**APPENDIX 4-C**

# CAPITAL COST: HIGH-SPEED TRAIN ALTERNATIVE

**APPENDIX 4-C**

# CAPITAL COST: HIGH-SPEED TRAIN ALTERNATIVE

## HIGH-SPEED TRAIN ALTERNATIVE

The estimated total costs for the High-Speed Train (HST) Alternative by region and segment are presented in Table 4-C-1.

**Table 4-C-1**
**High-Speed Train Alternative Capital Cost**
**Includes Contingencies and Program Implementation Cost**

| Alignment Option by Region and Segment | | Segment Length | | Average Cost | | Segment Cost |
|---|---|---|---|---|---|---|
| | | km | miles | $/km | $/miles | |
| **BAY AREA TO MERCED** | | | | | | |
| San Francisco to San Jose | | | | | | |
| | Segment 1–TBT (San Francisco) | | | | | $1,000,000,000 |
| | Segment 2–4th Street (San Francisco) | 0.9 | 0.6 | $950,097,010 | $1,529,032,922 | $855,087,309 |
| | Segment 3–Caltrain Shared Use (San Jose) | 73.9 | 45.9 | $36,325,285 | $58,459,880 | $2,684,438,570 |
| Oakland to San Jose | | | | | | |
| | West Oakland Downtown 7th Street Station (Segment 4) | 9.4 | 5.8 | $115,744,736 | $186,273,096 | $1,088,000,514 |
| | Oakland City Center Downtown 12th Street Station (Segment 5) | 9.3 | 5.8 | $119,650,633 | $192,559,028 | $1,112,750,882 |
| | Oakland Coliseum Segment (Segment 6) | 22.5 | 14.0 | $30,914,172 | $49,751,537 | $695,568,863 |
| | Niles Junction to the Mulford Line (San Jose) (Segment 7) | 43.7 | 27.2 | $31,496,334 | $50,688,436 | $1,376,389,785 |
| | Hayward Line to the I-880 (San Jose) (Segment 8) | 36.9 | 22.9 | $40,966,197 | $65,928,703 | $1,511,652,667 |
| San Jose to Los Banos | | | | | | |
| | Segment 9–(San Jose) | 15.6 | 9.7 | $24,164,987 | $38,889,777 | $376,973,799 |
| | Segment 10–(South San Jose) | 15.0 | 9.3 | $7,872,537 | $12,669,621 | $118,088,062 |
| | Segment 11–Morgan Hill Station only w/Segment 14 (Gilroy Bypass) | 12.8 | 8.0 | $17,804,084 | $28,652,895 | $227,892,272 |
| | Segment 12–Caltrain/Gilroy/ Pacheco Pass Align (Gilroy Station) | 25.4 | 15.8 | $27,490,846 | $44,242,228 | $698,267,492 |

| Alignment Option by Region and Segment | | Segment Length | | Average Cost | | Segment Cost |
|---|---|---|---|---|---|---|
| | | km | miles | $/km | $/miles | |
| | Segment 14–Caltrain/Morgan Hill/Pacheco Pass Align Gilroy Bypass (Morgan Hill Station) | 24.5 | 15.2 | $37,455,023 | $60,278,016 | $918,838,380 |
| | Segment 12 to SR-152 Connection | 3.5 | 2.2 | $18,667,537 | $30,042,488 | $65,747,064 |
| | PB (SR-152 Alignment Option) | 33.8 | 21.0 | $60,296,032 | $97,037,057 | $2,038,488,248 |
| | Segment 13 (Los Banos) | 90.8 | 56.4 | $11,542,776 | $18,576,297 | $1,047,645,412 |
| | Segment 13A (Los Banos Station to High-Speed Loop) | 50.8 | 31.6 | $9,640,884 | $15,515,499 | $490,084,712 |
| | Segment 30 (High-Speed loop) | 21.3 | 13.3 | $8,235,192 | $13,253,257 | $175,771,935 |
| | Segment 31 (High-Speed Loop to Chowchilla Loop) | 10.8 | 6.7 | $8,425,078 | $13,558,849 | $90,990,842 |
| | Segment 32 (Chowchilla Loop) | 11.1 | 6.9 | $9,095,170 | $14,637,258 | $100,856,344 |
| | Segment 33 (Chowchilla Loop to Fairmead) | 7.9 | 4.9 | $8,614,696 | $13,864,009 | $67,926,877 |
| | Segment 34 (Fairmead Loop) | 8.2 | 5.1 | $8,746,860 | $14,076,707 | $72,109,115 |
| San Jose to Merced | | | | | | |
| | Segment 9–(San Jose) | 15.6 | 9.7 | $24,164,987 | $38,889,777 | $376,973,799 |
| | PB 1–Diablo Range Direct Rt 130 Align (Northern Alignment Option) | 72.7 | 45.2 | $50,721,466 | $81,628,287 | $3,686,233,259 |
| | PB 2–Diablo Range Direct Min Tunnel Align (Minimize Tunnel Option) | 71.5 | 44.4 | $52,629,069 | $84,698,277 | $3,760,925,919 |
| | PB 3–Diablo Range Direct Incr. Tunnel Align (Tunnel under Park Option) | 71.4 | 44.3 | $54,603,463 | $87,875,755 | $3,895,957,070 |
| | Segment 16 (Merced) | 48.5 | 30.1 | $14,115,740 | $22,717,082 | $684,613,407 |
| | Segment 16A (Hwy 33 to San Joaquin River) | 4.4 | 2.7 | $7,890,859 | $12,699,107 | $34,909,162 |
| | Segment 17 ( San Joaquin River to UP Loop) | 13.7 | 8.5 | $8,803,684 | $14,168,155 | $120,786,538 |
| | Segment 18 (High Speed UP Loop) | 7.9 | 5.0 | $7,907,962 | $12,726,631 | $63,168,799 |
| | Segment 19 (High Speed BNSF Loop) | 16.8 | 10.4 | $8,595,883 | $13,833,732 | $144,324,869 |
| | Segment 21 (Between San Joaquin River and Hilmar) | 15.0 | 9.3 | $8,785,310 | $14,138,586 | $131,937,782 |
| | Segment 22 (Delhi Loop) | 8.8 | 5.5 | $8,697,633 | $13,997,483 | $76,391,309 |
| | Segment 23 (Delhi Loop to Livingston Connection) | 4.2 | 2.6 | $8,483,168 | $13,652,336 | $35,714,138 |
| | Segment 24 (Livingston Connection) | 11.0 | 6.9 | $9,642,253 | $15,517,701 | $106,614,387 |

