trains in opposing directions). Switches would be powered and the extended siding designed with Number 24 turnouts (40 mph through switch) to streamline passing movements. All track and ties on the siding would be replaced as required. A conceptual siding extension is illustrated in Exhibit 11.3.
- Curve realignment. Curve realignments would involve redesigning and reconstructing track curves to eliminate slowdowns and reduce travel times by permitting higher speeds. Track curves would either be removed completely or reduced to a two- or three-degree maximum curvature, increasing maximum train speeds to 79 mph (and possibly 90 mph in the future). Auxiliary measures such as right-of-way acquisition and construction of retaining walls or new structures may be required to facilitate the realignment. A conceptual curve realignment is illustrated in Exhibit 11.4.
- Second main track. A second main track involves construction of an additional track to increase operational reliability and capacity at strategic locations along the mainline, reducing conflicts between freight and passenger trains and/or permitting operation of more passenger train services. Similar to siding extensions, the second track would feature Number 24 turnouts, and be designed with the requisite signaling and infrastructure (e.g., new bridges). A conceptual second main track is illustrated in Exhibit 11.5.

Exhibit 11.3: Conceptual Siding Extension

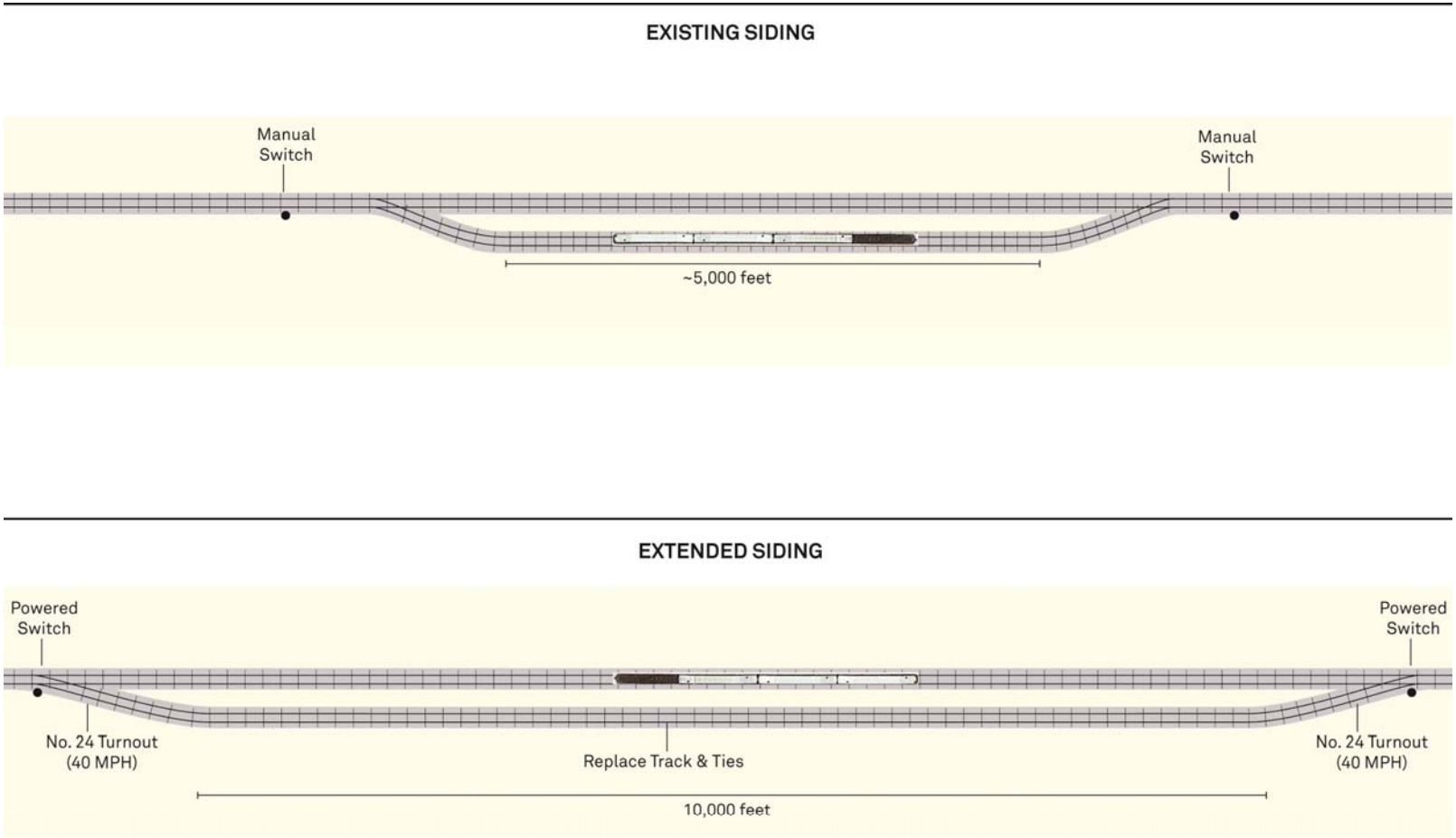


Exhibit 11.4: Conceptual Curve Realignment

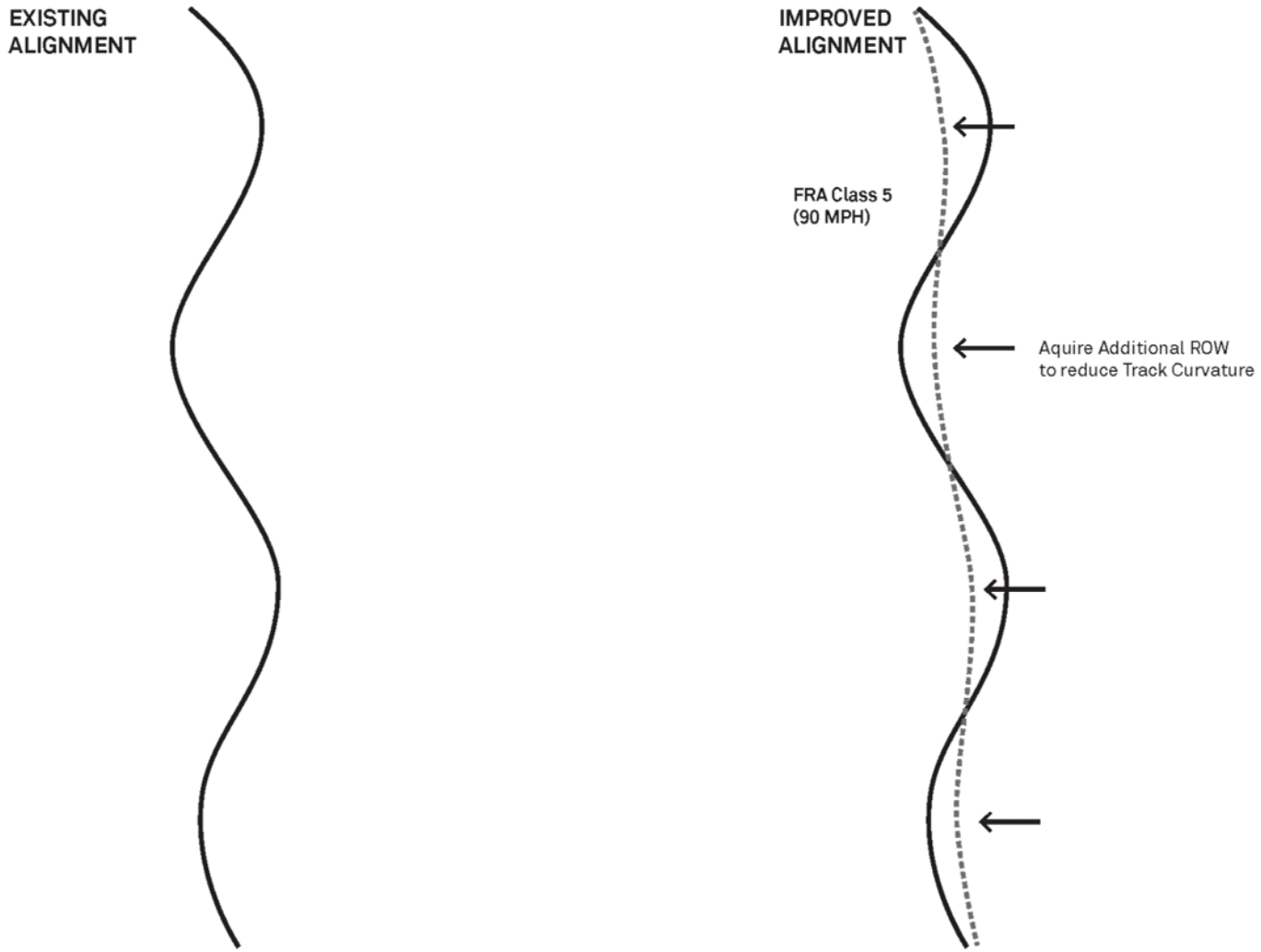
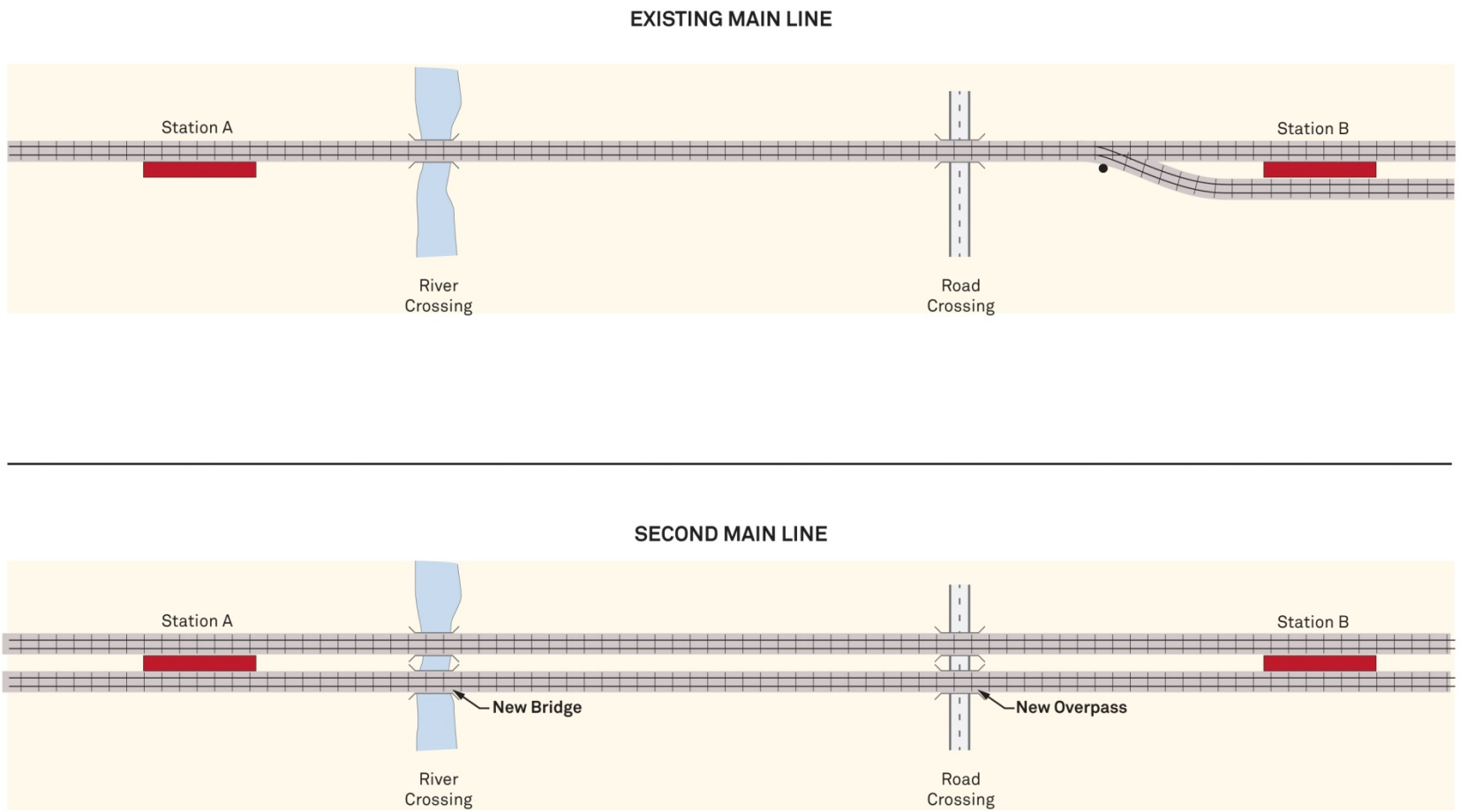


