2018 Business Plan: Technical Supporting Document

Capital Cost Basis of Estimate Report

June 1, 2018

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Prepared by WSP

for the Authority

CALIFORNIA High-Speed Rail Authority

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ACRONYMS AND ABBREVIATIONS

BNSF	Burlington Northern Santa Fe Railroad
FRA	Federal Railroad Administration
GAO	Government Accountability Office (United States)
HMF	Heavy Maintenance Facility
LGA	Locally Generated Alternative
LMF	Light Maintenance Facility
PEPD	Preliminary Engineering for Project Definition
ROW	Right of Way
SAA	Supplemental Alternative Analysis
SCC	Standard Cost Category
SCRIP	Southern California Regional Interconnector Project
UIC	International Union of Railways
UPRR	Union Pacific Railroad
V2V	Valley to Valley
YOE	Year of Expenditure

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1 INTRODUCTION

The California High-Speed Rail Authority (Authority) is responsible for planning, designing, building and operating a high-speed rail system in California. The system will connect and transform California. It will improve mobility, contribute to economic development and a cleaner environment, create jobs and preserve agricultural and other protected lands. The Phase 1 system will run approximately 520 miles from San Francisco/Merced to Los Angeles/Anaheim through the Central Valley in under three hours at speeds capable of over 200 miles per hour. Phase 2 will eventually extend the system to Sacramento and San Diego, totaling 800 miles with up to 24 stations.

This ***2018 Business Plan Capital Cost Basis of Estimate Report*** presents updated capital cost estimates in support of the Authority's *2018 Business Plan*. It lays out the estimating approach, methodology and assumptions that serve as the basis for both updated Phase 1 system capital cost estimates and for updated Silicon Valley to Central Valley Line capital cost estimates as described and presented in both the *2016 Business Plan* and *2018 Business Plan*. This report summarizes how the estimates are organized and presented (i.e., by geographic segment and by cost category), identifies specific changes to the estimates as compared with those presented in the *2016 Business Plan*, and describes the basis and key drivers of these cost changes. Finally, it provides a detailed segment-by-segment comparison of the updated 2018 capital cost estimates with those presented in the *2016 Business Plan*.

Capital costs of high-speed rail evolve as in any major transportation infrastructure project, from early planning and conceptual engineering through preliminary engineering, contract procurement and, ultimately, to final design and construction. As the project scope, alignment, procurement strategies, delivery mode and other key decisions are finalized—and as environmental mitigation and other project components are more accurately specified—capital costs become more certain and risk factors become more defined, supporting contingency modifications and schedule confidence.

This report reflects advancements in the development of the program resulting in the Authority's decision to prepare a comprehensive update to the baseline capital cost estimate. The following considerations and developments have influenced the updated capital cost estimates:

- Preliminary design of the Phase 1 program has now been advanced to a 15 percent design in most of the segments, as documented in preliminary engineering reports (see Table 7 for more definition on design development stages in each segment). Final design of the 119-route-mile segment between Madera and Poplar Road in Shafter (just north of Bakersfield) has been advanced to between 65 percent and 100 percent.
- Stakeholder engagement and environmental line-segment reviews have substantially advanced over the last two years. Multiple route alternatives have been identified, investigated, documented and costed.
- To qualify for all federal American Recovery and Reinvestment Act funds (which had to be committed within the September 2017 spending deadline), the Authority began construction in the Central Valley before securing all needed right of way (ROW) and completing all required third-party agreements. Predictably, this decision led to unavoidable construction delays. Our updated 2018 cost estimates and schedule reflects these delays and resulting increased construction costs.
- The current estimates include all executed contract amounts and approved amendments for Construction Packages 1, 2-3 and 4 in the Central Valley, reflecting the actual costs incurred, including currently projected cost of utility relocations and property acquisition, and the ongoing civil construction costs in the Central Valley.

- An independent constructability review was undertaken in the San Jose to Merced segment, with recommendations for contract packaging, construction means and methods, detailed construction cost estimates and schedule, and identification of risks and opportunities.
- Certified Professional Estimators, senior project staff and third-party industry professionals performed detailed independent review of the capital cost estimates, resulting in validation of the Authority's estimating approach and methodology.
- Contingencies were established based on further project definition and risk analysis.

Consistent with the *2016 Business Plan*, the Authority has subdivided the environmental sections into 12 discrete geographic segments, plus the heavy maintenance facility (HMF) and two trainset packages (an initial acquisition package to support the start of initial operations and a subsequent acquisition package to support service levels for the full Phase 1 system). The light maintenance facilities are now being included with the respective geographic segments rather than being included with the HMF, as was shown in the *2016 Business Plan*. Silicon Valley to Central Valley infrastructure implementation remains the Authority's near-term objective.

The *2016 Business Plan* identified the Silicon Valley to Central Valley Line as a line that would connect San José to either an interim station north of Bakersfield either at Poplar Avenue or to the existing Amtrak Station in the City of Wasco. The *2016 Business Plan* also noted the additional value in terms of ridership and revenue by extending the line to San Francisco, Merced and Bakersfield.

The *2018 Business Plan* now re-defines the Silicon Valley to Central Valley Line as San José to Bakersfield plus initial capital investments on the San José to San Francisco project section that would allow a one-seat ride from the Central Valley to San Francisco (4th and King Station).

Following this introduction is the capital cost summary, then a discussion of cost estimating approach and methodology, and, finally, a list of assumptions and exclusions.

Delivering the high-speed rail program involves the implementation of a series of highly complex, integrated megaprojects. As the program moves forward, there are, and will continue to be, uncertainties around cost, funding and timing. Apart from the 119-mile Central Valley Segment under construction, the current cost estimates are based on preliminary environmental reviews, design and alignment assumptions that are still early in the project lifecycle process.

Our past practice has been to provide point estimates too early in the process. This report continues to provide point estimates for purposes of comparison and to provide updates on current assumptions used for estimating purposes. These estimates are based on our best assessment to complete at this point in time, incorporating current material unit prices and material quantities and assume a fully funded schedule and cost-effective alignments.

However, the Authority intends to begin expressing costs in ranges until more detailed project level information is available from which it can develop contracts, budgets and procurements. These cost ranges, which are detailed further in this report, provide ranges to reflect risks, opportunities and design uncertainty associated with the current stage of project development and complexity to be managed going forward.

