

6 Project Costs and Operations

6.1 Introduction

This chapter discusses the estimated costs for building, operating, and maintaining the Central Valley Wye of the California High-Speed Rail (HSR) System based on a preliminary level of design used in preparing this Draft Supplemental Environmental Impact Report/Environmental Impact Statement (Draft Supplemental EIR/EIS). For the approach and details used to prepare the capital cost estimates, refer to the project-level *Merced to Fresno Project Section: Central Valley Wye Supplemental EIR/EIS Capital Cost Estimate Report* (Authority 2016a). Additional details are provided in Volume II of this Draft Supplemental EIR/EIS in:

- Appendix 6-A, Operations and Service Plan, comprises background information on the intended service and operations of the HSR system to provide sufficient detail for the environmental assessment of proposed HSR operations.
- Appendix 6-B, High-Speed Rail Operating and Maintenance Cost for Use in EIR/EIS Project-Level Analysis, summarizes the assumptions used to estimate full-system HSR operations and maintenance (O&M) costs.

6.2 Capital Costs

Capital costs represent the total cost associated with the design, management, land acquisition, and construction of the HSR system. The estimated long-term costs include both train operations and infrastructure maintenance. Operations consists of labor costs, electrical power, and other factors required to keep the HSR system in service, whereas maintenance includes routine servicing of vehicles and maintenance of the tracks, signals, communications, and other systems needed to keep the system safe and reliable.

To help evaluate and compare project capital costs, the Federal Railroad Administration (FRA) and the California High-Speed Rail Authority (Authority) have developed 10 main standardized capital cost categories. Each standard cost category is briefly described below:

- **10 Track Structures and Track**—includes elevated structures (bridges and viaducts), embankments and open cuts, retaining-wall systems, tunnels, culverts and drainage, track (ballasted and nonballasted), and special trackwork.
- **20 Stations, Terminals, Intermodal**—includes rough grading; excavation; station structures; enclosures; finishes; equipment; mechanical and electrical components, including heating, ventilation, and air-conditioning; station power; lighting; public address/customer information systems; and safety systems, such as fire detection and prevention, security surveillance, access control, and life safety systems.
- **30 Support Facilities: Yards, Shops, Administration Buildings**—includes rolling-stock service, inspection, storage, heavy maintenance and overhaul facilities and equipment, as well as associated yard tracks and electrification. In addition, maintenance-of-way facilities are included in this cost category.
- **40 Sitework, Right-of-Way, Land, Existing Improvements**—includes cost of demolition, hazardous materials removal, environmental mitigation, utility relocations, noise mitigation, intrusion protection, grade separations, roadway improvements, acquisition of real estate, and temporary facilities and other indirect costs.
- **50 Communications and Signaling**—includes all costs associated with implementing Automatic Train Control systems, inclusive of Positive Train Control and intrusion detection where it is applicable.
- **60 Electric Traction**—includes costs of the traction-power supply system, including supply, paralleling, and switching substations as well as connections to the power utilities and the traction-power distribution system in the form of the overhead contact system.

- **70 Vehicles**—includes costs for acquisition of the trainsets (design, prototype unit, and production and delivery of trainsets to the project site(s) on an annual basis). Acquisition of trainsets is considered a systemwide cost and is not included as part of the cost of individual HSR study alternatives.
- **80 Professional Services**—includes all professional, technical, and management services related to the design and construction of infrastructure (Categories 10 through 60) during the preliminary engineering, final design, and construction phases of the project/program (as applicable).
- **90 Unallocated Contingency**—includes program reserves.
- **100 Finance Charges**—includes finance charges expected to be paid by the project/program sponsor/grantee prior to either the completion of the project/program or the fulfillment of the FRA funding commitment, whichever occurs later in time (not included in the estimate).

6.2.1 High-Speed Rail Alternatives

The cost estimates prepared for each of the alternatives were developed by using recent bid data from large transportation projects in the western U.S. and by developing specific, bottom-up unit pricing to reflect common high-speed rail elements and construction methods with an adjustment for Central Valley labor and material costs. All material quantities for the Central Valley Wye alternatives and the 2012 Merced to Fresno Section are estimated based on a preliminary level of design. This level of design has generally been defined as encompassing at-grade or elevated profiles, structure types, placement of retaining walls, and amounts of earth fill. Stations are still conceptual, but roadway and utility relocations have been identified and power substations have been sized and located.

The capital cost estimates include the total labor effort and materials to construct the Central Valley Wye alternatives, including utility relocations and modifications to roadways required to accommodate HSR grade-separated guideways. It should be noted that the capital cost estimates reflect only related infrastructure improvements and do not include costs associated with the No Project Alternative.