Exhibit 11.5: Conceptual Second Main Track



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12.0 Operating and Maintenance Costs and Capital Replacement Forecast

This chapter of the SDP presents operating and financial projections for each forecast year of the intercity passenger rail service in the San Joaquin Corridor. The methods, assumptions and outputs for operating expenses for the train services are addressed. Documentation of key assumptions is included, along with a description of how unit costs and quantities are derived.

An estimate of the Profit and Loss Statement for the route is also presented, as well as details of capital replacement costs.

12.1 Costing Methodologies and Assumptions

The Operating and Maintenance cost estimates are developed by deriving the cost per train mile and applying this unit cost to the number of train miles operated by forecast year. The unit cost per train mile is calculated based on recent operating experience of the *San Joaquin* service and do not include any additional costs for access fees or maintenance costs associated with utilization of the first construction section of the IOS as they have not been determined.

The total operating expenses for the proposed train services include rail operations – maintenance of way, maintenance of equipment, transportation (train movement), station and on-board services – as well as administration and marketing costs. Expenses covering heavy overhaul of equipment are considered capital costs and are not included. The unit cost per train mile is the quotient of the total annual O&M expenses divided by the annual train miles. The expenses, which are presented in Table 12.1, are averaged over the past two state fiscal years (FY 2010-11 and 2011-12) to determine the unit cost of $57.94.

Table 12.1: Operational Expenses – San Joaquin Route

	State Fiscal Year 2010-11	**State Fiscal Year 2011-12**
Rail Operations Maintenance of Way Maintenance of Equipment Transportation (Train Movement) Station On-board Services	$74,586,224	$74,367,228
Administration	$1,300,000	$1,300,000
Marketing	$1,500,000	$1,500,000
Total Annual Operating and Maintenance Costs	*$77,386,224*	*$77,167,228*
Annual Train Miles	1,331,897	1,335,731
Unit Cost per Train Mile	$58.10	$57.77
Average Unit Cost per Train Mile	*$57.94*	

Source: "Statistical History 2004-2011 – Pacific Surfliner, *San Joaquin*, *Capitol Corridor*", Caltrans, 2012

The factors (or driving variables) influencing the operating cost are based on the physical characteristics of the lines supporting the service and the operating plan, which in turn is based on operational and capacity analysis and significant operations decisions. Such decisions include the location of crew bases and maintenance facilities, as well as basic schedule concepts, which are developed in a manner consistent with achieving efficient operations and favorable O&M costs.

12.2 Summary of Operating Expenses (OPEX)

The total operating costs are developed for the forecast years in base year dollars, based on a unit expense per train mile of $57.94. Daily roundtrips in the forecast years are the same for both weekdays and weekend days. Total annual OPEX for intercity passenger rail service in the San Joaquin Corridor amounts to nearly $77.2 million for the existing service. With the proposed Northern California "blended service" by 2018, annual OPEX are estimated to range from $111.3 million for conservative service scenario Build Alternative A up to $258.7 million for the 90 mph MAS speed option for Build Alternative D, the most optimistic service scenario.

Table 12.2: Estimated Operating Costs

San Joaquin Corridor		Base Year (Existing)	Build Alt A	Build Alt B	Build Alt C	Build Alt D
Route Miles (one way)	Oakland–Port Chicago	39.2	39.2	39.2	39.2	39.2
	Port Chicago–Stockton	40.6	40.6	40.6	40.6	40.6
	Richmond–Stockton	NA	67.6	67.6	67.6	67.6
	Sacramento–Stockton (UPRR)	48.2	48.2	48.2	48.2	48.2
	Sacramento–Stockton (WP)	NA	35.2	35.2	35.2	35.2
	Stockton–Bakersfield (BNSF)	232.4	232.4	232.4	232.4	232.4
	Stockton–Bakersfield (including miles on first construction section of the IOS)	NA	233.7	233.7	233.7	233.7
	Madera–Bakersfield (BNSF)		131.6	131.6	131.6	131.6
Daily Round-Trips	Oakland–Bakersfield (BNSF & UPRR Martinez Sub)	4	1	1	1	1
	Oakland-Stockton (BNSF)	0	5	5	5	5
	Richmond–Stockton	0	0	0	4	4
	Sacramento–Stockton (UPRR)	2	2	2	2	2
	Sacramento–Stockton (WP)	0	0	0	0	3
	Stockton–Bakersfield (using first construction section of the IOS)	0	7	7	11	11
	Madera-Bakersfield (first construction section of the IOS)	0	6	6	10	10
	Madera–Bakersfield (BNSF)	0	2	5	5	5
Annual Train Miles		1,331,520	1,921,360	2,221,390	3,103,230	3,203,970
Annual OPEX +(79 mph MAS)		$77,161,584	$111,342,812	$128,729,551	$179,832,179	$185,670,062
Annual OPEX (90 mph MAS)		$107,533,555	$155,169,034	$179,399,456	$250,616,855	$258,752,617

Source: San Joaquin Corridor Operating Plans, AECOM, 2012

Notes:

- "NA" indicates not applicable.
- Per mile estimates of higher speed service based on Richmond – Hampton Roads Passenger Rail Project Final EIS

12.3 Route Profit and Loss Statement

An estimate of the Profit and Loss Statement for the *San Joaquin* route is provided, based on revenue and operating cost forecasts for the 79 mph MAS speed option. Revenue forecasts were neither computed nor estimated for the 90 mph MAS speed option as the 90 mph speed option was not continued for further study during alternatives analysis as outlined in Chapter 5.

Table 12.3: Estimated Profit and Loss

	Baseline	Scenario A	Scenario B	Scenario C	Scenario D
Annual Ridership	1,388,000	2,060,000	2,160,000	2,470,000	2,640,000
Route Profit/Loss (2012 dollars)					
Ticket revenue[1]	$46,970,000	$76,400,000	$79,500,000	$90,900,000	$97,700,000
Total Ticket Revenue	*$46,970,000*	*$76,400,000*	*$79,500,000*	*$90,900,000*	*$97,700,000*
OPEX (79 mph MAS)	$77,161,584	$111,342,812	$128,729,551	$179,832,179	$185,670,062
Subsidy Required	*($30,191,584)*	*($34,942,812)*	*($49,229,551)*	*($88,932,179)*	*($87,970,062)*
Subsidy per rider	*($ 21.75)*	*($ 16.96)*	*($ 22.79)*	*($ 36.00)*	*($ 33.32)*

Notes:
(1) Includes associated connecting Bus revenue.