This approach will affect future decisions and strategies for planning, managing and implementing the system over time. Our goal is to manage scope, schedule and budget so that we deliver the Silicon Valley to Central Valley Line below our baseline estimate. Staying nimble and adjusting to future circumstances will allow the program to advance in line with events as they evolve. A summary of those ranges is presented in Table 1, which shows our base estimate and the range of costs around that estimate for the Central Valley Segment and each proposed implementation phase.

Table 1 Summary of Cost Estimates by Phase and by Range (YOE$)

Project Segment	Low (YOE$ Billions)	Base (YOE$ Billions)	High (YOE$ Billions)
Central Valley Segment	$10.1	$10.6	$12.2
Silicon Valley to Central Valley *	$25.1	$29.5	$36.8
Phase 1 **	$63.2	$77.3	$98.1

* Silicon Valley to Central Valley – YOE$ based on completion date of 2029.

** Phase 1 YOE$ was used as a basis for projecting YOE$.

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2 CAPITAL COST SUMMARY

Table 2, Table 3 and Table 4 present the *2018 Business Plan* capital cost estimates by the Federal Railroad Administration (FRA) Standard Cost Category (SCC) in both base year 2017 dollars and in year of expenditure dollars (YOE$) for the Central Valley, Silicon Valley to Central Valley Line and the Phase 1 system, respectively.

Table 2 Central Valley Segment Cost Estimate by SCC (Millions, 2017$ and YOE$)

Standard Cost Category (SCC)		
10 TRACK STRUCTURES AND TRACK	$ 2,502	$ 2,584
20 STATIONS, TERMINALS, INTERMODAL	$ 153	$ 174
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	$ 155	$ 176
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$ 4,810	$ 4,825
50 COMMUNICATIONS AND SIGNALING	$ 345	$ 394
60 ELECTRIC TRACTION	$ 704	$ 803
70 VEHICLES	—	—
80 PROFESSIONAL SERVICES (applies to Cats. 10-60)	$ 1,003	$ 1,075
90 UNALLOCATED CONTINGENCY	$ 586	$ 600
100 FINANCE CHARGES	—	—
Total: *	$10,257	$10,632

* Figures may not sum due to rounding.

** YOE$ figures in this table are derived using an escalation factor.

Table 3 Silicon Valley to Central Valley Line Cost Estimate by SCC (Millions, 2017$ and YOE$)

Standard Cost Category (SCC)		
10 TRACK STRUCTURES AND TRACK	$10,903	$12,168
20 STATIONS, TERMINALS, INTERMODAL	$ 625	$ 713
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	$ 487	$ 555
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$ 7,578	$ 7,982
50 COMMUNICATIONS AND SIGNALING	$ 788	$ 899
60 ELECTRIC TRACTION	$ 1,465	$ 1,671
70 VEHICLES	$ 998	$ 1,139
80 PROFESSIONAL SERVICES (applies to Cats. 10-60)	$ 2,792	$ 3,116
90 UNALLOCATED CONTINGENCY	$ 1,196	$ 1,297
100 FINANCE CHARGES	—	—
Total: *	$26,831	$29,539

* Figures may not sum due to rounding.

**YOE$ figures in this table are derived using an escalation factor.

*** Does not include costs for Phase 1 Project development or Bookends.

Table 4 Phase 1 Capital Cost Estimate by SCC (Millions, 2017$ and YOE$)

Standard Cost Category (SCC)		
10 TRACK STRUCTURES AND TRACK	$ 29,694	$ 34,343
20 STATIONS, TERMINALS, INTERMODAL	$ 1,966	$ 2,196
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	$ 940	$ 1,090
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$16,099	$ 18,039
50 COMMUNICATIONS AND SIGNALING	$ 1,494	$ 1,732
60 ELECTRIC TRACTION	$ 3,712	$ 4,195
70 VEHICLES	$ 4,493	$ 5,263
80 PROFESSIONAL SERVICES (applies to Cats. 10-60)	$ 6,517	$ 7,512
90 UNALLOCATED CONTINGENCY	$ 2,575	$ 2,924
100 FINANCE CHARGES	—	—
Total: *	$67,490	$77,295

* Figures may not sum due to rounding.

** YOE$ figures in this table are derived using an escalation factor.

Figure 1 shows a comparison of the capital cost estimates for the Phase 1 system between the *2016 Business Plan* and the *2018 Business Plan* by SCC. For this comparison, the *2016 Business Plan* costs have been escalated to base year 2017 dollars.

