

## **APPENDIX 6-B: HIGH-SPEED RAIL OPERATING AND MAINTENANCE COST FOR USE IN EIR/EIS PROJECT-LEVEL ANALYSIS**





## Memorandum

**DATE:** February 6, 2017  
**TO:** Regional Consultant Teams  
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**SUBJECT:** High-Speed Rail Operating and Maintenance Cost for Use in EIR/EIS Project-Level Analysis

This memo summarizes the assumptions used to estimate full system high-speed rail (HSR) operations and maintenance (O&M) costs published in the *California High-Speed Rail Authority's 2016 Business Plan*. For more information on the operations and maintenance cost model used for cost forecasting, please refer to the *Operations and Maintenance Cost Model Documentation*<sup>1</sup>.

A variety of factors drive the cost forecasts, including but not limited to, service planning assumptions, station operations, maintenance facility operations, staffing and energy use. Allocated contingency costs, which are included in each cost category, and unallocated contingency costs are also forecasted in addition to direct O&M costs. In total, nine cost categories comprise total O&M costs that are described in detail in the *Operations and Maintenance Cost Model Documentation*:

1. Train operations
2. Dispatching
3. Maintenance of equipment
4. Maintenance of infrastructure
5. Station and train cleaning
6. Commercial
7. General and administrative
8. Insurance
9. Unallocated contingency

The service plan is a key driver of O&M cost forecasts as it determines the number of trainset miles, bus miles, trainsets, stations and maintenance facilities necessary to support system operations – all of which are inputs to the O&M cost model. The O&M cost forecasts in the *California High-Speed Rail Authority's 2016 Business Plan* rely on a Phase 1 system with key service planning assumptions outlined below:

- The Phase 1 system will open in 2029 and will cover approximately 500 miles
- The Phase 1 system will serve 13 stations, including San Francisco, Millbrae, San Jose, Gilroy, Merced, Fresno, Kings/Tulare, Bakersfield, Palmdale, Burbank, Los Angeles, Gateway Cities/ Orange County, Anaheim

<sup>1</sup> [http://www.hsr.ca.gov/docs/about/business\\_plans/2016\\_Business\\_Plan\\_Operations\\_and\\_Maintenance\\_Cost\\_Model.pdf](http://www.hsr.ca.gov/docs/about/business_plans/2016_Business_Plan_Operations_and_Maintenance_Cost_Model.pdf)

- The Phase 1 system will include 196 revenue service train runs per day with varying stopping patterns between San Francisco and Anaheim, San Francisco and Los Angeles, San Jose and Los Angeles, Merced and Los Angeles, Merced and Anaheim
- The Phase 1 system assumes 6 hours of peak service and 10 hours of off-peak service daily. Phase 1 will include 8 round trip revenue service trains per hour during peak service and 5 round trip trains per hour during off-peak service
- The HSR system will include connecting bus service between Sacramento and Merced during Phase 1 operations
- After full operational ramp-up, high-speed rail operations will include 78 trainsets including spares, 34.5 million total trainset miles, and 2.2 million bus miles per year

To support Phase 1 high-speed train service outlined above, total O&M costs include additional assumptions related to maintenance and train operations. The system will include one operations control center and three terminal control facilities to manage dispatching. A heavy maintenance facility will be located in the Central Valley with three lighter maintenance facilities dispersed across the rest of the system, including one near Gilroy, one in northern California along the Peninsula Corridor at Brisbane and one in southern California, near Los Angeles. O&M will also include five maintenance of infrastructure facilities.

The O&M cost model assumes station staffing and operating costs will be based on station size and the model differentiates between three station sizes. San Francisco and Los Angeles represent the largest stations, and as a result, have the most staff. Other terminal stations represent the middle station sizes (e.g., San Jose) and intermediate stations (e.g., Palmdale) represent the smallest station size and have the lowest staffing levels. For more details on staffing assumptions and associated salaries, please refer to the *Operations and Maintenance Cost Model Documentation*.

Finally, energy costs were updated to \$0.074 per kilowatt hour (2015 dollars) for the 2016 Business Plan and are a key driver of train operations costs and station costs based on usage.

Table 1 below outlines total O&M medium, or base case, cost forecasts and personnel forecasts by cost category. It is important to note that the cost model does not attempt to optimize operations to reduce costs, but provides an achievable operating scenario that could be further improved upon by a private operator. Additionally, the 2025 Valley-to-Valley (V2V) forecasts reflect a different set of assumptions than those outlined above for Phase 1, but are not covered in this memo. The cost model also assumes a ramp-up period from the opening of revenue service through five years after the system expands to Phase 1 (i.e., 2025-2033).