The lowest subsidy per rider is for Build Alternative A and the highest subsidy per rider is for Build Alternative C. It is highly likely the subsidy per rider for the 90 mph MAS speed option will be arrayed similarly but will be much higher as the operating costs are higher for the 90 mph MAS speed option and the ridership increases will likely be only about eight percent higher based on the 90 mph forecast for the baseline service outlined in Chapter 8 and similar studies in Virginia. [xxxi]

12.4 Capital Replacement Costs

Capital replacement or economic depreciation is the portion of the value of physical plant and equipment that is used up in the production of passenger train service. These additional capital costs beyond those incurred in the initial implementation of the Service Development Program are anticipated to be required due to economic depreciation, obsolescence and lifecycle replacement and other factors. This would include track renewal, bridge replacement or rehabilitation, station renovation or replacement, signal system upgrades and rolling stock rehabilitation and replacement. Capital replacement costs exceed routine maintenance and ordinary repairs, which are included in O&M costs categorized in Section 12.2 above.

Capital replacement is usually treated as a discretionary expense in any particular year. It may be deferred when funds are unavailable but ultimately must be allocated to maintain the infrastructure, plant and rolling stock so the operation remains safe and reliable over the long term. Many of these capital replacement expenditures are incurred and paid for by the host railroads or local communities.

Track renewal and bridge maintenance and replacement is paid for and scheduled by the host railroads. Trackage rights fees paid by Amtrak and Caltrans includes an apportioned cost allocated for capital replacement in addition to routine and ordinary maintenance of infrastructure. Station renovation and/or replacement costs are usually paid for by local communities often with funding support from Caltrans. However, rolling stock is a critical capital replacement cost item and a major annual budget consideration.

Funding for the rolling stock overhaul program varies by budget year based on the specific overhauls planned for that particular budget year. The overhaul program has been funded through Public Transportation Account (PTA) funds appropriated each year by the Budget Act. Article XIX of the State Constitution prohibits the use of State Highway Account (SHA) funds for mass transit vehicle acquisition or maintenance. Thus, SHA funds cannot be used for the overhaul program, nor is there any dedicated funding source for the overhaul work needed in the future as the equipment ages.

Railcar Overhaul and Replacement

California owns its own fleet of 88 railcars and 17 locomotives and has spent over $300 million on the design and acquisition of railcars and locomotives since the early 1990's. The Northern California fleet, which is used on both the *San Joaquin* and *Capitol Corridor*, is entirely State-owned. It includes 78 cars – 66 California Cars and 12 new Pacific Surfliner fleet cars, and 17 locomotives – 15 Electro Motive Division F59PHI and two General Electric Dash-8 units.

California acquired the original 66 bi-level "California Cars" between 1995 and 1997. The "California Car" fleet is comprised of four distinctive car types –- cab, trailer, coach and food service cars. In 2001, California purchased and placed into service an additional 22 cars. The cars were acquired as an option to Amtrak's 40 car *Pacific Surfliner* fleet order for Southern California. Twelve of the State-owned cars were assigned to Northern California operations, and ten cars were assigned to *Pacific Surfliner* operations. In 2012, 14 Comet I coaches were purchased by Caltrans from New Jersey Transit. These railcars are currently being rehabilitated and are scheduled to go into *San Joaquin* service in late 2013. They are also proposed to be used on the Madera – Bakersfield local shuttle trains starting in 2018. Passenger railcars have an economic useful life of approximately 30 years. On-going routine maintenance keeps the railcars reliable and attractive to customers.

Caltrans received $245 million in American Recovery and Reinvestment Act of 2009 (ARRA) funds for equipment acquisition to replace some of the existing railcars and locomotives and to add capacity to the existing fleet. Caltrans and several Midwest states initiated a joint procurement of new railcars that will be compatible with existing equipment and recently awarded a contract to Sumitomo for railcars produced by Nippon Sharyo in Rochelle, Illinois. The equipment to be purchased will be designed and built using specifications approved by the PRIIA Section 305 Next-Generation Equipment Committee (NGEC). California will receive a total of 42 NGEC railcars. The railcars will include 29 allocated for capacity increases while the remaining 13 will be used to replace older or damaged equipment.

In 2003-04, Caltrans contracted for the midlife (eight-year) overhaul of the original 66 "California Cars." Design, engineering and the completion of the overhaul and testing of the four pilot (prototype) cars (cab, coach, foodservice and baggage) was completed in 2004-05, and midlife overhauls of the remainder of the fleet were completed in 2008.

However, additional work was still required to bring the cars up to current industry standards. Caltrans awarded a $13.1 million to Alstom for the complete replacement of the door systems and upgrade of the wheelchair lifts, as well as heavy cleaning of vehicle interior including upholstery and carpets; rebuilding and new flooring in toilet rooms; 110 volt convenience outlets at every seat; as well as other additions and improvements to the cars. In future years, the newer 22 cars (12 in the Northern California fleet and ten in the Southern California fleet) will need their midlife overhaul. Table 12.4 provides information on the overhaul program.

Locomotive Overhaul and Replacement

Caltrans purchased nine Electro Motive Division F59PHI locomotives that were delivered in 1994 and 1995. The locomotives have a maximum operating speed of 110 mph; include emission reduction technology and other features to improve operational and functional safety. Two additional General Electric Dash-8 locomotives were purchased from Amtrak in 1994. In 2001, Caltrans acquired an additional six model F59PHI locomotives. A locomotive has a projected economic life of approximately 20 years.

Table 12.4: Intercity Railcar Overhaul Program

State Fiscal Year	Projected Overhaul Funding Needs (Million dollars)
2011-12	$16.1
2012-13	$18.4
2013-14	$14.4
2014-15	$11.9
2015-16	$11.9
2016-17	$21.0
2017-18	$25.5
2018-19	$24.5
2019-20	$23.5

Source: Caltrans, Division of Rail

The current locomotive replacement schedule is being changed as a result of a major program currently underway to re-power the locomotives with new Tier 4 EPA standard head-end power (HEP) units, which supply electrical power to the train. Three locomotives have already had this upgrade. Caltrans currently has a contract to re-power five more locomotives beginning in February 2013. These repowering processes typically take approximately 6 weeks to complete at a cost of $ 260,000 per HEP unit. The schedule of specific locomotives to be retrofitted is still to be determined. This program is anticipated to give two more overhaul cycles to the equipment. Repowered locomotives will be overhauled again in eight years and then at year 16 will be replaced.

The joint procurement of locomotives with the Midwest states is proceeding. ARRA funds have been allocated to purchase six new NGEC locomotives for California capable of speeds up to 125 mph MAS, which could be used for *San Joaquin* “blended service” on the California high-speed rail first construction section of the IOS between Madera and north of Bakersfield. Procurement documents are being prepared and will likely be advertised in 2013.

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13.0 Public Benefits and Impact Analysis

This chapter describes the public benefits and impacts associated with passenger and freight rail improvements for the *San Joaquin* route. This analysis encompasses potential transportation, environmental, and economic effects for rail system users and non-users.

13.1 Operational and Transportation Output Benefits

The ridership and revenue forecasting process described in Chapter 8 provides a mechanism for calculating vehicle miles traveled (VMT), vehicle hours traveled (VHT), and travel mode changes as passenger rail service is expanded.

13.1.1 Travel Mode Changes

Passenger rail ridership increases arise from travelers diverting from air or personal vehicles or from taking entirely new trips ("induced travel"). These travel mode changes occur due to improved passenger rail travel times, reliability, and service frequencies that can be obtained with capital projects and service expansion. The ridership forecasting tools project that, in 2020, expanded service for the *San Joaquin* route and related elements of the Northern California Unified Rail Service will reduce statewide personal vehicle travel by about 0.78 million annual person trips and air travel by about 0.15 million annual person trips.

13.1.2 Personal Vehicle Travel

Table 13.1 summarizes the projected 2020 VMT and VHT changes in VMT by sub-region. These results reflect the illustrative year 2020 service plan assumptions for the *San Joaquin* route and other routes that are part of the NCURS. The forecast shows a daily VMT reduction in most regions. At the statewide level, daily VMT is projected to drop by about 134,000 miles in 2020, which represents a 0.01 percent reduction. The forecast shows a slight reduction in daily VHT (or hours spent driving) in most regions of the State, with daily statewide VHT falling about 2,900 hours in 2020.

Table 13.1: Changes in Daily Vehicle Miles Traveled and Vehicle Hours Traveled

Region	VMT		VHT	
	Change	Percent Change	Change	Percent Change
Sacramento	(11,000)	-0.03%	(300)	-0.02%
Bay Area	(24,000)	-0.02%	(500)	-0.01%
San Joaquin Valley	(73,000)	-0.09%	(1,600)	-0.07%
Central Coast	(4,000)	-0.01%	(100)	-0.01%
Los Angeles	(19,000)	~0%	(400)	~0%
San Diego	~0	~0%	~0	~0%
Rest of California	(2,000)	~0%	~0	~0%
Statewide Total	*(134,000)*	*-0.01%*	*(2,900)*	*-0.01%*

Source: AECOM and Cambridge Systematics, 2013.
Notes:
- Value reflects the illustrative service plan assumptions for the *San Joaquin* route and other routes that are part of the NCURS. Negative values indicate reductions from "baseline" or "no project" assumptions.