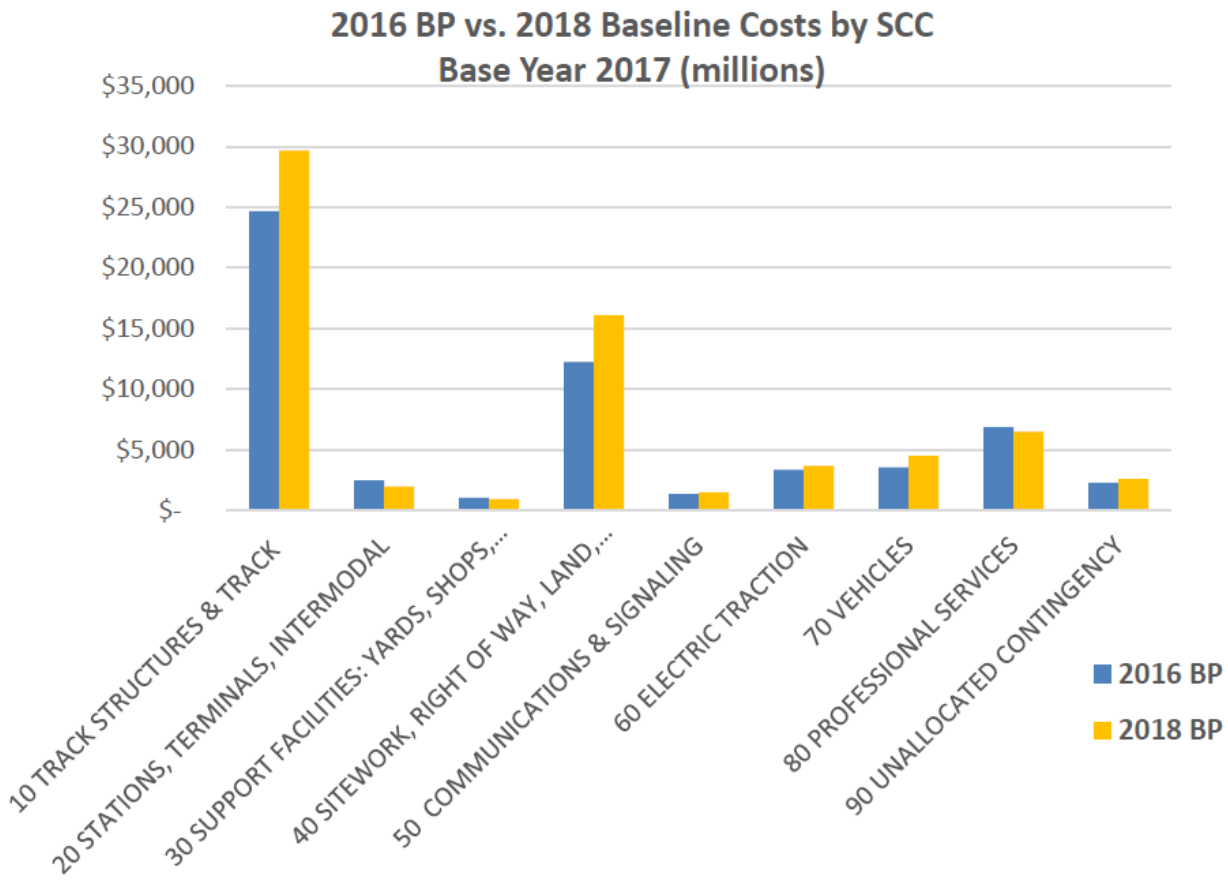

Figure 1 Capital Cost Comparison by SCC in 2017 Dollars, Millions

The changes between *2016 Business Plan* and *2018 Business Plan* capital cost estimates are further illustrated by showing the resulting cost increases and decreases within each environmental section as shown on Figure 2 below.

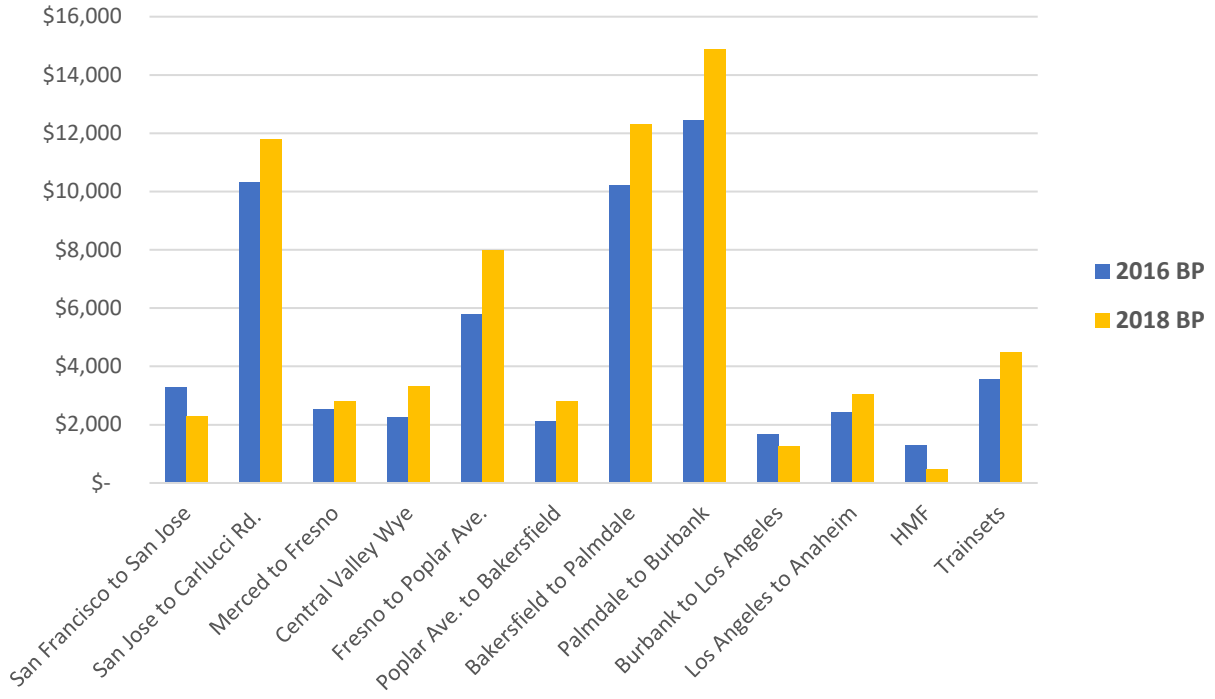

Figure 2 Capital Cost Comparison by Environmental Section in 2017 Dollars, Millions

As mentioned in Section 1, the environmental sections have been further broken down into 12 geographic segments, plus the HMF and trainset packages. The changes between *2016 Business Plan* and *2018 Business Plan* capital cost estimates are further illustrated by showing the resulting cost increases and decreases within each geographic segment, as summarized in Table 4.

A comparison of the *2018 Business Plan* capital cost estimates with the *2016 Business Plan* estimates for each geographic segment is provided in Section 4.2, along with major assumptions used to update the costs.

Table 5 *2016 Business Plan* to *2018 Business Plan* Phase 1 Capital Cost Comparison