**Table 1: Annual Operations and Maintenance Medium Case Cost Forecast (\$2015 millions)**

Cost Category	2025 Medium Case Cost	2029 Medium Case Cost	2040 Medium Case Cost	Personnel in PH1 System
Train Operations	\$28	\$240	\$285	1,210
Dispatching	\$13	\$29	\$30	187
Maintenance of Equipment	\$22	\$92	\$134	603
Maintenance of Infrastructure	\$53	\$120	\$122	579
Station and Train Cleaning	\$21	\$68	\$71	649
Commercial	\$42	\$51	\$94	N/A
General and Administrative	\$14	\$48	\$53	311
Insurance	\$26	\$52	\$52	N/A
Unallocated Contingency	\$9	\$29	\$35	N/A
<b>Total Cost</b>	<b>\$227</b>	<b>\$730</b>	<b>\$874</b>	<b>3,538</b>

Note: Numbers may not add due to rounding

As with all model forecasting, risks and uncertainties exist in model inputs and assumptions. For example, salaries or energy costs in 2040 may be lower or higher than those assumed in the model. The *California High-Speed Rail Authority's 2016 Business Plan* O&M forecasts include a Monte Carlo simulation to capture these risks and uncertainties by creating a forecast range with associated probabilities of occurrence. A high O&M cost forecast was developed to reflect the results of these Monte Carlo simulations. For more detail on the O&M risk analysis methodology, please refer to the *Operations and Maintenance Cost Model Documentation*.

The drawback of the methodology used for the O&M risk analysis is that it does not provide high scenarios for specific cost categories, but only identifies total O&M high scenario forecasts. As a result, to estimate high scenario costs by each cost category, medium cost category forecasts are multiplied by the percentage increase of total O&M costs from the medium to high scenario. In other words, if total high scenario costs are 10% higher than total medium costs, each cost category is multiplied by 1.10 to estimate high scenario costs by category.

Table 2 below outlines high scenario O&M costs.

**Table 2: Annual Operations and Maintenance High Scenario Cost Forecast (\$2015 millions)**

Cost Category	2025 High Scenario Cost	2029 High Scenario Cost	2040 High Scenario Cost
Train Operations	\$31	\$263	\$311
Dispatching	\$14	\$32	\$33
Maintenance of Equipment	\$24	\$101	\$146
Maintenance of Infrastructure	\$58	\$131	\$133
Station and Train Cleaning	\$23	\$74	\$77
Commercial	\$46	\$56	\$103
General and Administrative	\$15	\$53	\$58
Insurance	\$29	\$57	\$57
Unallocated Contingency	\$10	\$32	\$38
<b>Total Cost</b>	<b>\$249</b>	<b>\$798</b>	<b>\$956</b>

Note: Numbers may not add due to rounding

For planning, engineering, and design purposes, the 500 mile Phase 1 HSR system has been divided into nine geographic sections. None of the sections would operate independently and any cost number associated with each is not meant to represent the cost to operate and maintain each as a standalone system; rather, geographic sections operate as part of an integrated system. However, to assist the regional teams in their evaluation of environmental impacts associated with future construction and operation of individual HSR projects, total O&M costs have been distributed to each geographic section.

O&M costs in 2015\$ are apportioned to each geographic section based on the system-wide total cost per route mile. Table 3 below outlines the cost per route mile by year and scenario.

**Table 3: Cost per Route Mile (\$2015 millions)**

Cost Category	Approx. Route Miles	2025 Medium Cost	2025 High Cost	2029 Medium Cost	2029 High Cost	2040 Medium Cost	2040 High Cost
Valley-to-Valley	250	\$0.91/mi	\$1.00/mi	N/A	N/A	N/A	N/A
Phase 1	500	N/A	N/A	\$1.46/mi	\$1.60/mi	\$1.75/mi	\$1.91/mi

O&M costs by geographic segment are distributed in Table 4 below and are estimated by multiplying costs per route mile by approximate route miles in each geographic section. It is important to note that the O&M costs above for the Valley-to-Valley system do not assume service to Merced. There are approximately 250 total route miles in the Valley-to-Valley system assumed for O&M cost forecasting purposes. Nonetheless, the cost per route mile calculated for Valley-to-Valley in Table 3 is applied to the

geographic segments that include Merced in 2025 in Table 4 (San Jose-Merced, Merced-Fresno). As a result, total 2025 medium and high cost numbers in Table 4 will be higher than Table 1 and Table 2.

**Table 4: Annual Operations and Maintenance Costs by Geographic Segment (\$2015 millions)**

Cost Category	Approx. Route Miles	2025 Medium Cost	2025 High Cost	2029 Medium Cost	2029 High Cost	2040 Medium Cost	2040 High Cost
San Fran-San Jose	48	\$0	\$0	\$70	\$77	\$84	\$92
San Jose-Merced	84	\$76	\$84	\$123	\$134	\$147	\$161
Merced-Fresno	93	\$84	\$93	\$136	\$148	\$163	\$178
Fresno-Bakersfield	109	\$99	\$109	\$159	\$174	\$191	\$208
Bakersfield-Palmdale	80	\$0	\$0	\$117	\$128	\$140	\$153
Palmdale-Burbank	40	\$0	\$0	\$58	\$64	\$70	\$76
Burbank-Los Angeles	13	\$0	\$0	\$19	\$21	\$23	\$25
Los Angeles-Anaheim	31	\$0	\$0	\$45	\$49	\$54	\$59

Note: Total estimates in 2029 and 2040 scenarios may not match previous tables due to rounding.