13.1.3 Air Travel

Diversion of air trips to conventional rail may lead to reduced aircraft operations for intra-California air travel. The most recent analysis, which was conducted for the *Bay Area to Central Valley High-Speed Train Program EEIR/EIS (2008)* estimated that the full statewide high-speed rail system (Phases I and II)

could result in approximately 280,000 fewer annual commercial aircraft operations at California airports (a five percent reduction). This magnitude of aircraft operation reduction was projected to reduce air travel delay each year by about 13.9 million passenger hours.

13.2 User and Non-User Economic Benefits

Passenger and freight rail improvements will benefit the State in a number of ways, and many of these benefits are quantifiable. For example, improved passenger rail service directly benefits travelers who shift from autos to trains for travel within the State. As more people use rail, those who remain on California's highways enjoy the benefits of reduced congestion levels, saving themselves time on their trips. Finally, more passenger rail trips will also translate to crash reductions and lower air pollution emissions. These benefits are measurable by monetizing values generated from the ridership and revenue forecasting tools described in Chapter 8.

The benefits quantified in this analysis divide into "user benefit" and "non-user benefit" categories.

13.2.1 User Benefits Analysis and Results

User benefits accrue to individuals as they shift from airplanes or personal vehicle to passenger rail. These travelers place a monetary value on riding comfortable, reliable, and safe trains. Passengers also value the dependability provided by rail in almost all weather conditions, allowing travel even as flights are canceled and driving is treacherous. The user benefits for rail passengers are a reflection of these advantages.

User benefits in this analysis include intercity rail passengers who shift to rail for their trips, plus induced travel (i.e., new trips that would not have taken place otherwise if the rail improvements had not been made). The passenger rail user benefits reflect these advantages and are measured by consumer surplus, which is the difference between how much passengers are willing to pay and the actual train fare that is paid. User benefits were estimated through a process known as log-sum calculation,[xxxii] which is derived from "values of time" and other mathematical equations in the ridership forecasting models.

Annual user benefits are projected to total $29.9 million (2012 dollars) for the illustrative year 2020 service plan assumptions for the *San Joaquin* route and other routes that are part of the NCURS. This user benefit total includes a $28.8 million benefit for intercity travelers and a $1.1 million benefit for urban area travelers.

13.2.2 Non-User Benefits Analysis and Results

Non-user benefits include highway delay reductions, safety improvements, and lower pollution emissions that result from a less intensive use of motor vehicles on California's roadways. These benefits are measured by monetizing the VMT and VHT changes shown in Table 13.1.

Vehicle Crash and Air Pollution Reduction Benefits

Expanded passenger rail service through the San Joaquin Valley will reduce VMT and, by extension air pollution and crashes. For this analysis, VMT reductions were converted to monetary benefits using rates of 14.7 cents per mile for crash reduction[xxxiii] and 2.1 cents per mile for air pollution reduction[xxxiv] (both are in 2012 dollars). The monetized accident and pollution reduction benefits are shown by region in Table 13.2.

Table 13.2: Non-User Benefits by Subregion

Region	Annual Benefits (Millions, 2012 dollars)		
	Highway Crash Reduction	Air Pollution Reduction	Highway Delay Reduction
Sacramento Region	$0.6	$0.1	$3.3
Bay Area	$1.3	$0.2	$6.8
San Joaquin Valley	$3.9	$0.6	$18.9
Central Coast & Monterey Bay	$0.2	~$0	$1.4
Greater Los Angeles Region (SCAG)	$1.0	$0.1	$4.7
San Diego	~$0	~$0	$0.1
Rest of California	$0.1	~$0	$0.5
Statewide Total	*$7.1*	*$1.0*	*$35.7*

Source: AECOM and Cambridge Systematics, 2013.

Highway Delay Benefits

Traffic congestion is a perennial problem in California and it imposes costs on the State's people in the form of lost time. Hours not spent at work, with family, or other activities such as exercising or entertainment translate to economic and social losses for the State. Improved rail service will reduce traffic delays by diverting personal vehicle travel to intercity passenger rail. For this analysis, VHT reductions were monetized using values of time (in 2012 dollars per hour) for intercity business and non-work trips of $72.36 and $20.97, respectively.[xxxv] Table 13.2 summarizes these results by subregion.

13.2.3 Summary of User and Non-User Benefits

Table 13.3 summarizes the total benefits of the expanded passenger rail service levels through the San Joaquin Valley. The benefits are closely divided between the intercity passenger rail travelers and the personal vehicle operators who continue to use California's roadways.

Table 13.3: Summary of Annual User and Non-User Benefits

Benefits Summary	Year 2020 (Thousands, 2012 dollars)
User Benefits	
Passenger rail	$29.9
Non-User Benefits	
Accident Reduction	$7.1
Pollution Reduction	$1.0
Highway Delay Reduction	$35.7
Total Benefits (User and Non-User)	*$73.7*

Source: AECOM and Cambridge Systematics, 2013.

While this analysis forecast major benefit components for California's economy, data and analysis methods were not readily available to capture all potential benefits. Some examples are as follows:

- Increased rail usage promotes sustainable development and increased use of transit.
- Increased rail usage may reduce highway maintenance.

- Reduced in-state air travel may lead to fewer in-state flights at California's congested. This situation might reduce delays for remaining flights or free up capacity for transcontinental and international flights.
- New highway-rail grade separations might reduce the projected number of train-vehicle crashes, further increasing the benefits shown in Table 13.2.
- Improved rail operations might reduce fuel-related costs for freight and passenger rail operators.
- Potential economic development benefits from HSR that are expected to strengthen the competitiveness of California's industries, major metropolitan areas, and intermediate cities by more effectively connecting markets and encouraging business interactions that further stimulate growth.

13.3 Environmental Effects

This section describes the potential environmental effects of the proposed capital and service improvements for the *San Joaquin* route.

13.3.1 Air Quality Emissions

Table 13.1 illustrates that improved *San Joaquin* and NCURS rail services are projected to reduce automobile and truck VMT throughout California. VMT reductions lead directly to reduced emissions of carbon dioxide (CO_2) and key mobile source pollutants.[xxxvi] Air quality emissions were forecast using the California Air Resources Board Emissions Factor (EMFAC) model[xxxvii] coupled with the VMT forecasts.[xxxviii] The emissions from train locomotives were not included in the analysis because the type of locomotive to be operated has yet to be determined.

Tables 13.4 through 13.9 summarize the reduction in emissions due to reduced VMT for key pollutants by region within California. The column titled "'No Action' EMFAC Emissions" shows total statewide mobile source emissions by pollutant. "No Action" assumes continuation (but no expansion) of current passenger rail routes and service levels. The "Emissions Reduction from 'No Action'" column indicates each pollutants projected emission reduction arising from the illustrative service plan assumptions. The emission reduction projections are organized by pollutant in the following tables:

- Table 13.4 shows the reduction in carbon dioxide (CO2) emissions to quantify GHG emission reduction benefits.
- Table 13.5 and 13.6 show the reduction in reactive organic gases (ROG) and oxides of nitrogen (NOx) respectively; these are precursor emissions that contribute to the formation of ground level ozone and secondary aerosols.
- Table 13.7 shows the reduction in carbon monoxide (CO) emissions.
- Table 13.8 shows the reduction in particulate matter between 2.5 and 10 microns (PM10)
- Table 13.9 shows the reduction in particulate matter smaller than 2.5 microns (PM2.5)

Table 13.4: Carbon Dioxide Emission Reduction

Region	"No Action" Emission Reduction	"No Action" EMFAC Emissions
Sacramento Region	700	7,286,000
Bay Area	2,700	30,941,000
San Joaquin Valley	14,600	25,218,000
Central Coast & Monterey Bay	600	6,069,000
Greater Los Angeles Region (SCAG)	3,100	81,412,000
San Diego	<100	13,947,000
Rest of California	300	11,191,000
Statewide Total	*22,000*	*176,064,000*

Notes:
- Table values are in tons per year.

Table 13.5: Reactive Organic Gas Emission Reduction

Region	"No Action" Emission Reduction	"No Action" EMFAC Emissions
Sacramento Region	1	3,700
Bay Area	2	19,000
San Joaquin Valley	7	11,000
Central Coast & Monterey Bay	<1	3,000
Greater Los Angeles Region (SCAG)	1	39,000
San Diego	<1	7,000
Rest of California	<1	7,100
Statewide Total	*12*	*89,800*

Notes:
- Table values are in tons per year.

Table 13.6: Oxides of Nitrogen Emission Reduction

Region	"No Action" Emission Reduction	"No Action" EMFAC Emissions
Sacramento Region	2	7,587
Bay Area	4	34,780
San Joaquin Valley	21	36,349
Central Coast & Monterey Bay	1	7,916
Greater Los Angeles Region (SCAG)	4	93,138
San Diego	<1	13,932
Rest of California	<1	17,972
Statewide Total	*32*	*211,674*

Notes:
- Table values are in tons per year.

Table 13.7: Carbon Monoxide Emission Reduction

Region	"No Action" Emission Reduction	"No Action" EMFAC Emissions
Sacramento Region	8	33,822
Bay Area	18	151,288
San Joaquin Valley	54	93,269
Central Coast & Monterey Bay	3	31,621
Greater Los Angeles Region (SCAG)	13	347,544
San Diego	<1	63,086
Rest of California	1	56,187
Statewide Total	*97*	*776,816*

Notes:
- Table values are in tons per year.