Environmental Section	2016 BP (2017 $, Millions)	2018 BP (2017 $, Millions)	Change (2017 $, Millions)	Comments*
San Francisco to San Jose	$3,281	$2,380	$(901)	Shared tracks with Caltrain. Includes temp 4th and King, LMF at Brisbane and contribution of $713M to Caltrain electrification and $550M to Phase 2 of the DTX project
San Jose to Gilroy	$4,579	$2,820	$(1,759)	Includes at-grade Diridon Station. Assumes use of UPRR ROW from Tamien to Gilroy Station
Gilroy to Carlucci Rd.	$ 5,738	$ 8,984	$3,246	Per preliminary engineering for Alternative 2 including 13.4 miles of viaduct and 15.2 miles of tunnels
Merced to Wye Legs 1	$ 1,080	$ 797	$ (283)	Based on amended Hybrid Alternative from Merced to Ranch Road
Wye Legs 1	$ 1,238	$ 1,225	$ (13)	Based on SR152 to Road 11 Wye Alternative
Carlucci Rd. to Madera Acres (Wye Leg 2)	$ 1,005	$ 2,097	$1,092	Wye Leg 2 from Carlucci Road to Avenue 19. Includes 1.6 miles of viaduct and bridge structures and 15 grade separations
HMF	$ 1,300	$ 458	$ (842)	Includes HMF in the Central Valley; LMFs are accounted for in the geographic segments
Madera Acres to Poplar Ave.	$ 7,229	$ 9,982	$2,753	Reflects scope of CP 1, CP 2-3, CP 4 and SR99 projects plus track and systems and 2 stations [Madera (temp) and Fresno)]
Poplar Ave. to Bakersfield	$ 2,125	$ 2,805	$ 680	Based on LGA extending route from Poplar Ave to Oswell Street and high-speed rail station in Bakersfield
Bakersfield to Palmdale	$10,198	$12,290	$2,091	Assumes preliminary engineering for Alternative 2. Includes a LMF/MOIF at Palmdale
Palmdale to Burbank	$12,428	$14,867	$2,439	Reflects SAA Alternative E1 updated based on average cost growth assumptions.
Burbank to Los Angeles	$ 1,667	$ 1,252	$ (415)	Based on preliminary engineering for Alternative B but assuming Burbank Station to be at-grade
Los Angeles to Anaheim	$ 2,437	$ 3,040	$ 602	Preliminary engineering for Alternative 2R without high-speed rail station at Norwalk. Includes $500M bookend contribution in Southern California
Trainsets	$ 3,557	$ 4,493	$ 935	Assumes a total fleet of 72 trainsets for Phase 1
Total Phase 1**	$57,863	$67,490	$9,626	

* Numerical values indicating cost increases/decreases are not representative of the total cost variances. Other costs including allowances based on percentages also contribute to the total difference but are not listed in this table.

** Figures may not sum due to rounding.

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3 APPROACH AND METHODOLOGY

Development of the updated baseline capital cost estimate is a multi-step process including engineering analysis of construction quantities, development of unit pricing, estimation of project implementation costs and escalation to the year of expenditure (YOE). Figure 3 depicts the main activities and their sequence leading to development of the updated baseline capital cost estimate.

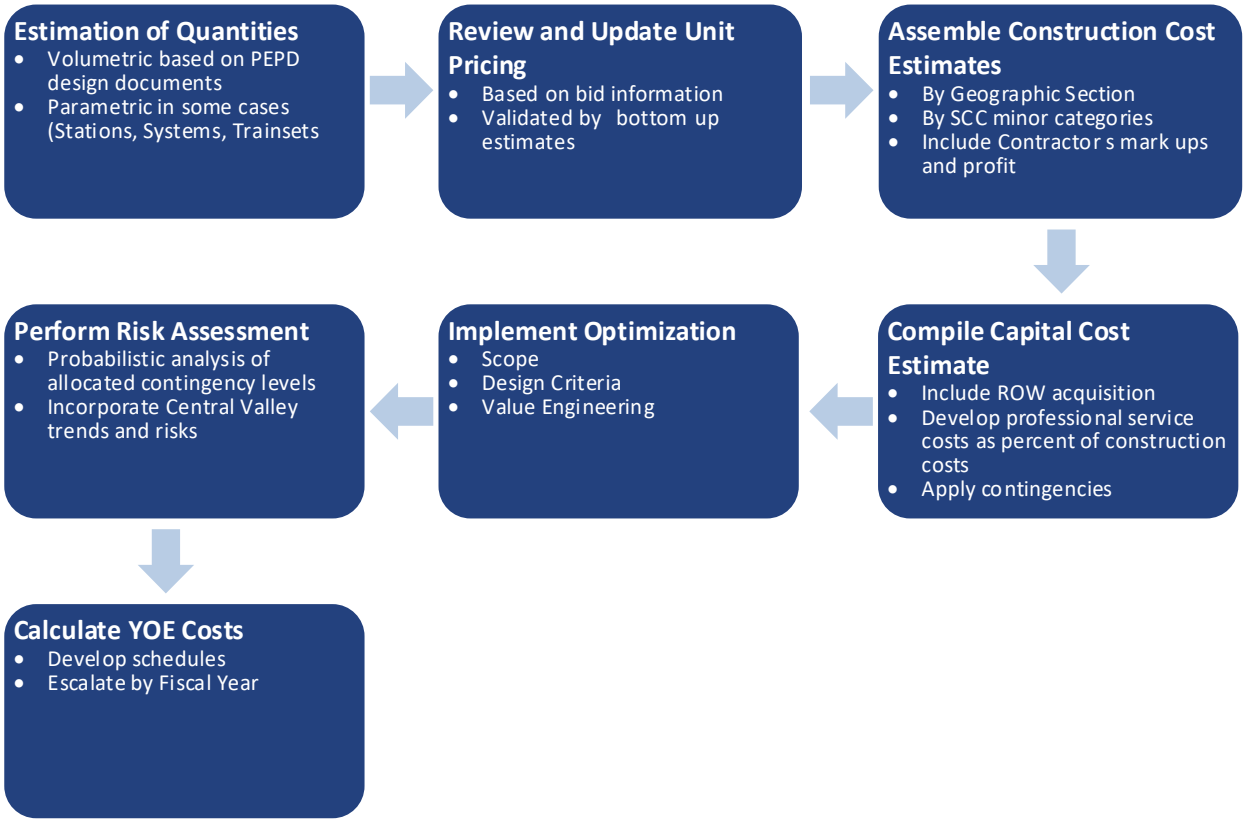

Figure 3 Baseline Capital Cost Estimate Development Process

The *2018 Business Plan* capital cost estimate is predominately a Class 3 estimate based on the level of design maturity in the sections that have been advanced to a 15% design level, as defined by the Association for the Advancement of Cost Engineering (see the summary of estimate classifications in Table 6. The exceptions are the Central Valley estimate, which is considered a Class 1 estimate, and the San Francisco to San Jose to Gilroy and Palmdale to Burbank estimates, which would be considered as Class 4 estimates that have to rely on a conceptual level of design. Class 3 estimates are typically prepared to form the basis for budget authorization, appropriation and/or funding. As such, they provide the initial control estimate against which actual costs and resources are monitored. The level of engineering ranges from 10 percent to 40 percent complete and typically includes horizontal and vertical alignments; typical cross sections; preliminary roadway and structure design; preliminary assessment of utility impacts; preliminary identification of systems facilities; development of environmental footprints and right of way requirements; and initial constructability reviews.