| Alignment Option by Region and Segment | Segment Length | | Average Cost | | Segment Cost |
|---|---|---|---|---|---|
| | km | miles | $/km | $/miles | |
| **SACRAMENTO TO BAKERSFIELD** | | | | | |
| Sacramento to Stockton | | | | | |
| UPRR: SAC DT Depot to STO DT Station (Option A1) | 147.9 | 92.0 | $23,991,883 | $38,611,192 | $3,550,318,793 |
| Option A1 Modified (Business Plan Option–Without Storage Leads) | 147.9 | 92.0 | $23,081,309 | $37,145,766 | $3,415,572,083 |
| Option A1 Mod (BP Option–Without Storage Leads or Stockton Loop) | 101.9 | 63.4 | $22,478,839 | $36,176,184 | $2,292,391,982 |
| CCT: SAC DT Depot to STO DT Station (Option A2) | 150.8 | 93.7 | $24,286,293 | $39,085,000 | $3,662,955,876 |
| UPRR: SAC DT Depot to STO DT Station (Option A3) | 141.5 | 87.9 | $23,489,340 | $37,802,428 | $3,323,741,567 |
| CCT: SAC DT Depot to STO DT Station (Option A4) | 144.3 | 89.7 | $23,806,869 | $38,313,441 | $3,436,378,650 |
| UPRR: Power Inn Rd. Station to STO DT Station (Option A5) | 135.9 | 84.5 | $21,653,901 | $34,848,575 | $2,943,198,201 |
| CCT: Power Inn Rd. Station to STO DT Station (Option A6) | 139.7 | 86.8 | $21,848,342 | $35,161,498 | $3,053,087,327 |
| UPRR: Power Inn Rd. Station to STO DT Station (Option A7) | 129.4 | 80.4 | $20,987,492 | $33,776,094 | $2,716,620,974 |
| CCT: Power Inn Rd. Station to STO DT Station (Option A8) | 133.3 | 82.8 | $21,210,492 | $34,134,977 | $2,826,510,101 |
| Stockton to Merced | | | | | |
| Express Loop/UPRR: to Modesto DT Station (Option B1) | 54.6 | 33.9 | $28,756,637 | $46,279,322 | $1,569,249,693 |
| Option B1 Modified (Business Plan Option–No Express Loop) | 30.4 | 18.9 | $33,104,824 | $53,277,050 | $1,006,386,644 |
| Express Loop/BNSF: to Modesto Briggsmore Station (Option B2) | 27.8 | 17.2 | $45,229,467 | $72,789,772 | $1,255,117,716 |
| Modesto to Merced | | | | | |
| UPRR: to Merced DT Station (Option C1) | 59.6 | 37.0 | $22,486,897 | $36,189,153 | $1,340,219,057 |
| UPRR: to Merced DT Station (Option C2) | 80.2 | 49.8 | $19,168,165 | $30,848,172 | $1,536,251,767 |
| UPRR: to Merced DT Station (Option C3) | 59.6 | 37.0 | $22,967,324 | $36,962,325 | $1,369,174,037 |
| UPRR: to Merced DT Station (Option C4) | 80.7 | 50.1 | $19,376,534 | $31,183,508 | $1,562,814,328 |
| BNSF: to Merced DT Station (Option C5) | 65.2 | 40.5 | $19,995,884 | $32,180,256 | $1,304,447,509 |

| Alignment Option by Region and Segment | | Segment Length | | Average Cost | | Segment Cost |
|---|---|---|---|---|---|---|
| | | km | miles | $/km | $/miles | |
| | BNSF: to Merced DT Station (Option C6) | 84.7 | 52.7 | $17,876,776 | $28,769,882 | $1,514,860,095 |
| | BNSF: to Merced DT Station (Option C7) | 65.3 | 40.5 | $20,067,325 | $32,295,228 | $1,309,388,913 |
| | BNSF: to Merced DT Station (Option C8) | 85.3 | 53.0 | $17,940,783 | $28,872,891 | $1,529,415,867 |
| | UPRR: to Merced Municipal Airport Station (Option C9) | 60.2 | 37.4 | $17,389,924 | $27,986,370 | $1,045,934,389 |
| | UPRR: to Merced Municipal Airport Station (Option C10) | 60.6 | 37.7 | $17,028,699 | $27,405,034 | $1,032,637,326 |
| | BNSF: to Merced Municipal Airport Station (Option C11) | 66.3 | 41.2 | $15,523,173 | $24,982,126 | $1,028,456,805 |
| | BNSF: to Merced Municipal Airport Station (Option C12) | 66.8 | 41.5 | $15,702,078 | $25,270,046 | $1,048,082,327 |
| | BNSF: to Castle Air Force Base Station (Option C13) | 80.4 | 50.0 | $15,916,267 | $25,614,749 | $1,279,604,194 |
| | BNSF: to Castle Air Force Base Station (Option C14) | 79.4 | 49.3 | $19,207,188 | $30,910,973 | $1,524,647,384 |
| | BNSF: to Castle Air Force Base Station (Option C15) | 80.9 | 50.3 | $16,061,487 | $25,848,457 | $1,299,229,716 |
| | BNSF: to Castle Air Force Base Station (Option C16) | 79.4 | 49.3 | $19,266,041 | $31,005,687 | $1,529,588,787 |
| Merced to Fresno | | | | | | |
| | BNSF: to Fresno DT Station (Option D1) | 100.9 | 62.8 | $17,154,526 | $27,607,533 | $1,732,593,373 |
| | BNSF: to Fresno DT Station (Option D2) | 142.2 | 88.4 | $16,993,518 | $27,348,417 | $2,416,784,203 |
| | BNSF: to Fresno DT Station (Option D3) | 92.3 | 57.3 | $17,823,825 | $28,684,666 | $1,644,625,735 |
| | BNSF: to Fresno DT Station (Option D4) | 130.1 | 80.8 | $17,126,298 | $27,562,105 | $2,228,011,515 |
| | UPRR: to Fresno DT Station (Option D5) | 88 | 54.7 | $23,397,979 | $37,655,397 | $2,059,022,166 |
| | UPRR: to Fresno DT Station (Option D6) | 123.7 | 76.9 | $21,464,014 | $34,542,983 | $2,655,978,587 |
| | UPRR: to Fresno DT Station (Option D7) | 96.7 | 60.1 | $22,196,156 | $35,721,251 | $2,146,989,804 |
| | UPRR: to Fresno DT Station (Option D8) | 135.9 | 84.4 | $20,937,919 | $33,696,314 | $2,844,751,274 |
| Fresno to Tulare | | | | | | |
| | UPRR: to Visalia Airport Station (Option E1) | 50.0 | 31.1 | $14,386,082 | $23,152,154 | $719,304,091 |
| | BNSF: to Hanford Station (Option E2) | 47.8 | 29.7 | $14,557,377 | $23,427,827 | $696,090,074 |