Table 13.8: Large Particle (PM_{10}) Emission Reduction

Region	"No Action" Emission Reduction	"No Action" EMFAC Emissions
Sacramento Region	<1	1,096
Bay Area	1	4,700
San Joaquin Valley	2	3,396
Central Coast & Monterey Bay	<1	889
Greater Los Angeles Region (SCAG)	<1	11,884
San Diego	<1	2,021
Rest of California	<1	1,556
Statewide Total	*3*	*25,541*

Notes:
- Table values are in tons per year.

Table 13.9: Small Particle ($PM_{2.5}$) Emission Reduction

Region	Emission Reduction from "No Action"	"No Action "EMFAC Emissions
Sacramento Region	<1	496
Bay Area	<1	2,144
San Joaquin Valley	<1	1,661
Central Coast & Monterey Bay	<1	408
Greater Los Angeles Region (SCAG)	<1	5,526
San Diego	<1	914
Rest of California	<1	744
Statewide Total	*2*	*11,892*

Notes:
- Table values are in tons per year.

13.3.2 Climate Change Assessment

In 2008, through the Governor's Executive Order S-13-08, Caltrans was charged with examining a preliminary assessment of the State's transportation system vulnerability to sea-level rise.[xxxix] Caltrans also developed guidance on incorporating sea-level rise in Project Initiation Documents in May 2011.[xl]

In 2012, the National Research Council confirmed that tide gages show that global sea level has risen about 7 inches during the 20th century, and recent satellite data shows that the rate of sea-level rise is accelerating.[xli]

Scientists have continued to narrow predictions of climate change and scenarios that include sea-level rise, temperature rise, as well as the variability of precipitation. Both passenger and freight rail systems in California are susceptible to the impacts of a changing climate. This section outlines the potential effects of changes in storm activity, sea levels, temperature, and precipitation patterns could be on the rail network, paying specific attention to coastal tracks and bridges. California is climactically diverse, with bioregions that span from the coastal marine to the Sonoran desert, and associated infrastructure are found statewide. Accordingly adaptation strategies may take on a very local approach.

Projected Climate Change Consequences and Possible Rail System Effects

Future projections of climate change for California have been synthesized by the 2009 California Climate Change Scenarios Assessment and the 2012 Reports on the Third Assessment from the California Climate Change Center, which examined changes in average temperatures, precipitation patterns, sea-level rise, and extreme events.[xlii] In California, the physical impacts on railroads from these changes include inundation, landslides, flooding, high winds, intense waves, storm surge, accelerated coastal erosion, and change in construction material durability.[xliii] The following sections provide a summary of the potential consequences of climate change and the affiliated impacts to the state rail system.

Temperature

Current emissions model scenarios all project hotter conditions by the end of the century, with business as usual projecting a 1°C increase by 2100. Temperature levels are expected to rise more quickly and be higher by the end of the century under higher emissions scenarios.

Rail tracks are laid on top of and within a range of land surfaces, including cleared pavement right-of-way, solid earth and a network of bridges and tunnels. Expected increases in temperature and temperature extremes may produce a range of new effects, including the following:

- More freeze-thaw conditions may occur, creating frost heaves and potholes on road and bridge surfaces and compromising rail beds.
- Longer periods of extreme heat can cause deformation of rail lines and derailments, or at a minimum, speed restrictions.[xliv] Buckled rails and heat kinks result from overheated rails that expand and cannot be contained by the material supporting the track.
- Higher heat can increase cost to cool equipment, and equipment may even have to be redesigned if inadequate for increased temperature. Many urban rail systems are controlled by a system of complex electrical train control and communications systems that are sensitive to overheating with substations, signal rooms, and electrical boxes designed with ventilation and air conditioning.[xlv]
- Increased extreme heat can also strain overhead catenary wires, cause overheating of vehicles, and lead to failed air conditioning systems within the vehicle itself.

An overall extension of extreme heat days can cause challenges for customer service and worker safety; passengers waiting on platforms in hot weather, or construction and maintenance crews working in cramped spaces in indoor vehicle maintenance facilities.

Precipitation

Projected changes in precipitation are less clear-cut than for temperature. The seasonal pattern of cool, wet winters and hot, dry summers, typical of a Mediterranean climate, is likely to continue. However, the amount of precipitation is likely to change; and, where and how much rain and snow fall differs with emission scenarios.

Expected changes in precipitation, both for averages as well as extremes, will produce a range of new impacts, including:

- The frequency, intensity, and duration of intense precipitation events contribute to design specifications for transportation infrastructure; and projected changes may necessitate design specification updates for rail beds and storm water drainage around rail tracks.[xlvi]
- More intense precipitation may cause flooding of coastal rail lines. Low-lying bridge and tunnel entrances for rail and rail transit will be more susceptible to flooding, and thousands of culverts could be undersized for flows. In urban rail systems, during heavy rain storms, the volume of water can exceed the capacity of street storm water drains and systems, leaving no capacity to accommodate water pumped out of subway tunnels.[xlvii]
- Changing precipitation may result in erosion and subsidence of rail beds, causing interruption or disruption of rail traffic. As a result, commuter and freight trains could experience extensive delays due to damaged or inundated tracks.[xlviii]
- The changing precipitation (for instance, changes from frozen to liquid precipitation) may change runoff patterns, increasing the risk of floods, landslides, slope failures, and consequent damage to rail beds, especially rural rail beds in the winter and spring months.

Sea-Level Rise

Sea levels have risen by about seven inches on the California coast in the past century.[xlix] Present sea-level rise projections suggest that global sea levels in the 21st century can be expected to be much higher. These projections are summarized in the State of California Sea-Level Rise Interim Guidance Document and shown in Table 13.10.[l,li]

Table 13.10: Sea-Level Rise Projections

Mean Sea-Level Rise (Meters)	Year to Reach Projected Sea-Level Rise in High (A2) Scenario	Year to Reach Projected Sea-Level Rise in Low (B1) Scenario
0.0	2000	2000
0.5	2054	2057
1.0	2083	2098
1.4	2100	2125

Source: Ocean Protection Council (OPC), 2011.
Notes:
- The State has agreed on two emissions scenarios (A2 and B1) from the Special Report on Emissions Scenarios from the Intergovernmental Panel on Climate Change (IPCC) representing a range of possible futures.[lii]

The Sacramento–San Joaquin Delta

The Sacramento–San Joaquin Delta region (Delta), once marshland, is the largest estuary in California and the State's most important water supply. The Delta is very sensitive to climate forces. Climate changes are projected to more than double the risk of Delta flooding events by the middle of the century and cause an eight-fold increase of flooding by the end of the century.[liii] A complex system of levees controls flooding and protects the region from periodic inundation, leaving it one of the most vulnerable areas when considering climate change. In fact, nearly 300,000 acres of the Delta are below sea level,

and the rich railway networks rest on continuously subsiding land and soft peat soils, protected only by the aging levee system.[liv]

Major rail lines such as the BNSF traverse the Delta with segments below sea level which are protected by levees.[lv] The Altamont Corridor Express, *San Joaquin*, and *Capitol Corridor* routes are major commuter and intercity rail systems running through the Delta. Rising sea level and higher winter water flows are likely to pose adverse impacts to these railroads in the long term.

The Central Valley

The Central Valley is California's inland region defined by its status as one of the most productive agricultural regions in the country. In the north, it is defined partially by the Delta. On the east it is bordered by the Sierra Nevada Mountains and on the west by the Coast Range. These two mountain ranges meet to form the southern border of the region. In this region, rail assets are vulnerable to climate impacts, such as temperature increases, reduced precipitation, and flooding.

Key rail corridors connecting Northern and Southern California straddle the Central Valley. These include the UPRR, BNSF, and the *San Joaquin* route, which uses both UPRR and BNSF tracks. Because of its proximity to the Delta, the flooding events have the potential to impact the northern section of the *San Joaquin* route. However, another important impact is the temperature increases – both in terms of average temperatures and extremes. In extreme heat conditions, rails can deteriorate, warp, and buckle, slowing vehicles at a minimum and requiring faster replacement.

Potential Adaptation Options for the California State Rail Network

Of the various climate stressors, sea-level rise and inland flooding pose the biggest climate impact to the California state rail network. Adaptation strategies should be coordinated with a wide range of stakeholders, including other state agencies (e.g., California Emergency Management Agency, California Natural Resources Agency); federal agencies [e.g., U.S. Army Corps of Engineers and regional and local partners metropolitan planning organizations (MPO), counties, and cities], potential strategies may include:

- Improving the drainage around rail stations and rail facilities, and increasing the capacity for storm water drainage.
- Retrofitting entrances to stations to minimize volume of floodwater that might inundate the station, and placing water-sensitive elements above a flood elevation.
- Elevating railroad tracks, rail beds, and/or station sites, but still maintaining adequate clearances.
- Conducting partial or temporary closures in extreme events, and providing alternative routes for goods movement.
- Constructing a permanent or temporary floodwall/barrier to manage tidal flows.
- Building levees and strengthening coastal armoring around key high-risk locations.
- Providing supportive hazard mitigation and emergency evacuation plans.
- In the most extreme cases, abandoning the asset or finding alternate routes for the coastal rail lines and at-risk stations under consideration.