Table 6 Estimate Classifications by AACE International

Estimate Class	Primary Characteristic: Maturity Level of Project Definition Deliverables (Expressed as % of complete definition)	Primary Characteristic: End Usage (Typical Purpose of estimate)	Secondary Characteristic: Methodology (Typical estimating method)	Secondary Characteristic: Expected Accuracy Range (Typical variation in low and high ranges) *
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study of feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
	65% to 100%	Check estimate or bid/tender	Detailed unit cost with forced detailed take-off	L: -3% to -10% H: +3% to +15%

* The state of technology, availability of applicable reference cost data, and many other risks affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50 percent level of confidence for given scope).

Typical accuracy ranges for Class 3 estimates are -10 percent to -20 percent on the low side and +10 percent to +30 percent on the high side, the accuracy ranges that were applied on the Valley to Valley and Phase 1 estimates vary depending on the complexity of the project scope elements, maturity of underlying technical baseline information, and the inclusion of appropriate contingencies.

3.1 Capital Cost Ranges

Because each of the environmental sections are at various stages of project development, they carry different levels of design risk – and therefore different ranges. The ranges reflect an assumed scope (e.g., alignment) and do not capture significant future scope changes that may be defined or any schedule impacts that may result from those changes. We will continue to review and update our estimates as we advance design, complete environmental reviews, and make decisions (e.g., final alignments). Table 7 and Table 8 provide a summary of the year of expenditure cost estimate in ranges by project section for the Silicon Valley to Central Valley Line and Phase 1 respectively.

Table 7 Silicon Valley to Central Valley Cost Estimate by Project Section and Range (YOE$)

Geographic Segment	V2V Low (YOE$$, Millions)	V2V Base (YOE$$, Millions)	V2V High (YOE$$, Millions)
San Jose to Gilroy	$ 2,252	$ 3,217	$ 4,826
Gilroy to Carlucci Rd.	$ 8,199	$10,249	$13,323
Carlucci Rd. to Madera	$ 2,033	$ 2,392	$ 2,870
Central Valley Segment	$10,100	$10,632	$12,227
San Francisco and Bakersfield Extensions (initial investment) *	$ 1,529	$ 1,911	$ 2,342
Rolling Stock (16 Trainsets)	$ 1,025	$ 1,139	$ 1,253
Total	$25,138	$29,539	$36,840

Costs exclude Phase 1 project development and bookends.

* SF to SJ Investment includes: Temporary platform at 4th and King Street and a light maintenance facility.

** Poplar to Bakersfield: Extension to Bakersfield and initial investment at Bakersfield station. YOE$ based on completion by 2029.

Table 8 Phase 1 Cost Estimate by Project Section and Range (YOE$)

Geographic Segment	Phase 1 Low (YOE$$, Millions)	Phase 1 Base (YOE$$, Millions)	Phase 1 High (YOE$$, Millions)
Silicon Valley to Central Valley Line	$ 25,138	$29,539	$36,840
San Francisco to San Jose (balance/full investment)	$ 1,659	$ 2,074	$ 2,696
Merced to Wye	$ 2,028	$ 2,386	$ 2,863
Bakersfield to Palmdale	$ 13,076	$16,345	$19,614
Palmdale to Burbank	$ 13,159	$17,546	$25,442
Burbank to Los Angeles	$ 1,256	$ 1,478	$ 1,699
Los Angeles to Anaheim	$ 3,049	$ 3,587	$ 4,125
Heavy Maintenance Facility (Balance)	$ 173	$ 216	$ 281
Rolling Stock (Balance)	$ 3,712	$ 4,124	$ 4,536
Total	$63,250	$77,295	$98,097

YOE$ assumes completion by 2023.

* SF to SJ investments include: Additional investment to complete full service to Transbay.

** Bakersfield to Palmdale: Completes full investment in Bakersfield Station. YOE$ based on completion by 2033

Table 9 Expected Accuracy Ranges by Project Section

Geographic Segment	Low Range %	High Range %
San Francisco to San Jose	-20%	30%
San Jose to Gilroy	-30%	50%
Gilroy to Carlucci Rd.	-20%	30%
Merced to Wye Legs 1	-15%	20%
Wye Legs 1	-15%	20%
Carlucci Rd. to Madera Acres (Wye Leg 2)	-15%	20%
Madera Acres to Poplar Ave. w/ HMF	-5%	15%
Poplar Ave. to Bakersfield	-20%	20%
Bakersfield to Palmdale	-20%	20%
Palmdale to Burbank	-25%	45%
Burbank to Los Angeles	-15%	15%
Los Angeles to Anaheim	-15%	15%
HMF (Balance)	-20%	30%
Rolling Stock (16 Trainsets)	-10%	10%
Rolling Stock (Balance)	-10%	10%

A consistent format is used for the reporting, estimating, and managing of the project's capital costs. Standard Cost Categories (SCC) established by the Federal Railroad Administration (FRA) continue to be used in the development of the *2018 Business Plan* capital cost estimate update.

The methodology used for generating the capital cost estimate is consistent with FRA guidelines for estimating capital costs. The FRA guidance enables FRA-funded projects to develop budget baselines that summarize to the Standard Cost Categories SCC as shown in Appendix A. This cost structure was used for capital cost detail and summary sheets and is described below. The FRA recently made minor adjustments to the SCC breakdown, which have not been reflected in the 2018 estimate.

3.2 Basis of Quantities

The development of an accurate and credible capital cost estimate starts with the estimation of quantities that adequately reflect the scope of a project or program. The quantities in each geographic section of the Phase 1 program were estimated by direct measurement and calculation of construction elements as depicted on the preliminary engineering drawings (i.e., volumetric quantification) or as assumed by experienced engineering staff where required details were inadequate on the preliminary engineering drawings. When the preliminary designs have not advanced beyond the basic footprint definition (such as passenger stations or maintenance facilities) parametric or analogy estimating of quantities was undertaken to capture construction scope of these features. A detailed listing of engineering documents forming the technical baseline for the *2018 Business Plan* capital cost estimate is included in Appendix B.

3.3 Basis of Cost

The basis of any cost estimate is centered around the unit costs used to price different construction elements that make up discrete project elements such as embankments, viaducts, tunnels, earth retaining

structures, track, grade separation, etc. that are referred to as Unit Price Elements. The estimates have been derived by pricing quantified cost items with unit costs in 2017 dollars.

The unit costs were developed using standard industry practices based on historical bid data validated by unit cost analysis. Bid prices were used for more common construction elements, while the unit cost analysis method was applied for complex construction elements.