Right-of-way costs were estimated based on the preliminary design and are documented in the *Merced to Fresno Project Section: Central Valley Wye Right-of-Way Cost Overview Engineering Report, Preliminary Engineering for Project Definition Record Set* (Authority 2016b). However, as the design of the project evolves, the right-of-way limits will be reassessed to reflect refined property acquisition needs. As a result, property acquisition costs are estimated in broad categories (i.e., urban, suburban, and rural and by population-density level), based on local land values rather than relying on a parcel-by-parcel assessment at this phase of project development. Right-of-way costs include the estimated cost to acquire properties needed for the future right-of-way, and include costs associated with temporary easements for construction that are assumed to be part of the construction contractor's responsibility to negotiate use.

The capital cost estimates also do not include the cost of acquiring HSR vehicles because they are part of the statewide system and are not associated with construction of individual sections. Consistent with the *2016 Business Plan: Connecting and Transforming California* (2016 Business Plan) (Authority 2016c),¹ the cost of vehicles was determined by using publicly available data regarding recent sales of comparable equipment to other projects around the world. Additional costs are included for adaptation of existing trainset designs to meet U.S. safety regulations and

¹ As described in Chapter 2, the Authority publishes an update to its Business Plan every two years to inform the public on the status of project implementation. Preparation of this Draft Supplemental EIR/EIS relies on the 2016 Business Plan (Authority 2016a). However, the Authority prepared the Merced to Fresno Section and Fresno to Bakersfield Section environmental documents based on the 2008 and 2010 Business Plans, which contained the system ridership, service plans, construction and operating costs, and other assumptions that were available at the time.

to comply with “Buy America” requirements.² The systemwide cost of vehicle procurement is divided into two milestones: Silicon Valley to the Central Valley and Phase 1, which extends from San Francisco in the north to Anaheim in the south. Total vehicle procurement cost is estimated at \$3.39 billion in 2015 dollars.

Again, using cost information collected from large transportation projects and adjusting for Central Valley labor and material costs, professional services are estimated at 13.5 percent of the construction costs; these costs are divided between final design (6 percent), construction management (4 percent), program management (3 percent), and agency costs (0.5 percent). Environmental mitigation costs are estimated at approximately 3 percent of the capital cost, given potential project impacts and typical mitigation costs in the region. At this early stage of design, the capital cost estimates include contingencies to account for changes in material costs and changes during project design. Currently allocated contingencies (money reserves assigned to each cost category to cover risks associated with design uncertainty) are assumed to be between 10 percent and 25 percent of the estimated construction and right-of-way acquisition costs, and unallocated contingency (project reserves intended to cover unknown risks) is estimated at 5 percent of the construction and right-of-way acquisition costs.

Table 6-1 shows estimates for each alternative from Carlucci Road to the west, Ranch Road to the north, and Avenue 19 to the south. The alignments range in distance from 51 to 55 miles and are estimated to have construction costs between \$3.6 billion and \$4.2 billion (2015\$). Alternatively, the Merced to Fresno Final EIR/EIS, which included consideration of a Wye alternative, estimated total construction costs for building the preferred alternative, 76 miles in length, between \$3.8 billion and \$4.8 billion (2010\$).³

Table 6-1 Capital Cost of the HSR Alternatives (2015\$ Thousands)¹

FRA Standard Cost Categories	SR 152 (North) to Road 13 Wye Alternative	SR 152 (North) to Road 19 Wye Alternative	Avenue 21 to Road 13 Wye Alternative	SR 152 (North) to Road 11 Wye Alternative
10 Track structures and track	\$1,502,093	\$1,760,396	\$1,600,956	\$1,370,524
20 Stations, terminals, intermodal	\$238,016	\$241,910	\$128,942	\$222,165
30 Support facilities: yards, shops, admin. bldgs.	\$0	\$0	\$0	\$0
40 Sitework, right-of-way, land, existing improvements	\$1,155,334	\$1,192,485	\$1,100,569	\$1,122,159
50 Communications and signaling	\$89,956	\$89,236	\$90,059	\$88,875
60 Electric traction	\$265,982	\$284,666	\$270,548	\$261,065
70 Vehicles	Considered a systemwide cost and not included as part of individual Central Valley Wye alternatives			

² Buy America requirements apply to mass transit projects and give preference to the use of domestically produced materials on any procurements funded at least in part by federal funds. Administered by the Federal Transit Administration, the requirements are described at 49 Code of Federal Regulations 661.

³ See *Merced to Fresno Section Final Environmental Impact Report/Environmental Impact Statement*, page 5-4, April 2012. Also, the costs shown in Table 6-1 reflect an adjustment of just the Wye alternative portion and are not in addition to the \$3.8 billion to \$4.8 billion estimate identified in the Merced to Fresno Final EIR/EIS.