13.3.3 Land Use and Community Benefits

Intercity passenger rail, commuter rail, and freight rail services are important components of California's transportation system, providing benefits to the State that extend beyond the mobility of people and goods. Safe and efficient rail systems contribute to community, land use, safety, and public health

benefits. This section describes the community and greening benefits further by safe and efficient passenger and freight rail services enjoyed by rail users, as well as the greater public.

- Capital and operational improvements through the San Joaquin Valley can be broken down into the following categories: Rail line improvements improve the speed, capacity, reliability, and safety of a railroad corridor. Rail line improvements may include double-tracking, siding improvements, curve realignments, and panelized turnouts to increase capacity and improve safety and travel times. Community and greening benefits resulting from rail line improvements include reduced braking and acceleration noise, reduced idling on sidings, and enhanced safety.
- Grade separations may be considered a subset of rail line improvements, but these improvements are so prevalent and such an important part of the rail improvement plan that they are noted separately. Grade separations improve the safety, speed, capacity, and reliability of rail service by eliminating dangerous at-grade crossings of rail and highway systems. More specifically, greening and community benefits of grade separation improvements include reduced braking and acceleration noise, less traffic disruption, reduced idling at crossing, enhanced safety, and removal of barriers and walls dividing the community.
- Bridges are planned along some corridors. Existing bridges require widening to accommodate expected passenger rail and freight rail activity, and new bridge construction is planned to accommodate proposed track extensions. Community and greening benefits resulting from these improvements include providing enhanced supporting wildlife corridors/crossings, providing agriculture access, and may reduce barriers dividing communities.
- Signal and train control improvements provide integrated command, control, communications, and information systems for controlling train movements with safety, security, precision, and efficiency. Community and greening benefits resulting from these improvements include reduced braking and acceleration noise, reduced idling on sidings, enhanced safety, and less traffic disruption.
- Rolling stock improvements include purchasing new railcars/locomotives, and upgrading existing railcars/locomotives. In addition to improving the passenger experience (e.g., amenities, ride comfort), new rolling stock can also offer tangible travel time benefits. . Community and greening benefits resulting from these improvements include reduced braking and acceleration noise expanded system capacity, and emission reductions from cleaner locomotives.
- Station and station access improvements may include providing new or improved station platforms; enhanced pedestrian and bike facilities; and customer amenities, such as additional parking, shuttle service to enhance access to the station, electronic signage with real-time arrival and departure information, and enhanced lighting. Community and greening benefits resulting from station improvements include enhanced safety, mitigation of issues related to noise and emissions from locomotives, land use benefits supporting vibrant TOD communities, and promotion of multimodal transportation options such as bicycling or pedestrian activity, which may help reduce obesity and improve broader measures of health throughout the community.
- Freight terminal improvements include new and expanded freight rail yards and intermodal facilities. Greening benefits of these projects include the mitigation of noise and pollution concerns and diversion of trucks from the highway system, as well as improved efficiency and safety.

The way these benefits accrue to users and non-users of the rail system differs somewhat by rail service type. The accrued benefits are described in more detail for passenger rail (both intercity and commuter) and the freight rail system in the following section.

Intercity and Commuter Passenger Rail

Passenger rail includes a complex system of intercity and commuter rail to connect cities across the state. Intercity passenger rail in California serves metropolitan and rural areas, and provides service between regions in the State. Commuter rail service is a key component of the State's integrated rail system serving local travel and providing regional connections to and from intercity Amtrak service. Safe and efficient intercity and commuter passenger rail services that are well-integrated with local transportation options can contribute to community and greening benefits to users and non-users of the system in regards to community livability, land use, safety, and public health.

As with the intercity passenger rail system, community and greening benefits of commuter rail service improvements may be valued differently for users and non-users of the system. Benefits that result from improvements to California's commuter rail system also extend beyond better transportation service provided to users of the system. Generally, the capital and operation improvements to the State's commuter rail systems have the potential to impact local road congestion; alternate transportation options (i.e., non-motorized transportation, transit, etc.); land use patterns; community livability; the environment; and public health.

For users, improved passenger rail service that operates more safely, comfortably, and efficiently will enhance personal mobility and offer travelers greater diversity of transportation options. Capital and operational improvements, such as grade separation projects, double-track projects, station improvements, and service frequency improvements, are examples of projects that will improve the attractiveness and viability of rail travel as the preferred mode for many intercity and commuter trips. Rail station improvements that enhance pedestrian and bike facilities and amenities and increase TOD around station areas will be important factors encouraging users to utilize active transportation modes to access stations. Users of passenger rail may enjoy economic benefits associated with a reduced travel cost compared to automobile ownership/travel. Providing more varied and affordable travel modes also mitigates transportation equity and environmental justice issues for users of the passenger rail system.

Passenger rail improvements may bring about community and greening benefits for non-users in several ways. Shifting the rail system to a cleaner energy source through projects like electrification will reduce greenhouse gas emissions and diesel-generated criteria air pollutants from system operations. Increasing the appeal of rail travel through grade separation projects, double-track projects, station improvements, and service frequency improvements will encourage people to shift from driving single-occupancy vehicles (SOV) to comparatively cleaner and safer rail travel. Non-users will also enjoy reduced congestion on roadways as drivers shift to train travel. That mode shift will translate to congestion relief for the non-users along parallel highway corridors. TODs supported by the commuter rail services facilitate concentrations of homes, shops, and jobs nearby rail stations. Thus, users and non-users may enjoy access to vibrant TOD communities with diverse and accessible recreational and employment opportunities. Benefits may also be enjoyed by non-users as more compact development presents more opportunities to integrate walking and biking for mobility purposes.

One of the most important roles that improved passenger rail service plays is that of supporting the development of livable communities. The *Vision California* scenario modeling project[(lvi)] undertaken by the state of California found significant economic, fiscal, health, water and environmental co-benefits from the state, regions, and localities choosing to grow through TOD and infill near existing and future local and intercity rail service. Households could save over $7,250 per year in auto costs and utility bills. Local governments could save more than $47 billion in infrastructure costs (water pipes, sewers, roads, and utility lines) while gaining over $120 billion in new revenue. Reduced health incidences would save approximately $1.9 billion a year by 2035. By 2050 water saving would total 19 million acre-feet. Over 3,700 square miles less farmland, open space, and recreation areas would be lost to development, and 75 million metric tons of less GHG would be created by 2050. These enormous indirect benefits from

smarter growth and development choices would be above and beyond the direct user and non-user benefits discussed above.

Freight Rail

Freight rail operations in California help link the State to both domestic and international markets. The freight railroad system in California consists of an expansive network of Class I railroads, short line railroads, and switching yards/terminals stretching more than 5,000 miles across the State. Safe and efficient freight rail services that are well-integrated with the State's transportation system can contribute to community and greening benefits to users and non-users of the system in the areas of safety, job creation, noise reduction, the environment, and public health.

For planning analysis, benefits to users and non-users of the freight rail system will depend on the varying perspectives and freight knowledge of stakeholders and whether they are more focused on the impacts on track, the rolling stock, or the freight facilities, for example. For users of the freight rail system (i.e., shippers), service and infrastructure improvements that allow the system to operate more safely and efficiently will reduce freight transportation costs. Rail grade separation projects, double-track projects, and freight facility improvements are examples of projects that will improve the reliability and economic competitiveness of freight rail travel as a preferred mode for freight trips.

Freight rail improvements may also bring about community and greening benefits for non-users in several ways. For example, the Generator Set (GenSet) technology (or sets of engines turning a generator) replaces the large diesel engine and generator found in almost all existing freight locomotives with two or three much smaller diesel engines and generators providing fuel consumption reduction and improved air quality benefits. Shifting the rail system to a cleaner energy source through projects that expand the use of GenSet Locomotives at switching yards, implement idling limit devices, and facilitate eventually electrification will reduce GHG emissions and benefit public health in communities located near rail lines terminals. However, for the electrification of passenger and freight rail to occur, enough electricity must be available in the California power grid. Enhancing freight rail movement through grade separation projects will improve safety and reduce congestion and the associated emissions from vehicle idling, reduce conflicts between trains traffic within neighboring communities, and improve community connectivity by removing divisive at-grade tracks. Rail line improvements may reduce noise along freight corridors, and new freight intermodal terminals will create jobs.

14.0 Summary Service Development Plan

This chapter presents the summary of the Service Development Plan (SDP) prepared for the San Joaquin Corridor. This SDP describes how San Joaquin trains could be routed from Bakersfield to Madera via the first construction section of the IOS then over existing rail lines north to Madera where services would could connect to a unified regional network comprised of the *San Joaquin*, the Altamont Corridor Express (ACE) and the *Capitol Corridor*. This phase could involve blended operations with trains interlining between the high-speed track and conventional rail routes shared with freight traffic. This San Joaquin SDP evaluates one service scenario of many that may evolve with additional operations modeling analysis and studies forthcoming in the next year.

14.1 Key Findings

Five alternatives were evaluated in this service development planning effort. These alternatives included the No-Build Alternative, which provided a baseline discussion of the continued operations of the current *San Joaquin* service with no improvements beyond those identified in current programming and funding plans through 2018. Four Build Alternatives with two speed options were defined and evaluated, which provided a set of improvement projects to accommodate increased passenger service levels at initiation of blended service in 2018 and planned for forecast year 2020. This was done after taking into consideration the Authority 2012 Business Plan, which described a phased implementation of blended high-speed train services in the San Joaquin Corridor.