Contractor margin is added on top of fully burdened direct construction cost to have a complete in place cost. This approach is based on the contractor's field staffing which includes indirect costs such as office space, field consumables, bonds, insurance, and contractor's home office overhead and margin. Contractor's design coordination costs required in the design-build process are also included as part of the contractor's overhead.

Project Office Indirect Cost	6.0%
Home Office Overhead	0.5%
Margin	3.0%
Design Coordination	2.5%
Total	**12.0%**

3.4 Allowances & Other Costs

In addition to direct estimation of items of work by direct quantification and pricing, allowances and other costs had to be included to account for program costs associated with environmental mitigation, real estate acquisitions, temporary facilities, trainsets, and professional services.

3.4.1 Environmental Mitigation

The scope of environmental commitments for the entire program cannot be determined now due to the full extent of the environmental mitigation measures being unknown while environmental clearance is being sought However, environmental mitigation costs have been established based on actual commitments on the Central Valley projects (CP 1, CP 2-3, CP 4, SR99) that had already received environmental clearance and are now in construction. These costs were used as the baseline in determining what environmental mitigation costs can be expected on the other projects of the Phase 1 program. This was accomplished by application of factors accounting for corridor type (i.e., new, existing or shared use), relation to grade (at-grade, elevated or in tunnel), and an area factor affecting land acquisition costs needed to implement off-site mitigation for impacted environmental resources.

Site improvements such as passenger stations and maintenance facilities received a flat allowance of 3 percent of the respective construction costs to estimate the environmental mitigation costs associated with these program features.

3.4.2 Temporary Facilities

An allowance was used to account for the cost of temporary facilities, indirect costs and mobilizations in the capital cost estimate. This allowance was assumed at 4 percent of the total cost of track structures, station buildings, maintenance facilities, roadway modifications, and highway grade separations.

3.4.3 Right of Way (ROW)

Anticipated ROW requirements including permanent acquisitions and temporary easements are estimated based on project footprints established in the preliminary engineering documents. Required property acquisitions were quantified and estimated based on preliminary land valuations.

3.4.4 Professional Services

Professional services required to implement the program range from initial planning, preliminary engineering, environmental evaluation, and program management to final design, construction management and start up. Transit Cooperative Research Program Report 138 Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects had been endorsed by Federal Transit Administration as the guidance and estimating cost of professional services on major rail transit programs. This report offers a methodology of evaluating professional services costs based on the experience of major transportation programs, while recognizing key influencing factors characterized as mathematical relationships (i.e., project lengths, construction cost, mode, delivery method, access conditions) and categorical relationships (development duration, political influence, agency policies).

Applying these estimating methodologies, the following allowances as percent of construction costs were included in the baseline estimate for the professional services:

- Preliminary Engineering/Environmental – 2.5 percent
- Program Management – 4.0 percent
- Final Design – 6.0 percent
- Construction Management – 3.0 percent
- 3rd Party Agency Reviews and Permits – 0.5 percent
- Start-up & Testing – 0.5 percent

3.5 Risk Assessment

Risk and uncertainty is a typical part of the estimating process as the cost estimate is a forecast only, and there is always a chance that the actual cost will differ from the forecast estimate. To account for this risk or uncertainty in the estimate, a risk assessment was conducted with participation of the program functional managers and key staff members. Previously assumed contingency levels were assessed, and a probabilistic analysis was performed to determine the contingency levels relative to probability. Contingency levels representing P50 probability were applied on the estimated base costs following the SCC coding structure presented in Appendix A, with an exception of the Central Valley projects where included contingencies reflect the remaining Board approved project contingencies as well as trends and risks identified by the project team.

3.6 Allocated and Unallocated Contingencies

For the purposes of this estimating program, contingency is divided into two major categories – allocated and unallocated.

Allocated contingency is added to each cost category based on an assessment of the level of design information, complexity of design element, means and methods and site accessibility available for individual items of work. The resulting allocated contingencies implemented in the estimate range between 10 and 50 percent reflecting professional judgment and experience related to the cost variability typically seen for items of work within each particular cost category. The exact percentage selected for each cost category is included in Appendix C. The contingencies are generally higher for underground work reflecting the additional exposure for unknowns as well as the construction complexity. It is also higher for stations, terminals, storage yard facilities and utilities since their design progress is still in the conceptual level and identification of all the utilities are not determined.

Unallocated contingency is typically included to address uncertainties that are more global in nature like schedule delays, changes in contracting environment, or other such issues that are not associated with

individual construction activities. Unallocated contingencies have been estimated at five percent of the total construction costs including right of way and professional services for the segments that are in preliminary engineering stage of development. Unallocated contingencies have been adjusted to include approved project contingencies and 3rd party allowances for the segments issued for final design and construction.

3.7 Review and Optimization

Upon completion of the draft baseline estimate following the steps outlined above, a workshop was held assessing major scope changes, cost trends, and other influencing factors in each geographic section. It was recognized that while preliminary engineering documents tend to capture the entire project footprint for complete environmental analysis and clearance aimed at minimizing the risk of supplemental evaluations in the future, it also results in a conservative design subject to optimization through subsequent design development stages. Optimization measures were applied on the baseline estimate as high-level adjustments including but not limited to the following:

- Structural design criteria optimization
- Lower profile where possible
- Minimize separation between bored tunnels
- Assume no mechanical ventilation in short tunnels
- Station modular design
- Reflect participation of other parties in grade separation costs
- Reflect future application of formal Value Engineering

In addition, several scope optimizations were incorporated into the baseline capital cost estimate, and are further described in Section 4.2.

3.8 Year of Expenditure

The updated estimate in constant dollars was escalated to year of expenditure dollars based on the phased approach to the design and construction as following:

- Silicon Valley to Central Valley Line – includes cost of high-speed rail from San José to Bakersfield plus initial capital investments on the San José to San Francisco project section that would allow a one-seat ride from the Central Valley to San Francisco (Caltrain station at 4th and King). It also includes costs of completing track, stations and systems elements to make it fully operable. In addition, acquisition of 16 trainsets and the initial phase of the heavy maintenance facility are also included in the total capital cost of this operating segment. Contributions to the early projects in the bookends include $600 million in Proposition 1A funds and $114 million in Cap-and-Trade funds in the north and $500 million in the south. There is also a $550 million contribution towards DTX project in San Francisco. Estimated completion of this implementation phase is by 2029.
- Phase 1 – extends from San Francisco in the north to Anaheim Station in the south. An additional 56 trainsets are included with Phase 1 implementation. Estimated completion of this implementation phase is by 2033.