| Alignment Option by Region and Segment | | Segment Length | | Average Cost | | Segment Cost |
|---|---|---|---|---|---|---|
| | | km | miles | $/km | $/miles | |
| Tulare to Bakersfield | | | | | | |
| | UPRR: to Bakersfield Airport Station (Option F1) | 129.5 | 80.4 | $14,560,631 | $23,433,065 | $1,885,092,142 |
| | UPRR: to Bakersfield Airport Station (Option F2) | 116.0 | 72.1 | $14,345,668 | $23,087,115 | $1,664,097,538 |
| | UPRR (around Tulare): to Bakersfield Airport Station (Option F3) | 129.9 | 80.8 | $14,486,519 | $23,313,793 | $1,882,624,613 |
| | UPRR (around Tulare): to Bakersfield Airport Station (Option F4) | 116.5 | 72.4 | $14,263,898 | $22,955,519 | $1,661,630,010 |
| | BNSF: to Bakersfield Airport Station (Option F5) | 143.2 | 89.0 | $12,567,500 | $20,225,431 | $1,799,917,402 |
| | BNSF: to Bakersfield Airport Station (Option F6) | 129.8 | 80.6 | $12,168,493 | $19,583,291 | $1,578,922,799 |
| | UPRR: to Golden State Station (Option F7) | 129.5 | 80.4 | $14,677,457 | $23,621,078 | $1,900,217,028 |
| | UPRR: to Golden State Station (Option F8) | 116.0 | 72.1 | $14,476,055 | $23,296,953 | $1,679,222,425 |
| | UPRR (around Tulare): to Golden State Station (Option F9) | 129.9 | 80.8 | $14,602,903 | $23,501,095 | $1,897,749,500 |
| | UPRR (around Tulare): to Golden State Station (Option F10) | 116.5 | 72.4 | $14,393,734 | $23,164,470 | $1,676,754,897 |
| | BNSF: to Golden State Station (Option F11) | 143.2 | 89.0 | $12,673,106 | $20,395,388 | $1,815,042,289 |
| | BNSF: to Golden State Station (Option F12) | 129.8 | 80.6 | $12,285,058 | $19,770,884 | $1,594,047,686 |
| | UPRR: to Truxtun (Union Ave Station) (Option F13) | 118.1 | 73.4 | $16,711,736 | $26,894,932 | $1,973,890,000 |
| | UPRR (around Tulare): to Truxtun (Union Ave Station) (Option F14) | 118.6 | 73.7 | $16,621,608 | $26,749,886 | $1,971,422,471 |
| | UPRR :to Truxtun (Amtrak) Station (Option F15) | 135.7 | 84.3 | $17,241,322 | $27,747,219 | $2,338,975,045 |
| | UPRR: to Truxtun (Amtrak) Station (Option F16) | 122.2 | 75.9 | $17,332,650 | $27,894,196 | $2,117,980,441 |
| | UPRR (around Tulare): to Truxtun (Amtrak) Station (Option F17) | 136.2 | 84.6 | $17,160,896 | $27,617,786 | $2,336,507,516 |
| | UPRR (around Tulare): to Truxtun (Amtrak) Station (Option F18) | 122.7 | 76.2 | $17,243,030 | $27,749,968 | $2,115,512,913 |
| | UPRR: to Truxtun (Amtrak) Station (Option F19) | 144.4 | 89.7 | $17,597,847 | $28,320,989 | $2,541,287,432 |

| Alignment Option by Region and Segment | | Segment Length | | Average Cost | | Segment Cost |
|---|---|---|---|---|---|---|
| | | km | miles | $/km | $/miles | |
| | UPRR: to Truxtun (Amtrak) Station (Option F20) | 130.9 | 81.4 | $17,719,734 | $28,517,147 | $2,320,292,828 |
| | UPRR (around Tulare): to Truxtun (Amtrak) Station (Option F21) | 144.9 | 90.0 | $17,521,065 | $28,197,422 | $2,538,819,903 |
| | UPRR (around Tulare): to Truxtun (Amtrak) Station (Option F22) | 131.4 | 81.7 | $17,634,631 | $28,380,187 | $2,317,825,300 |
| | BNSF: to Truxtun (Amtrak) Station (Option F23) | 143.9 | 89.4 | $14,976,145 | $24,101,769 | $2,155,681,265 |
| | BNSF: to Truxtun (Amtrak) Station (Option F24) | 130.5 | 81.1 | $14,827,912 | $23,863,211 | $1,934,686,662 |
| **BAKERSFIELD TO LOS ANGELES** | | | | | | |
| Bakersfield to Sylmar I-5 Corridor | | | | | | |
| | I-5 (Wheeler Ridge Corridor) (Option 1.01) | 46.0 | 28.6 | $10,521,451 | $16,932,634 | $483,986,739 |
| | I-5 (Union Avenue Corridor) (Option 1.02) | 47.2 | 29.3 | $15,435,861 | $24,841,610 | $728,572,622 |
| | I-5 Tehachapi Crossing Option (Sylmar) (PB) | 90.8 | 56.4 | $63,353,553 | $101,957,660 | $5,752,819,344 |
| Bakersfield to Sylmar SR-58/SR-14 Corridor | | | | | | |
| | SR-58/Soledad Canyon (SR-58 Corridor) (Option 1.03) | 14.2 | 8.8 | $14,365,163 | $23,118,489 | $203,985,313 |
| | SR-58 Alignment Option (PB) | 73.8 | 45.9 | $37,309,279 | $60,043,464 | $2,755,178,312 |
| | SR-58/Soledad Canyon (Antelope Valley Corridor) (Option 2.01) | 33.6 | 20.9 | $13,493,307 | $21,715,373 | $453,510,048 |
| | Soledad Canyon Alignment option (Sylmar) (PB) | 55.3 | 34.3 | $40,278,035 | $64,821,214 | $2,225,240,596 |
| San Fernando Valley | | | | | | |
| | Metrolink/UPRR: Begin Alignment to Sylmar Sta (Option 3.01) | 0.3 | 0.2 | $18,984,447 | $30,552,506 | $4,935,956 |
| | Metrolink/UPRR: Sylmar Sta to Burbank Airport Sta (Option 3.02) | 10.8 | 6.7 | $40,700,880 | $65,501,718 | $437,534,465 |
| | Metrolink/UPRR: Burbank Airport Sta to Burbank DT Sta (Option 3.03) | 7.5 | 4.7 | $34,888,752 | $56,148,003 | $261,665,639 |
| | Metrolink/UPRR: DT Burbank Sta to Exist. LAUS or LAUS S. (Under I-5 & SR-110 Variant) (pick from Opts 4.01, 4.02, 4.03) (Opt 3.04A) | 18.2 | 11.3 | $44,530,329 | $71,664,617 | $811,787,891 |