The Build Alternatives are described in Chapter 4. The Build alternatives were evaluated to determine their reasonableness and feasibility in meeting the Corridor's future travel needs and challenges based on the following criteria assessing how well each alternative met the following:

- The Purpose and Need for the action;
- Technical feasibility based on right-of-way (ROW) and engineering constraints;
- Economic feasibility based on market potential and/or ridership, capital and operating costs; and
- Major environmental concerns.

Based on the future Corridor population and employment growth, and corresponding increase in travel demand, the rail network provided by the No-Build Alternative was identified as not supporting the rail service volumes needed in this corridor.

As outlined in Chapter 5, three of the Build Alternatives (Build Alternatives B, C and D) were not advanced to more detailed technical analysis. The increase in service from the existing 6 daily round trips trains to a very optimistic service scenario involving 11 round trip trains required substantially more infrastructure improvements than could be environmentally cleared and constructed in time for service initiation in 2018. Moreover, CAPEX ranging from an additional $173 to $1,515.5 million, additional rolling stock costs exceeding $288 million and annual operating subsidies ranging from $49.2 to $88.9 million exceed reasonably expected funding levels for those alternatives.

The increases in service and capital improvements identified by Build Alternative A were found to be technically feasible. Build Alternative A and the "blended" service operating scenario was found to meet future Corridor travel needs during the interim period before the California HSR system is fully implemented. The SDP analytical efforts identified that the proposed improvement projects included in Build Alternative A best met the identified Purpose and Need, was technically feasible, and was the most affordable.

Build Alternative A has no significant environmental impacts and have community, natural resource, and air quality benefits. The proposed service increase as described in Chapter 4 operating at current speeds on the BNSF and UPRR and 125 mph on the first construction section of the IOS is consistent with reasonably expected funding resources. Besides the increased frequency of trains in the Corridor, implementation of the proposed improvement projects would allow faster trips between the San Francisco Bay Area and Sacramento from the Central Valley by taking advantage of the first construction section of the IOS as identified in the Authority 2012 Business Plan.

14.2 Operational Initiative Priority

Future San Joaquin Corridor service plans have been developed by Caltrans DOR building upon the prior *San Joaquin Strategic Plan* (2010). The resulting service increases are designed to address the forecasted rail system demand through the provision of increased weekday service along with new services. Operational plans have been developed for proposed horizon planning year 2020 train volumes in various segments of the Corridor between the cities of Oakland/Sacramento and Bakersfield. The train volumes represent more frequent *San Joaquin* intercity services. By 2018, the following operational revisions are feasible and practicable and could be made in the San Joaquin Corridor:

- Four additional daily *San Joaquin* trains making ten daily round trips trains between various terminals:
- Seven round trip trains will be routed via the first construction section of the IOS (5 round trips between Oakland and Bakersfield, and 2 round trips between Sacramento and Bakersfield)
- One round trip via the first construction between Madera and Bakersfield.
- Two local shuttle trains operating between Madera and Bakersfield on the BNSF route.
- One round trip train between Oakland and Bakersfield on the BNSF route.
- While Corridor local freight activity is not expected to increase significantly, additional through freight trains are projected to occur, and future freight consists may increase in length.

Operational priorities to support the planned increase in rail activity will include implementation of the following improvements:

- Passenger safety initiatives such as the FRA-mandated installation of Positive Train Control (PTC) that is fully funded and anticipated to be completed and in operation by the end of 2013;
- Grade-crossing improvements already programmed, planned and funded to improved safety

14.3 Capital Funding Priority

Improvement and expansion of the San Joaquin Corridor's intercity rail system has not kept pace with the travel demand resulting from increases in population, employment, and travel demand. The Corridor's rail system infrastructure is currently operating just below its design capacity. Improvement projects have been identified that are required to accommodate the increased frequency of *San Joaquin* service and forecasted rail activity and improve mobility and reliability in this part of the state's rail system. Projects were identified from prior studies, including the *Amtrak 20-Year Plan* and current *State Rail Plan*, the *San Joaquin Corridor Strategic Plan* (2008), San Joaquin *Initial Study* Program EIS/EIR currently under preparation, UPRR recommendations, BNSF capacity analyses and by coordination with the Northern California Rail Partners Working Group, Authority, and studies prepared by Corridor MPOs. The SDP identifies Corridor improvement projects necessary to support implementation of blended service by

shifting some *San Joaquin* service onto the first construction section of the IOS in the Central Valley in 2018. These projects reflect system operational needs and reasonably expected funding availability.

Priority would be given to Corridor capital projects providing improved travel time and increased reliability and safety, such as siding improvements, double tracking and signal upgrades. As increased funding becomes available and with more time, the more costly curve realignment projects listed in prior studies and provision of a second main track could be accomplished that would allow the *San Joaquin* service to be expanded beyond the four additional trains recommended in this SDP.

In order to support the forecasted 2018 service levels, priority would be given to:

- Passenger service improvements at the Corridor's existing stations, such as the provision of new and/or improved station platforms, electronic signage with real-time arrival and departure information, automated ticket vending machines, additional parking, and improved transit connectivity;
- Acquisition of replacement rolling stock and locomotives for aging equipment and the acquisition of additional rolling stock and locomotives for the added three trainsets and new locomotives capable of 125 mph MAS.
- System infrastructure improvements required to improve rail system capacity and speed constraints that currently negatively impact intercity passenger and freight rail performance and will include the improvements are listed in Table 14.1. Completion of Corridor infrastructure projects already partially or fully funded are listed as immediate projects in Section 4.2.
- Projects identified in Table 14.1; and
- Infrastructure projects that would support implementation of the California HSR system in the Central Valley for which funding is already available and allocated. The scope of this SDP does not include capital improvements that are the responsibility of the Authority to implement such as construction of the first section of the IOS, necessary track connections between the first construction section of the IOS and the BNSF and any temporary/interim station stops to facilitate seamless passenger travel.

Table 14.1 presents the Corridor improvements projects which in this SDP have been determined to be necessary for Alternative A. All of these projects have been designed and engineered by BNSF and will have CEQA clearance.

Table 14.1: Funded Rail Improvement Projects

Project	Cost (Millions, Year 2012 dollars)	Source(s)
Merced to Le Grand second main track (Segment 1)	$40.4	Proposition 1A, *San Joaquin Corridor Strategic Plan (2008),* Northern California Rail Partners Working Group, BNSF capacity Analysis
Stockton to Escalon second main track Segments 3 & 4)	$ 54.0	STIP, SJCOG RTP (financially-constrained) *San Joaquin Corridor Strategic Plan* (March 2008), Northern California Rail Partners Working Group, BNSF Capacity Analysis
Port Chicago to Oakley (Segment 2)	$55.0	STIP, TCRP, Proposition 1B (Intercity Rail Improvement), *San Joaquin Corridor Strategic Plan (2008)*, Northern California Rail Partners Working Group; BNSF Capacity Analysis

Project	**Cost (Millions, Year 2012 dollars)**	**Source(s)**
Jastro to Una (Segment 1)	$42.0	BNSF Capacity analysis to support 11 trains at 79 mph north of Bakersfield
Una to Shafter (Segment 2)	$22.0	BNSF Capacity analysis to support 11 trains at 79 mph north of Bakersfield
Total Infrastructure Cost	*$213.4*	

In addition to the infrastructure improvement projects, additional rolling stock is required as noted in Chapter 11. Total cost of the additional rolling stock and 125 mph Next Generation (NGEC) locomotives, including spares, is $288.8 million. Funding has been secured by Caltrans for the acquisition of 11 new cars (ten coaches and one cab-baggage car) for augmentation of existing *San Joaquin* service, and for six new 125 mph-capable NGEC locomotives to replace Amtrak-owned locomotives currently used on the San Joaquin service. Acquisition of rolling stock currently funded will reduce the number of new cars and locomotives needed to be funded and acquired for the 2018 blended service to 45 cars and 16 NGEC locomotives. The unfunded cost for the additional rolling stock is $225.5 million. No funding source for this acquisition has been identified.

This SDP is the first of a series of studies that will consider future plans for improving the San Joaquin service by the Authority and other regional rail agencies.

End Notes

(i) Parsons Brinckerhoff, *San Joaquin Strategic Plan*; Caltrans, Division of Rail; Sacramento, CA, January 2008.

(ii) California High Speed Rail Authority, *"Building California's Future", California High-Speed Rail Program Revised Business Plan;* Sacramento, CA, April 2012.

(iii) The Northern California Rail Partners Working Group is comprised of representatives of the Authority, Capitol Corridor Joint Powers Authority, San Joaquin Regional Rail Commission/ACE, Caltrans, and Sacramento RT, Caltrain, and FRA working on the complex tasks of blending the passenger rail services for 2018 and beyond.

(iv) Caltrans, *San Joaquin Corridor Programmatic Environmental Impact Report (EIR) 2035-Vision, (Initial Study)*, Sacramento, CA, November 2012.

(v) Council of Fresno County Governments, 2007.

(vi) San Joaquin Valley includes Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus and Tulare Counties.

(vii) California Department of Agriculture, 2010.

(viii) Northern California Unified Service is the restructuring and integration of San Joaquin Corridor, ACE, and Capitol Corridor operations to provide connections between Sacramento, Oakland, and San Jose and the California HSR tracks in the San Joaquin Valley.

(ix) Express service would be provided along the first construction section of the California HSR system between Rosedale and Madera.

(x) Existing service is provided along the Fresno subdivision (former SPRR); a future service option would follow the UPRR Sacramento Subdivision (former WPRR).