The baseline year of expenditure costs are determined by cost loading the program planning schedule with the costs in constant 2017 dollars to determine Fiscal Year expenditures. Fiscal Year expenditures are then escalated based on the following projected future inflation factors:

Fiscal Year	2017/2018	2018/2019 to 2024/2025	2025 2026	2026/2027 to 2033/2034
Inflation Factor	1.125%	2.25%	2.625%	3.00%

These inflation factors reflect compound Construction Cost Index forecast developed for the *2016 Business Plan*.

3.9 Independent Reviews

In effort to validate the methodologies and processes used in development of capital cost estimates, two independent reviews have been conducted concurrently with the development of the *2018 Business Plan* estimate:

- Estimate Assurance Process Report, Turner & Townsend, November 17, 2017.
- Independent Review of Cost Estimate Methodology and Processes, WSP USA, October 31, 2017.

4 ASSUMPTIONS, EXCLUSIONS AND RECONCILIATION

4.1 Design Development Stages

Each geographical segment is at various stages of development ranging from conceptual design, or roughly 5 percent design, to final design. In addition, many segments are still undergoing alternatives review and refinement and environmental review. This cost estimate has made some assumptions on those segments currently under review (see Appendix B, Table 25) that are outside of the CP 1, CP 2-3 and CP 4 construction contracts. Table 10 provides the current design development stages this estimate is based on for each segment. In addition, the level of design completion outlines the assumptions made for each geographical segment. It is important to note that as the environmental review is completed, and alternatives are selected as informed by that review, these estimates may change.

Table 10 Design Development Stages

Project Segments	Design Development Stage
San Francisco to San Jose	Conceptual*
San Jose to Gilroy	Conceptual
Gilroy to Carlucci Road	Preliminary**
Merced to Wye Legs 1	Preliminary
Wye Legs 1	Preliminary
Carlucci Road to Madera Acres (Wye Leg 2)	Preliminary
Construction Package 1	Final
Construction Package 2-3	Final
Construction Package 4	Final
First Construction Segment to Bakersfield	Preliminary
Bakersfield to Palmdale	Preliminary
Palmdale to Burbank	Conceptual
Burbank to Los Angeles Union Station	Preliminary
Los Angeles Union Station to Anaheim	Preliminary

*Conceptual design is generally in support of Alternative Analysis / Supplemental Alternative Analysis reports and is about 5 percent complete or less

**Preliminary design is generally in support of EIR documents and is about 15 percent complete

4.2 Estimate General Assumptions and Exclusions

The following summarizes the sources and general assumptions used in the development of the *2018 Business Plan* estimate. Since 2012, the estimate has been updated in several ways. The *2014 Business Plan* capital cost estimate recognized modifications based upon known scope changes and increases associated with known cost escalation. The changes in scope identified do not modify the overall scope and performance of the design for the system. The *2018 Business Plan* capital cost estimate reflects a more comprehensive update reflecting engineering development occurred to date. The information below provides the basis on which the estimate is derived, and assumptions and elements known, as of December 2017. In addition, each geographic segment estimate includes a summary by Major SCC relative to the *2016 Business Plan* costs.

General Assumptions

The estimate is based upon the latest information available from several different sources. In general, the following sources have been used:

- *2018 Business Plan*
- Adopted Supplemental Alternatives Analysis or work done supporting environmental analysis
- Preliminary Engineering for Project Definition Reports
- Industry and peer reviews
- Value engineering and constructability reviews

Preliminary engineering estimates have reached a higher level of detail as part of environmental review. Estimates at Completion were prepared for the CP 1, CP 2-3. CP 4 and SR99 contracts and utility relocation contracts. Initial capital investments in San Francisco to San Jose and Poplar Avenue to Bakersfield section necessary to support Silicon Valley to Central Line operations have been estimated at $1.9 billion in YOE dollars.

Other general assumptions include:

- Estimate assumes 2017 right of way costs.
- Estimates are based on quantities for track and track structures, stations, maintenance facilities, utilities, roadway grade separations, and railway systems (traction power, overhead catenary, communications and train control).
- Includes allowances for professional services based on estimated construction costs in each segment.
- Estimate includes CP 1, CP 2-3 and CP 4 current contract amounts and approved change orders through December 2017.
- Allocated contingencies in the range of 10-50 percent of the construction costs as noted in Table 6 Appendix C.
- Unallocated contingency is 5 percent of the construction cost, except where adjusted to reflect approved project contingencies for CP 1, CP 2-3 and CP 4.

Exclusions:

- Costs associated with Authority administration
- Finance charges

San Francisco to San Jose (~44 miles)

Table 11 San Francisco to San Jose Cost Breakdown

Standard Cost Category	2016 BP Cost (2017$, millions)	2018 BP Cost (2017$, millions)
10 TRACK STRUCTURES & TRACK	$ 125	$ 85
20 STATIONS, TERMINALS, INTERMODAL	$1,053	$ 595
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	—	$ 313
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$ 874	$ 464
50 COMMUNICATIONS & SIGNALING	$ 171	$ 65
60 ELECTRIC TRACTION	$ 613	$ 713
80 PROFESSIONAL SERVICES	$ 367	$ 101
90 UNALLOCATED CONTINGENCY	$ 78	$ 44
TOTAL: *	$3,281	$2,380

* Figures may not sum due to rounding

Assumes completion of Transbay Terminal and DTX Project, and includes allowance for temporary station upgrades at the Caltrain 4th and King station in support of Silicon Valley to Central Valley Line operation. Contributions to the early projects in the bookends include $600 million in Proposition 1A funds and $114 million in Cap-and-Trade funds in the north. There is also a $550 million contribution towards DTX project in San Francisco. Shared use of tracks with Caltrain commuter service including the following improvements:

- Curve straightening
- 40 grade crossing alterations (e.g., quad-gates or other improvements)
- San Mateo grade separation
- 4th and King temporary station at-grade
- Millbrae station at-grade
- Light Maintenance Facility at Brisbane

San Jose to Gilroy (~42 miles)