| Alignment Option by Region and Segment | | Segment Length | | Average Cost | | Segment Cost |
|---|---|---|---|---|---|---|
| | | km | miles | $/km | $/miles | |
| | Metrolink/UPRR: DT Burbank Sta to LAUS E. Bank (Under I-5 & SR-110 Variant) (pick Options 4.04B) (Option 3.04B) | 16.1 | 10.0 | $44,903,642 | $72,265,407 | $724,744,786 |
| | Metrolink/UPRR: DT Burbank Sta to Exist. LAUS or LAUS S. (Over I-5 & SR-110 Variant) (pick from Options 4.01, 4.02, 4.03) (Option 3.04C) | 18.3 | 11.4 | $41,204,295 | $66,311,884 | $752,802,463 |
| | Metrolink/UPRR: DT Burbank Sta to LAUS E. Bank (Over I-5 & SR-110 Variant) (pick from Options 4.04A) (Option 3.04D) | 16.2 | 10.1 | $42,431,252 | $68,286,481 | $686,537,656 |
| | I-5: DT Burbank Sta to Exist. LAUS or LAUS S. (Aerial at Silver Lake) (pick from Options 4.01, 4.02, 4.03) (Option 3.04E) | 17.3 | 10.8 | $46,076,089 | $74,152,278 | $798,959,392 |
| | I-5: Beg DT Burbank Sta to Beg Exist LAUS or To Beg LAUS South (Cut & Cover at Silver Lake) (pick from Opt 4.01, 4.02, 4.03) (Opt 3.04F) | 17.3 | 10.8 | $53,999,919 | $86,904,446 | $936,358,594 |
| | Metrolink/UPRR: (Sylmar Metrolink Station) (Option 3.05) | 0.0 | 0.0 | $0 | $0 | $298,860,062 |
| | Metrolink/UPRR: (Burbank Airport Station) (Option 3.06) | 0.0 | 0.0 | $0 | $0 | $592,627,029 |
| | Metrolink/UPRR: (Burbank DT STA Metrolink/UPRR Variant) (Opt 3.07) | 0.0 | 0.0 | $0 | $0 | $291,551,471 |
| | Metrolink/UPRR: (Burbank DT Station I-5 Variant) (Option 3.08 ) | 0.0 | 0.0 | $0 | $0 | $291,551,471 |
| Los Angeles Union Station | | | | | | |
| | Combined I-5/UPRR: (Existing LAUS w/South Connection) (Option 4.01) | 5.7 | 3.6 | $89,237,253 | $143,613,438 | $511,329,460 |
| | Combined I-5/UPRR: (Existing LAUS w/East Connection) (Option 4.02) | 5.9 | 3.7 | $85,776,215 | $138,043,437 | $505,221,906 |
| | Combined I-5/UPRR: (LAUS South) (Option 4.03) | 5.2 | 3.2 | $90,733,551 | $146,021,495 | $474,536,469 |
| | Combined I-5/UPRR: (LAUS East Bank Over 110- FWY variant) (Opt 4.04A) | 7.3 | 4.5 | $78,969,142 | $127,088,515 | $577,264,429 |

| Alignment Option by Region and Segment | Segment Length | | Average Cost | | Segment Cost |
|---|---|---|---|---|---|
| | km | miles | $/km | $/miles | |
| Combined I-5/UPRR: (LAUS East Bank Under 110 Fwy) (Option 4.04B) | 7.3 | 4.5 | $78,651,488 | $126,577,301 | $574,942,379 |
| **LOS ANGELES TO SAN DIEGO VIA INLAND EMPIRE** | | | | | |
| Segment 1 | | | | | |
| 1A Colton Line | 91.7 | 57.0 | $44,774,631 | $72,057,784 | $4,104,042,673 |
| 1B UPRR | 106.8 | 66.4 | $27,208,490 | $43,787,820 | $2,906,138,825 |
| 1C San Bernardino Loop | 101.6 | 63.1 | $47,396,668 | $76,277,543 | $4,816,449,401 |
| Segment 2 | | | | | |
| 2A Escondido Freeway | 118.5 | 73.6 | $33,541,927 | $53,980,499 | $3,974,718,386 |
| 2B Escondido–Downtown | 118.7 | 73.8 | $41,186,959 | $66,283,986 | $4,888,892,058 |
| Segment 3 | | | | | |
| 3A–QualComm | 15.2 | 9.4 | $84,260,813 | $135,604,634 | $1,280,764,357 |
| 3B–San Diego–Carroll Canyon | 31.1 | 19.3 | $45,706,837 | $73,558,023 | $1,421,482,620 |
| 3C–San Diego–Miramar Road | 30.7 | 19.1 | $43,935,250 | $70,706,931 | $1,348,812,167 |
| **LOS ANGELES TO SAN DIEGO VIA ORANGE COUNTY** | | | | | |
| Option 1 | | | | | |
| LAUS-LAX (elec): MTA Harbor Subdivision | 25.4 | 15.8 | $75,923,478 | $122,186,993 | $1,924,660,161 |
| LAUS-UP Santa Ana (elec): UPRR/LOSSAN Corridor | 44.2 | 27.4 | $78,114,307 | $125,712,792 | $3,448,746,669 |
| LAUS-IRV (elec): LA to IRV (LOSSAN) | 69.3 | 43.0 | $33,318,203 | $53,620,450 | $2,307,485,456 |
| Support Facilities Costs (includes right-of-way but does not include contingencies or program implementation cost) | | | | | |
| Sacramento | | | | | $96,877,650 |
| San Diego | | | | | $146,831,113 |
| Bay Area (Los Banos) | | | | | $87,455,910 |
| Storage Yard & Main Repair Facility | | | | | $296,436,987 |