FRA Standard Cost Categories	SR 152 (North) to Road 13 Wye Alternative	SR 152 (North) to Road 19 Wye Alternative	Avenue 21 to Road 13 Wye Alternative	SR 152 (North) to Road 11 Wye Alternative
80 Professional services (applies to Cats. 10-60)	\$420,232	\$460,991	\$414,079	\$395,043
90 Unallocated contingency	\$162,566	\$178,432	\$159,550	\$153,237
100 Finance charges	Estimate to be developed prior to construction of the selected Central Valley Wye alternative			
Total	\$3,834,181	\$4,208,116	\$3,764,704	\$3,613,068

Source: Authority, 2016a

¹ Sums may not total due to rounding.

6.2.2 Light Rolling Stock Maintenance Facilities

O&M of the HSR system would require the placement of maintenance facilities along the alignment. While there are no such facilities to be constructed as part of the Central Valley Wye alternatives, O&M activities would be provided from facilities located in adjoining HSR sections.

For systemwide operations, terminal station locations would be supported by a light rolling-stock maintenance facility (LMF) for supplying inspected and serviced trainsets at the start of the revenue day. Planning for these facilities is based on the current implementation phases of the HSR project. The need for developing LMF sites depends upon the service plans and phasing adopted by the 2016 Business Plan (Authority 2016c). Terminal station locations would evolve as the system matures through the operating service segments as follows:

- San Jose to north of Bakersfield
- Valley to Valley Extended—San Francisco to Bakersfield and Merced
- Phase 1 Service—San Francisco, San Jose (Gilroy), Palmdale, Los Angeles, and Anaheim

Depending on location, the LMF would be sized to support specific maintenance activities. These activities include cleaning and servicing activities between runs, predeparture inspections and testing, monthly inspection and maintenance activities, and in some instances train wash and wheel defect detection facilities.

6.3 Operations and Maintenance Costs

Chapter 2, Alternatives, describes O&M activities in detail. For purposes of comparison, the following assumptions for the O&M cost estimate from the Merced to Fresno Final EIR/EIS have been carried forward for the O&M cost estimate for the Central Valley Wye alternatives. HSR service during Phase 1 would connect San Francisco with Los Angeles/Anaheim via the Central Valley by 2029. The plan is to offer express, limited-stop, and all-stop services, depending on time of day and projected needs. For Phase 1, there would be 13 HSR stations; however, none of those stations is located within the Central Valley Wye. By 2040, multiple facilities would be required for overnight storage, inspection, and routine maintenance of over 78 trainsets, each 656 feet long. A heavy maintenance facility (HMF) serving the entire HSR system would be needed and would be located in the Merced to Fresno or Fresno to Bakersfield Sections. The HMF would store and maintain a portion of the trainsets. One maintenance-of-way facility would also be required approximately every 100 miles.

O&M costs account for staff labor and material supplies required to run the HSR system and to perform required maintenance. O&M costs are estimated based on daily rail miles, operation speeds, travel times, HSR station configurations, maintenance and storage facilities, and assumed operating frequencies in accordance with the 2016 Business Plan (Authority 2016c).

6.3.1 Operating Speeds

The HSR system would operate at high speeds (up to 220 miles per hour) throughout the Central Valley Wye.⁴ Because of the track geometry of the turnouts for the Central Valley Wye, speeds for diverging trains through the turnouts would be reduced.

6.3.2 Travel Times

Table 6-2 shows the optimal express-train times between Merced, Fresno, and other destinations in the proposed statewide HSR system. The Central Valley Wye alternatives would connect to the Bay Area and Los Angeles in Phase 1 with future extensions to Sacramento and San Diego during Phase 2.

Table 6-2 Optimal HSR Express Travel Times from Merced and Fresno to Other Cities (hours:minutes)

	San Francisco	San Jose	Los Angeles	Anaheim	Sacramento (Phase 2)	San Diego (Phase 2)	Bakersfield ¹
Merced	1:49	1:00	2:12	2:52	0:40	3:39	1:42
Fresno	1:40	0:57	1:50	2:30	0:59	3:07	0:39

Source: Authority, 2016c

¹ Travel times are essentially the same for the Bakersfield HSR station to be built either at Truxtun Avenue in the vicinity of the existing Amtrak station or at the intersection of F Street and State Route 204.

6.3.3 Development of Operation and Maintenance Costs

The 2016 Business Plan expands the concept of a phased strategy for the implementation of the HSR system in California. Service between Silicon Valley and the Central Valley, also referred to as Valley to Valley (V2V) service, is scheduled to begin operations in 2025. The segment would be either between San Jose to north of Bakersfield with potential extension to San Francisco and Bakersfield with a branch to Merced from the Bay Area (Valley to Valley Extension, or V2VE). The HSR system would start operations of the completed Phase 1 in 2029 when service is extended to San Francisco and Anaheim, and completion of the second leg of the wye in the Central Valley allows direct service to/from Southern California.