(xi) Existing service is provided along the UPRR Martinez Subdivision; a future service option would follow the BNSF Stockton Subdivision to Richmond (approximately 25.5 track miles) and then a 1.5 mile track extension along the edge of the UPRR right-of-way to Richmond Amtrak/BART.

(xii) On-going and additional capacity analysis and simulation modeling by BNSF may affect the projects being identified for inclusion in each alternative.

(xiii) ACE recently constructed a comparable facility in Stockton at a cost of $75-million.

(xiv) Achieving this time savings would require 2 "Tier 3" ("Next Generation") diesel locomotives per train to deliver a top speed of 125 mph; with the existing locomotives and train consist, the maximum achievable speed would be 110 mph, resulting in a travel time savings of about 30 minutes.

(xv) The proposed Fresno HSR station is located about 0.8 miles west of the existing Amtrak station in Fresno; the proposed Kings/Tulare HSR station is located about 2 miles from the existing Amtrak Hanford station.

(xvi) The current BNSF track crosses over the UPRR line in North Richmond; in order to reach the BART / Amtrak station in Richmond, the "North Richmond Connector" would be required to transition a connection over to the UPRR right-of-way and then a track extension of about 1.5 miles along the edge of the UPRR line would be required to reach the existing Richmond Station.

(xvii) The cost rate is based on two years of actual operating costs averaged by the number of total trains miles for the two years.

(xviii) See Chapter 8 for a description of the two models.

(xix) The two models assume very similar auto fuel operating costs. Amtrak/Caltrans model assumes a 16 cents per mile average derived from 2011 AAA auto operating cost estimates.

(xx) Market-to-market refers to the process by which the change in the value of an asset or fund is recorded to reflect its current fair market value. Marking to market occurs on a daily basis.

(xxi) In travel demand modeling, logsum is a composite measure of utility – or benefit – that is derived by making a specific trip. Logsum is used in choice-based models to predict the likelihood of a traveler selecting a particular option (such as destination, mode or route) given a set of socioeconomic and accessibility conditions.

(xxii) The HSR R&R Model was chosen for this purpose over the Caltrans/Amtrak Model because the latter did not produce all-mode trip tables for future years. The HSR R&R Model was developed for High-Speed Rail Authority purposes and was only calibrated to produce trip tables for years 2000 and 2030.

(xxiii) Keeney, Willard and Gary Agnew; *San Joaquin Valley Capacity Analysis*, "Summary of RTC Simulations", BNSF, October 8, 2010.

(xxiv) Wilmoth, Jerry, General Manager Network Infrastructure, UPRR; letter to Caltrans Division of Rail dated March 4, 2010.

(xxv) *San Joaquin Corridor Intercity Passenger Rail: Programmatic Environmental Impact Review / Environmental Impact Statement*, October 28, 2011, p. 20.

(xxvi) Executive Order 13514 – Federal Leadership in Environmental, Energy, and Economic Performance.

(xxvii) An analysis of the Stockton Diamond, where the two San Joaquin service branches meet, is currently being performed by URS Corporation for BNSF and UPRR. The outcome of the analysis may have implications for the feasibility and location of a joint Stockton station.

(xxviii) *San Joaquin Corridor Intercity Passenger Rail: Programmatic Environmental Impact Review / Environmental Impact Statement*, October 28, 2011, p. 20.

(xxix) "Multi-state partnership announces intent to award contract for next generation of American trains" (September 27, 2012), http://www.dot.ca.gov/hq/paffairs/news/pressrel/12pr121.htm. Accessed February 14, 2013.

(xxx) "Metrolink to buy newest, cleanest locomotives" (December 18, 2012), http://www.metrolinktrains.com/news/news_item/news_id/836.html. Accessed February 14, 2013.

(xxxi) Virginia Department of Rail and Public Transportation, *Richmond - Hampton Roads Passenger Rail Project Tier 1 Final Environmental Impact Statement*; September 2012.

(xxxii) An explanation of the log-sum process and its application to this analysis is available in *Economic Growth Effects Analysis for the Bay Area to Central Valley Program-Level Environmental Impact Report and Tier 1 Environmental Impact Statement*, Appendix A, California High-Speed Rail Authority, July 2007.

(xxxiii) Federal Highway Administration, *Highway Economic Requirements System*.

(xxxiv) National Research Council, *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use*, Committee on Health, Environmental, and Other External Costs and Benefits of Energy Production and Consumption, 2009.

(xxxv) The values of time were adjusted to 2012 dollars and sourced from, "Information Requested in —Section 3.2 Validation and Documentation of the Independent Peer Review of the California High Speed Rail Ridership and Revenue Forecasting Process, 2005-10, Draft Report for Internal Review," Cambridge Systematics, February 7, 2011, available on California High Speed Rail Authority website.

(xxxvi) This analysis addressed reactive organic gases (ROG), oxides of nitrogen (NOx), carbon monoxide (CO), large particles (PM_{10}), and small particles ($PM_{2.5}$).

(xxxvii) The analysis used the EMFAC 2011 model.

(xxxviii) This emissions analysis reflects vehicle travel reduction due to mode shifts from personal vehicles to passenger rail and residual congestion reduction from this mode shift. Additional emission reduction might arise from: a) improved rail system efficiency through reduced locomotive idling and improved locomotive fuel economy; b) reduced aircraft operations from air to rail modal shifts; c) reduced vehicle acceleration and deceleration from highway bottleneck elimination; and d) shifting of freight from trucks to rail .Emission increases might arise from: a) additional locomotive operation due to expanded service levels; and b) passenger travel to/from intercity passenger rail stations.

(xxxix) Caltrans, *Vulnerability of Transportation Systems to Sea Level Rise: Preliminary Assessment*, submitted by Business, Transportation, and Housing Agency, February 2009.

(xl) Caltrans, *Guidance on Incorporating Sea Level Rise for Use in the Planning and Development of Project Initiation Documents*, May 16, 2011.

(xli) National Research Council. *Sea-Level Rise for the Coasts of California, Oregon and Washington: Past, Present, and Future*. National Academies Press, 2012.

(xlii) Cayan, D., M. Tyree, M. Dettinger, H. Hidalgo, T. Das, E. Maurer, P. Peter Bromirski, N. Graham, and R. Flick, *Climate Change Scenarios and Sea Level Rise Estimates for the California 2008 Climate Change Scenarios Assessment*, PIER Research Report, CEC-500-2009-014, Sacramento, California: California Energy Commission. 2009 and Reports on the Third Assessment from the California Climate Change Center, http://www.climatechange.ca.gov/adaptation/third_assessment/.

(xliii) Kahrl, F., and D. Roland-Holst, *Climate Change in California: Risk and Response*, University of California Press, 2012.

(xliv) National Research Council of the National Academies (NRC), *Potential Impacts of Climate Change on U.S. Transportation*, Transportation Research Board Special Report 290, Washington, D.C., 2008.

(xlv) Federal Transit Administration Office of Budget and Policy, *Flooded Bus Barns and Buckled Rails: Public Transportation and Climate Change Adaptation*, FTA Report No. 0001, August 2011.

(xlvi) National Research Council of the National Academies, *Potential Impacts of Climate Change on U.S. Transportation*, Transportation Research Board Special Report 290, Washington, D.C., 2008.

(xlvii) Federal Transit Administration Office of Budget and Policy, *Flooded Bus Barns and Buckled Rails: Public Transportation and Climate Change Adaptation*, FTA Report No. 0001, August 2011.

(xlviii) National Research Council of the National Academies (NRC), *Potential Impacts of Climate Change on U.S. Transportation*, Transportation Research Board Special Report 290, Washington, D.C., 2008.

(xlix) National Research Council. Sea-Level Rise for the Coasts of California, Oregon and Washington: Past, Present, and Future. National Academies Press, 2012.

(l) Ocean Protection Council (OPC), *State of California Sea-Level Rise Interim Guidance Document*, Ocean Protection Council. 2011.

(li) The recent sea-level rise publication from the NRC *titled Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future* (NRC 2012) revises some of the projections included in the OPC report and Caltrans guidance. Caltrans is working with other State agencies to determine specific sea-level rise values to incorporate into future planning and design documents. As new state guidance becomes available it will be important to incorporate that information into future planning assessments and update Caltrans guidance, as appropriate.

(lii) These are both scenarios evaluated by California for statewide climate assessments. Each scenario leads to a projection of possible emissions levels based on population growth rate, economic development, and other factors. Ultimately, the effect on climate change depends on the amount and the rate of accumulation of heat-trapping gases in the atmosphere that these scenarios suggest. Of the two options provided, the A2 scenario is the more realistic choice for decision-makers to use for climate adaptation planning. Generally, the B1 scenario might be most appropriately viewed as a version of a “best case” or “policy” scenario for emissions, while A2 is more of a status quo scenario incorporating incremental improvements. These two scenarios are represented above.

(liii) USGCRP, 2009, *Global Climate Change Impacts in the United States*, Karl, T. R., J. M. Melillo, and T. C. Peterson (eds.), United States Global Change Research Program. Cambridge University Press, New York, New York.

(liv) Roos, M., Sea Level Rise: What is the Water Engineer to Do with all Those Projections? Sacramento, California: Department of Water Resources, Draft 7, October 2008.

(lv) California Emergency Management Agency and California Natural Resources Agency, *California Climate Change Draft Adaptation Policy Guide*, April 2012.

(lvi) California High Speed Rail Authority and Strategic Growth Council funded project. http://www.visioncalifornia.org/

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