## Definition of Cost Elements

The capital costs for the proposed HST Alternative have been categorized into discrete cost elements. In general, the capital costs were estimated by determining the appropriate unit costs for the identified cost elements and the cost element quantities from conceptual high-speed train alignment and station option plans prepared for each region. Each cost element is defined below along with the methods and assumptions applied in each case. Many of these elements were reviewed as part of the peer reviews of

the Authority's Corridor Evaluation.[1] The unit costs and assumptions were also reviewed and in some cases revised by the regional teams as part of the alignment and station screening performed as part of this program. However, application of these assumptions is consistent with past evaluations and provides appropriate level of detail for the comparison of alignment and station options at this program level.

A. ALIGNMENT COSTS

Track Items

High-Speed Train Track: For steel-wheel-on-steel-rail systems (VHS), this includes ballast, subballast rails, ties, fasteners, etc. No special trackwork (turnouts, sidings, etc.) is included in this cost element. Cost for Special Track work is included as part of the Passenger Station Cost. The track required in the maintenance and service facilities, as well as the at-grade or elevated reinforced concrete substructures/foundation costs, including switches, within maintenance and service facilities are included in the cost of the those facilities.

Track unit costs were applied per unit length of alignment. Unit costs were applied to account for lengths of ballasted track section and direct fixation (slab track). Special trackwork costs were estimated based on Station Configuration.

The "ballasted track" unit cost, applied to most corridors, is $833,602 per km ($1,341,552 per mile) of alignment; this is a double-tracked cost. In areas where a single track is added to the existing corridor, this cost would be one half, $416,801 per km ($670,776 per mile).

For "direct fixation track", the unit cost is given as $1,576,480 per km ($2,537,099 per mile) of alignment. In areas where adding a single track is proposed, this cost would be one half, $788,240 per km ($1,268,549 per mile).

Earthwork and Related Items

Included in the detailed categories below are all the earthwork elements and other items related to site development.

Site Preparation: This includes the costs for "clearing and grubbing," which cover the removal of unsuitable surface debris, and removal of vegetation. This also includes the cost of "grading," which is the movement of dirt around the site to prepare the surface for construction. Site preparation also includes work done to make the site usable after the demolition of existing structures.

Unit costs for site preparation were applied to the total area required for earthwork operations along a given segment. The amount of area was based on the earthwork volume calculations.

Earthwork: The general category of "earthwork" is made up of four constituent activities: excavation, embankment, spoil, and borrow. Earthwork incidental to the construction of a structure, such as the excavation for a bridge foundation, is not included here—that cost is a part of the structural estimates.

[1] *California High-Speed Rail Corridor Evaluation German Peer Review Report (Phase I)*, DE-Consult Deutsche Eisenbahn-Consulting GmbH December 2000.

*Review of The Final Report on California High-Speed Rail Corridor Evaluation (Phase I)*, Japan Railway Technical Service September 2000.

Peer Review – Phase I, SNCF International October 2000.

Unit costs of earthwork were applied to the total volume of earthwork required along a given segment. A digital terrain model (DTM) was used to calculate the earthwork volumes based on the profile of each segment. If a DTM was unavailable an assumption of 1m (3.28 ft) (depth of cut/fill) by 8.3m (27.2 ft) (the width of the cross-sectional track bed) was assumed to be the required cut/fill quantity.

Landscaping/Erosion Control: This includes areas alongside the tracks within the high-speed train right-of-way. Plantings in station areas are included under passenger stations. The landscaping along the route includes the seeding of cut slopes and embankments. Site preparation and landscaping costs would only be applied to areas of new right-of-way for the alignment, including bypass alignments and corridor widening.

Security Fencing: This is a security chain link fence 2.5m (8.2 ft) in height along the right-of-way. All at-grade sections, trench sections, cut and fill sections, tunnel portals, maintenance areas, and any other areas where tracks are accessible to public would be fully fenced. A unit cost for fencing was applied per length of alignment and includes fencing for both side of right-of-way.

Drainage Facilities: This includes culverts and other structures needed for track and cross drainage purposes only, including track underdrains if needed. This does not include the cost of bridges or bridge drainage costs. The cost of drainage facilities was estimated at 5% of the earthwork cost for each segment.

Structures, Tunnels, and Walls

Structures are defined as those appurtenant elements that require structural engineering for system design, and fall into the categories below. Buildings (such as passenger terminals and maintenance facilities) are not included under structures, but are included other elements.

Viaducts and Bridges: This includes costs for prestressed reinforced concrete aerial structures including the bridge, as well as the abutment (for a bridge or viaduct). Cost for that bridge would consist of the excavation for the abutment including all wing walls and transition slabs. The foundation work is included as well as the earthwork needed to construct the foundations. Waterway crossings that were calculated on a per crossing basis are included under bridge costs.

A unit cost was applied per length of aerial structure. Different unit costs were used for "special structures" requiring spans greater than 120 feet (36.6 meters) and for "high structures with heights exceeding 30 feet (9.1 meters). Unit costs for other special or unique structures (i.e., bay crossing) would be addressed on a case by case basis at the subsequent project level analysis.

High-Speed Train Tunnels & Trenches: This includes tunnel boring machine (TBM) and drill and blast (D&B) tunnels constructed beneath the ground level that only require surface occupation (construction access) at the openings of the tunnel. The costs for these tunnels for the high-speed train system include all structural work, full lining and grouting, ventilation systems, special drainage, etc. needed to make the tunnel ready to receive the railroad. This item does not include the track, signaling or traction power systems, which are addressed in separate cost elements. Unit costs are applied per unit length of twin single track tunnel sections for two discrete cases: twin single track tunnels less than six miles in total length, and twin single track tunnels greater than 6 miles in total length. Tunnels greater than six miles in total length require a third access tunnel and additional ventilation/cooling facilities and are significantly more expensive.