An important goal of the 2016 Business Plan (Authority 2016c) is to achieve a balance between O&M costs and projected farebox revenue as proof of the requirements mandated by Proposition 1A, the Safe, Reliable High-Speed Passenger Train Bond Act, adopted by California voters in November 2008. The Authority has continued to refine its O&M cost model to reflect a more accurate cost basis for the program’s current level of detail.

O&M costs were estimated to include the operation activities needed to serve and carry the forecast train service for Phase 1—as described in Chapter 2 of this Draft Supplemental EIR/EIS—the maintenance costs necessary to keep the system in a state of good repair, and the administrative costs. The current HSR O&M model is based on cost categories defined in the U.S. Department of Transportation (U.S. DOT) Inspector General’s *High-Speed Intercity Passenger Rail Program (HSIPR) Best Practices: Operating Costs Estimation* report (U.S. DOT 2011), where applicable. The report defines the general parameters for estimating the preliminary, intermediate, final, and commercial closeout stages of a program. No program falls neatly into all of these parameters and there is usually some overlap between the stages. In this context, large parts of the Authority’s O&M cost model fall into the intermediate stage, while others might be classified as preliminary or have advanced to the final stage.

Unit prices were developed and applied to calculate the cost for each activity included in the operating plan. Although many of the O&M unit costs for the HSR system would be similar to the

⁴ Maximum speed is assumed to be 220 mph along the corridor leading to the Central Valley Wye and 150 mph within the Central Valley Wye, based on the speed profiles for the design of the curved rail sections

costs of United States conventional rail operations and can be reliably estimated from United States practices and costs, the unit cost to maintain high-speed trainsets and dedicated high-speed rail infrastructure has no close analogy in the United States. Therefore, international O&M unit cost projections from comparable HSR operations were applied to planned California operations, HSR technology, and local cost levels and labor practices.

The O&M costs of HSR equipment includes the cost of (1) crew, administration, and supplies to operate and dispatch the HSR services; (2) electric power for traction, onboard systems, stations, and maintenance/other facilities; and (3) cleaning, inspection, maintenance, and overhaul of the trainsets.

Maintenance of infrastructure covers the costs of patrolling, inspecting, and maintaining the right-of-way, fencing, structures, bridges, tunnels, roadbed, track, signaling, overhead electric traction power system, substations and similar electrical facilities, communications, intrusion detection, and facilities.

Station O&M costs include the day-to-day operations of the station, ticket sales and machine maintenance, public safety, passenger handling, and cleaning.

Insurance, administration, and contingency costs round out the categories of O&M costs presented. For a more detailed discussion of how O&M costs were derived, please refer to Appendix 6-B. The O&M cost model includes the following categories of operations and maintenance cost:

- Train operations
- Dispatching
- Maintenance of equipment
- Maintenance of infrastructure
- Station and train cleaning
- Commercial
- General and administrative activities
- Insurance
- Unallocated contingencies

The upgrades made to the 2016 O&M model have improved the detail and flexibility of the model to allow for more precise estimating and easier validation of source material.

Table 6-3 shows the ridership, revenue, and O&M costs at the key implementation phases for the “medium scenario”⁵ according to the 2016 Business Plan. For Phase 1, annual systemwide O&M costs are estimated to range from \$730 million to \$738 million by 2029 (2015\$). Similarly, annual V2V operating costs are estimated between \$227 million and \$237 million by 2025. By comparison, the Merced to Fresno Final EIR/EIS reported significantly higher systemwide operating costs ranging between \$1.9 billion and \$2.7 billion (2010\$). These cost estimates resulted from higher ridership projections and, more importantly, completion and operation of both Phases 1 and 2 of the California HSR System.⁶

⁵ The Authority’s 2016 O&M Model produced medium (base case) and high forecasts to represent a range of future system operating costs. For additional detail, please refer to Appendix 6-B of this document and to the *Operations and Maintenance Cost Model Documentation* prepared for the 2016 Business Plan available at: http://hsr.ca.gov/docs/about/business_plans/2016_Business_Plan_Operations_and_Maintenance_Cost_Model.pdf.

⁶ See *Merced to Fresno Section Final Environmental Impact Report/Environmental Impact Statement*, page 5-8, April 2012.

Table 6-3 Medium Scenario Revenue and Annual O&M Costs¹

	V2V 2025	V2VE 2025	Phase 1 2029	2040
Ridership (in millions)	3.0	5.3	19.3-22.8	42.8
Revenue (2015\$ millions)	\$184	\$287	\$1,104-\$1,262	\$2,413
O&M Costs (2015\$ millions)	\$227	\$237	\$730-\$738 ¹	\$874

Source: Authority, 2016c

¹ Range in cost will vary based on whether the system operates Valley to Valley or Valley to Valley Extended.

O&M = operations and maintenance

V2V = Valley to Valley

V2VE = Valley to Valley Extended