Cross-over Chambers: This involves an oversized tunnel segment to accommodate universal cross over tracks at an average spacing of ten miles apart (not to exceed 12 miles) in long tunnel sections.

Seismic Chambers: This involves an oversized tunnel segment (3600' long x 77' wide x 37' high) to accommodate potential track realignment and passage of the train subsequent to a possible future fault rupture event along fault zones where especially large displacement is predicted.

Cut & Cover Double Track Tunnel & Trench: Used in Urban areas where depth of alignment is not sufficient for tunneling methods. The cost accounts for all anticipated labor, equipment, and mobilization costs. Cost includes excavation support, excavation bracing, excavation, structural backfill, and structure cost. Excavation includes removing the material from within the supported area and disposing of that amount of material not used for backfill or unsuitable for use. Structural back-fill includes obtaining sufficient, acceptable material for use, and the placing and compacting of that material. Cost does not include, traffic control, street relocation or utility relocation.

Mechanical & Electrical for Tunnels: This includes mechanical and electrical systems related to tunnel (such as lighting, fans, etc.). This is a cost for twin single track TBM length.

Retaining Walls: These are concrete walls used to support embankments and retained fill along cut sections (retaining walls that are a part of abutments for bridges are included in the bridge costs).

Containment Walls: These are structural concrete walls (including foundations and walls) required to prevent incursion of vehicles from one area to another. Generally, they are included whenever the high-speed train track is at-grade and adjacent to (within 30 feet [9.1 meters]) existing freight and passenger rail operations on dedicated portions of the high-speed train line (or alternative). Containment walls are also required adjacent to existing structures where prescribed by horizontal clearances (Caltrans Bridge and American Railway Engineering and Maintenance-of-Way Association [AREMA] Standards).

Grade Separations

Bridges and Undercrossings: These are highway and railroad overcrossings/undercrossings of the high-speed train system. All crossings with other transportation facilities must be grade-separated from the high-speed train system. The unit costs applied for these grade separations include all of the cost elements necessary to complete the construction of the grade separations, such as earthwork, traffic handling, drainage, etc. The number of existing crossings (roadway and rail) per segment was quantified per USGS planimetric information, field reconnaissance and other mapping sources according to type (at-grade, under or over) and general land use density category (Dense Urban, Urban, Dense Suburban, Suburban & Undeveloped). Professional judgments were made regarding the proposed crossing type, including the option of closure for minor roadways, based on aerial photography and mapping. Costs were estimated on a per-crossing basis using an representative unit cost.

Building Items

Costs for all building such as station facilities are based on the conceptual designs defined in the Engineering Criteria Report.

Intermediate/Terminal Passenger Stations: Different Passenger Station facility unit costs were developed for several station classifications. The different unit costs account for differences in station size, configuration and general location. These costs are assumed to be a rough average, since station costs are expected to vary widely at specific locations.

Passenger Station: This includes cost of passenger platform and inspections platform (for certain stations) and also include tracks and special tracks going through stations plus substructure supporting tracks and platform outside of the main line track envelops. This cost also includes circulation, lighting, security measures and all auxiliary spaces including intermodal connection areas. Spaces are provided within the station for ticket sales, passenger information, station administration, baggage handling, and commercial space for newsstands, small restaurants, etc. Cost does not include cost of traction power, Overhead Catenary System OCS and signal and communication.

Parking: This includes all facility costs associated with the construction of parking structures and at grade parking lots including right of way.

Site Development: This cost involves the paving and landscaping of the site around the passenger station building. Also included in this cost is the provision of street and roadway modifications necessary to provide access to the site. Different site development unit costs are provided for several levels of station size, based on the forecasted ridership.

Rail and Utility Relocation

Railroad Relocation and Removal: This involves the cost of track relocations (temporary or permanent) or track removal required to place high-speed train track into existing rail corridors, including all construction work needed to relocate or remove the railroad, including earthwork, trackwork, etc. A unit cost was applied to the length of alignment requiring relocation or removal.

Utility Relocation: The cost of major utility relocations that must be done before constructing the facilities, such as overhead power lines, pipelines, sewers and fiberoptics and underground ductbanks. Different unit costs were applied to the total length of alignment based on the intensity of land use development along the alignment.

B. RIGHT-OF-WAY ITEMS

This relates to the total cost associated with the purchase of land and/or easement rights for the high-speed train system. This includes relocation assistance and demolition costs. Property values and acquisition costs can range from quite modest in undeveloped areas, to quite significant in areas where high-value commercial properties near the stations are needed. These costs include those for title searches, appraisals, legal fees, title insurance, surveys, and various other processes.

The basic unit cost estimates assume that a minimum right-of-way width of 50 feet (15.2 meters) would be necessary throughout the length of each segment. Even when the alignment is primarily within existing rail rights-of-way, costs are estimated to account for the purchase and or lease agreements necessary for operation in these corridors. Wider right-of-way sections are necessary in mountainous areas where large cut and fill slopes are required.

Three general parameters were followed: (1) a minimum right-of-way corridor of 50 feet (15.2 meters) has been assumed in congested corridors; (2) a 100-foot (30.4-meter) corridor has been assumed in less developed areas to allow for drainage, future expansion and maintenance needs;

and (3) a wider corridor was used in variable terrain to allow for cut and fill slopes, based on computerized terrain modeling of the alignment options.

C. ENVIRONMENTAL IMPACT MITIGATION

This cost is total cost associated with potential mitigation of environmental impacts such as impacts to wetlands, parkland, biological resources, and wildlife habitat. Noise mitigation with sound walls and right-of-way impact and relocation mitigation are estimated separately as defined above.

The total cost of environmental mitigation was estimated to be 3% of the line construction costs (i.e., track, earthwork, structures, etc.) for each segment, based on other recently implemented transportation corridors in California. This factor is based on the average to estimate a total cost of mitigation.

D. SYSTEM ELEMENTS

Signaling and Communications Items

Signaling: These costs cover the cost of wayside, on-board and central control software and hardware for the overall signaling system. The unit costs are applied per length of track. The VHS technologies operate either on the basis of moving block technology with automatic train protection (ATP) or automatic train control (ATC) and automatic train operation (ATO).

Communications: This includes a high capacity fiber optic backbone with full redundancy, which is key for the operation of the Supervisory Control and Data Acquisition (SCADA) and reliable ATC systems. The communication system would be used for operations; maintenance and emergencies; phone and fax capabilities (enroute); closed circuit television; public information systems; public address systems; and other monitoring and detection devices needed for a safe and efficient operating system. The unit costs are applied per length of track.

Wayside Protection Systems: This includes systems/equipment to monitor and/or detect obstacles that may be placed or fall onto the track; intrusion; flooding; wind; seismic activity and equipment failures (broken rails, hot axles, dragging equipment, etc.). The unit costs are applied per length of track.

Electrification Items

Traction Power Supply: This cost is the entire cost of the substations, including site preparation; foundations; cable trenches; fencing; electrical equipment, etc. The unit costs are applied per unit length of track. It does not include the cost of transmission lines from the local utility source to the substations; those are included in the energy costs, a part of the operating and maintenance costs

Traction Power Distribution: This cost includes the catenary poles and foundations; the catenary wires and supports; tensioning devices; power feeders and returns; transformers and other appurtenances. The unit costs are applied per unit length of track.

E. VEHICLE COSTS

This includes costs for trainsets including an inventory of small parts estimated to be needed for regular maintenance. The costs are based on an estimated fleet size to accommodate the high-end ridership forecasts according to the conceptual operating plan, including estimated spare/out of service requirements. This unit cost includes a 15% contingency to account for uncertainties related

to the variance of cost between manufacturers, burn-in and testing and other economic uncertainties at this stage of estimation.

The unit cost estimates for each train set are based upon published manufacturers' documentation on recent sales of in-service trainsets at the time of the preparation of this document, as well as telephone inquiries with representatives of the manufacturer. Five manufacturers were considered to develop the unit costs, which are representative of the different manufacturers cost information.

## F. SUPPORT FACILITY COSTS

Costs for all support facilities are based on the conceptual designs defined in the Engineering Criteria Report. The support facilities include the Train Storage, Service and Inspection, and Light Maintenance Facilities defined near the terminal stations at Sacramento, the Bay Area (at Los Banos due to land use constraints in the Bay Area), and San Diego. They also include the Main Repair and Maintenance Facility to be located in the mid-portion of the system (Central Valley).

The costs include all costs associated with support maintenance facilities, including right of way and facilities. In addition to civil work and structural work, the unit cost includes trackwork, traction power, OCS and signal and communication and also maintenance equipment costs.

The facilities sizing was based on the greatest potential need (fleet size) associated with various operating scenarios. These operating scenarios are based on the Business Plan Sensitivity Analysis ridership forecasts, which represent the highest reasonable forecasted ridership, and the conceptual service plan from the Corridor Evaluation. For the purposes of defining these general facilities, we have assumed the following trainset storage requirements: Sacramento (9 trains), San Francisco/Oakland (15 trains), San Diego (21 trains), Los Angeles (4 trains), Fresno and Bakersfield (2 trains).

## G. PROGRAM IMPLEMENTATION COSTS

Costs for these elements are computed as a percentage of the total of construction and procurement costs. The percentages are intended to represent the average overall cost of these implementation items, based on implementation of rail transit and other related improvement projects throughout the state. The percentages are predicated on a Design-Build (DB) and Design-Build-Operate-and-Maintain (DBOM) procurement approach and would be significantly higher using a traditional procurement approach. These costs would be divided between the owner and the contractor in this procurement approach and are noted accordingly. These costs should be included in the cost estimates for overall consistency in the order of magnitude.

### Preliminary Engineering and Environmental Review

These are preliminary engineering design costs to approximately a 35% level. This would includes preliminary geotechnical investigations; land surveying and mapping; engineering; architecture; landscape architecture; traffic engineering; right-of-way engineering and preparation of preliminary plans and analyses in all necessary technical disciplines; and various other technical studies and support of the draft environmental document. The environmental review would entail all studies and analyses necessary to complete further federal and state required environmental documents. (Owner–2.5%)

### Program & Design Management

Costs for the overall management and administration of the project. Included were the Program Manager's office, contract management and administration, project control including both cost

and schedule, general administration, computer support, quality assurance, configuration management, system safety, publications, public relations, support of the bidding process, agency liaison, community information and involvement and legal support. (Owner–5.0%)

Final Design

Costs for final design and preparation of construction and procurement documents for all facilities and systems. This would include geotechnical investigations; land surveying and mapping; engineering; architecture; landscape architecture; traffic engineering; right-of-way engineering; preparation of plans and specifications in all necessary technical disciplines; and various other technical studies and support of the final design process. Design support during construction, including shop drawing review is also included in this item. (Contractor–5.0%)

Construction & Procurement Management

Costs for all management of construction and procurement work after contracts are awarded to contractors or suppliers. This would include on-site inspection in factory and field, quality control, contract administration and acceptance inspection. (Owner–1.0%; Contractor–4.0%)

Agency Costs

The costs of maintaining the owner's organization (or operator of the system) during the entire program, whether that owner is a franchisee or a government agency. (Owner–1.0%)

Force Account Costs

Costs for the services of other organizations or agencies of local, state or federal government that may be required to support the project. Work within railroad rights-of-way may be on force account with the appropriate railroad. There may be unforeseen costs as a result of moving the railroad to allow for high-speed trains. (Owner–1.0%)

Risk Management

The costs of owner (or operator of the system)-supplied insurance or any other allowances decided to be applied for the management of risk to the owner. (Owner–6.0%)

Testing & Pre-Revenue Operations

The costs of pre-revenue testing, acceptance testing, safety certification and training related to start-up of the system for revenue service. These costs would be included in the DBOM contract. These costs are not included as part of the program implementation costs at this level of evaluation.

## H. CONTINGENCIES

A contingency is added as a percentage of overall project costs—based on past experience for projects in early stages of definition. Contingencies should not be considered as potential savings. They are an allowance added to a basic estimate to account for items and conditions that cannot be assessed at the time of the estimate. The contingency amount is expected to be reduced as the project matures. The contingency is estimated at 25% of the total of construction costs.

## Unit Costs

The unit costs for all elements described above are presented in Table 4-C-2.

**Table 4-C-2**
**High-Speed Train Unit Cost**

| Cost Elements | | Unit | Unit Price (YR Sept. 2003) |
|---|---|---|---|
| **ALIGNMENT COST** | | | |
| **Track Items** | | | |
| 1 | Double Track Section–Total | km | |
| 2 | Double Track Section–At-Grade | km | $846,282 |
| 3 | Double Track Section–On Structure | km | $1,600,459 |
| 4 | Double Track Section–In Tunnel or Subway | km | $1,600,459 |
| 5 | Double Track Section–In Trench | km | $1,600,459 |
| 6 | Single Track Sections–In Tunnel or Subway | km | $1,000,287 |
| 7 | Freight Double Track–At-Grade | km | $846,282 |
| 8 | Freight Single Track–At-Grade | km | $423,141 |
| 9 | Four-track construction or reconstruction | km | $1,692,564 |
| **Earthwork Items** | | | |
| 1 | Site Preparation–Undeveloped | Hectares | $10,294 |
| 2 | Total Cut | m3 | $7.59 |
| 3 | Total Fill | m3 | $7.59 |
| 4 | Landscape/Erosion Control | Hectares | $6,881 |
| 5 | Security Fencing (Both Sides of R/W) | km | $86,687 |
| 6 | Special Drainage Facilities | 5% of Earthwork Cost | |
| **Structures, Tunnels, Walls** | | | |
| 1 | Standard Structure | km | $11,702,749 |
| 2 | High Structure | km | $14,043,299 |
| 3 | Long Span Structure | km | $32,020,021 |
| 4 | Waterway Crossing–Primary | km | $24,606,000 |
| 5 | Waterway Crossing–Secondary (Irrigation/Canal Crossing) | km | $19,700,000 |
| 6 | Twin Single Track Drill & Blast (<6 Miles) | km | $63,942,150 |
| 7 | Twin Single Track TBM (<6 Miles) | km | $47,261,589 |
| 8 | Twin Single Track TBM w/3rd Tube (>6 Miles) | km | $67,185,592 |
| 9 | Double Track Drill & Blast | km | $71,355,733 |
| 10 | Double Track Mined (Soft Soil) | km | $82,012,758 |
| 11 | Seismic Chamber (Drill & Blast/Mined) | ea | $80,782,844 |
| 12 | Crossovers | ea | $80,782,844 |
| 13 | Cut & Cover Double Track Tunnel | km | $41,006,379 |
| 14 | Trench Short | km | $42,322,835 |
| 15 | Trench Long | km | $33,464,567 |
| 16 | Mechanical & Electrical for Tunnels | km | $1,645,723 |

| Cost Elements | | Unit | Unit Price (YR Sept. 2003) |
|---|---|---|---|
| 17 | Retaining Walls | km | $3,749,214 |
| 18 | Containment Walls | km | $1,278,634 |
| 19 | Single Track Cut and Cover Subway | km | $25,628,987 |
| **Grade Separations** | | | |
| 1 | Street Overcrossing HSR–(Urban) | ea | $14,628,436 |
| 2 | Street Overcrossing HSR–(Suburban) | ea | $5,526,298 |
| 3 | Street Overcrossing HSR–(Undeveloped) | ea | $931,886 |
| 4 | Street Undercrossing HSR–(Urban) | ea | $15,278,589 |
| 5 | Street Undercrossing HSR–(Suburban) | ea | $5,851,374 |
| 6 | Street Undercrossing HSR–(Undeveloped) | ea | $986,065 |
| 7 | Street Bridging HSR Trench | ea | N/A |
| 8 | Minor crossing closures | ea | $151,702 |
| **Building Items** | | | |
| 1 | Terminal | LS | $95,355,731 |
| 2 | Site Development/Parking (Terminal Station) | LS | $23,838,933 |
| 3 | Urban | LS | $47,677,865 |
| 4 | Site Development/Parking (Urban Station) | LS | $11,919,466 |
| 5 | Suburban | LS | $23,838,933 |
| 6 | Site Development/Parking (Suburban Station) | LS | $5,959,733 |
| 7 | Rural | LS | $11,919,466 |
| 8 | Site Development/Parking (Rural Station) | LS | $2,383,893 |
| 9 | Parking–Structure | space | $14,244 |
| 10 | Parking–At Grade | space | $2,042 |
| **Rail and Utility Relocation** | | | |
| 1 | Single Track Relocation (Temporary) | km | $1,083,588 |
| 2 | Single Track Relocation (Permanent) | km | $1,083,588 |
| 3 | Single Track Removal | km | $54,000 |
| 4 | Major Utility Relocations–Dense Urban | km | $758,511 |
| 5 | Major Utility Relocations–Urban | km | $579,719 |
| 6 | Major Utility Relocations–Dense Suburban | km | $406,345 |
| 7 | Major Utility Relocations–Suburban | km | $232,971 |
| 8 | Major Utility Relocations–Undeveloped | km | $11,919 |
| **Right of Way Items** | | | |
| 1 | Right-of-Way Required for Each Segment | | |
| | Dense Urban | Hectares | $3,499,093 |
| | Urban | Hectares | $2,332,729 |
| | Dense Suburban | Hectares | $1,166,364 |
| | Suburban | Hectares | $408,227 |
| | Undeveloped | Hectares | $291,591 |

| Cost Elements | | Unit | Unit Price (YR Sept. 2003) |
|---|---|---|---|
| 2 | Right-of-Way Required for Passenger Station & Parking Facilities | | |
| | Dense Urban | Hectares | $3,499,093 |
| | Urban | Hectares | $2,332,729 |
| | Dense Suburban | Hectares | $1,166,364 |
| | Suburban | Hectares | $408,227 |
| | Undeveloped | Hectares | $291,591 |
| **Environmental Mitigation** | | | |
| Environmental Mitigation | | 3% of Line Cost | |
| **System Elements** | | | |
| 1 | Signaling (ATC) | km | $720,586 |
| 2 | Communications (w/Fiber Optic Backbone) | km | $595,973 |
| 3 | Wayside Protection System | km | $57,213 |
| **Electrification Items** | | | |
| 1 | Traction Power Supply | km | $368,420 |
| 2 | Traction Power Distribution | km | $686,995 |
| **Vehicle Costs** | | | |
| 1 | Fleet size estimate | Trainset | $44,000,000 |
| **Program Implementation Costs** | | | |
| Program Implementation Costs | | 25.5% of Total Cost & Procurement | |
| **Contingencies** | | | |
| Contingencies | | 25% of Total Construction Cost | |