Table 12 San Jose to Gilroy Cost by SCC

Standard Cost Category	2016 BP Cost (2017$, millions)	2018 BP Cost (2017$, millions)
10 TRACK STRUCTURES & TRACK	$2,264	$ 981
20 STATIONS, TERMINALS, INTERMODAL	$ 97	$ 242
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	$ 32	$ 12
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$1,273	$ 808
50 COMMUNICATIONS & SIGNALING	$58	$ 136
60 ELECTRIC TRACTION	$ 122	$ 232
80 PROFESSIONAL SERVICES	$ 550	$ 298
90 UNALLOCATED CONTINGENCY	$ 185	$ 113
TOTAL: *	$4,579	$2,820

* Figures may not sum due to rounding

Assumes at-grade approach and station at Diridon. Shared use of tracks with Caltrain commuter service through Tamien. Baseline capital cost estimate assumed use of UPRR right of way from Tamien through Gilroy Station to US Highway 101 crossings where the alignment would leave UPRR right of way to connect with the Alternative 2 depicted in preliminary engineering documents proceeding towards Pacheco Pass. The costs included in this section cover high-speed rail route form San Jose Station to 8 miles south of Gilroy Station and includes the following scope elements:

- 2 high-speed rail tracks and 1 freight track corridor from San Jose through Gilroy (US 101 crossing)
- 3.3 miles of viaduct and bridge structures (including 12 bridge replacements in Caltrain and UPRR right of way to accommodate high-speed rail and UPRR tracks)
- 32 grade crossings alterations (e.g., quad-gates or other improvements)
- Upgrades to two existing grade separations
- San Jose Diridon station at-grade
- Gilroy station at-grade
- Upgrades to Caltrain stations

Gilroy to Carlucci Road (~46 miles)

Table 13 Gilroy to Carlucci Road Cost by SCC

Standard Cost Category	2016 BP Cost (2017$, millions)	2018 BP Cost (2017$, millions)
10 TRACK STRUCTURES & TRACK	$3,165	$6,345
20 STATIONS, TERMINALS, INTERMODAL	$ 12	—
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	$ 20	$ 8
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$1,041	$ 767
50 COMMUNICATIONS & SIGNALING	$89	$ 157
60 ELECTRIC TRACTION	$ 283	$ 301
80 PROFESSIONAL SERVICES	$ 846	$1,059
90 UNALLOCATED CONTINGENCY	$ 282	$ 348
TOTAL: *	$5,738	$8,984

* Figures may not sum due to rounding

Assumptions:

Consistent with Alternative 2 and reflecting San Luis Reservoir avoidance high-speed rail route extends through Pacheco Pass towards Central Valley Wye terminating at Carlucci Road with the following major scope elements:

- 13.4 miles of viaduct and bridge structures
- 15.2 miles of tunnels
- 7 grade separations

Carlucci Road to Madera Acres (Wye Leg 2) (~35 miles)

Table 14 Carlucci Road to Madera Acres (Wye Leg 2) Cost by SCC

Standard Cost Category	2016 BP Cost (2017$, millions)	2018 BP Cost (2017$, millions)
10 TRACK STRUCTURES & TRACK	$ 356	$578
20 STATIONS, TERMINALS, INTERMODAL	—	$ 138
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	$ 20	—
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$ 213	$ 789
50 COMMUNICATIONS & SIGNALING	$62	$ 93
60 ELECTRIC TRACTION	$ 147	$ 174
80 PROFESSIONAL SERVICES	$ 160	$ 240
90 UNALLOCATED CONTINGENCY	$ 47	$ 83
TOTAL: *	$1,005	$2,097

* Figures may not sum due to rounding

Assumptions:

Based on SR 152 to Road 11 Wye Alternative reflected in the preliminary engineering documents and includes the Leg 2 of the Central Valley Wye from Carlucci Road to Avenue 19 at Madera Acres (northern terminus of CP 1 design-build contract) with the following major features:

- 1.6 miles of viaduct and bridge structures
- 15 grade separations
- Includes roadway improvements under SCC 20

Merced Station to Wye Legs 1 (~9 miles)

Table 15 Merced Station Wye Legs 1 Cost by SCC

Standard Cost Category	2016 BP Cost (2017$, millions)	2018 BP Cost (2017$, millions)
10 TRACK STRUCTURES & TRACK	$ 331	$ 346
20 STATIONS, TERMINALS, INTERMODAL	$ 88	$ 63
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	—	—
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$ 515	$ 157
50 COMMUNICATIONS & SIGNALING	$ 24	$ 24
60 ELECTRIC TRACTION	$ 15	$ 45
80 PROFESSIONAL SERVICES	$ 67	$ 31
90 UNALLOCATED CONTINGENCY	$ 40	$ 32
TOTAL: *	$1,080	$797

* Figures may not sum due to rounding

Assumptions:

Based on the amended Hybrid Alternative reflected in preliminary engineering documents from Merced Station to Ranch Road including the following major scope elements:

- 0.6 miles of viaduct and bridge structures
- High-speed rail station in Merced
- 1 grade separation

Wye Legs 1 (~15 miles)

Table 16 Wye Legs 1 Cost by SCC

Standard Cost Category	2016 BP Cost (2017$, millions)	2018 BP Cost (2017$, millions)
10 TRACK STRUCTURES & TRACK	$ 638	$ 615
20 STATIONS, TERMINALS, INTERMODAL	$ 47	$ 32
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	—	—
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$ 208	$ 246
50 COMMUNICATIONS & SIGNALING	$ 40	$ 39
60 ELECTRIC TRACTION	$ 124	$ 103
80 PROFESSIONAL SERVICES	$ 133	$ 142
90 UNALLOCATED CONTINGENCY	$ 47	$ 49
TOTAL: *	$1,238	$1,225

* Figures may not sum due to rounding

Assumptions:

Based on SR 152 to Road 11 Wye Alternative reflected in the preliminary engineering documents and includes the Legs 1 of the Central Valley Wye scope from Ranch Road to the Leg 2 of the Wye with the following major features:

- 5.2 miles of viaduct and bridge structures
- 1 grade separation

Madera Acres to Poplar Avenue (~119 miles)

Table 17 Madera Acres to Poplar Avenue Cost by SCC

Standard Cost Category	2016 BP Cost (2017$, millions)	2018 BP Cost (2017$, millions)
10 TRACK STRUCTURES & TRACK	$ 1,553	$ 2,483
20 STATIONS, TERMINALS, INTERMODAL	$ 182	$ 153
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	—	—
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$2,623	$ 4,765
50 COMMUNICATIONS & SIGNALING	$ 280	$ 344
60 ELECTRIC TRACTION	$ 598	$ 693
80 PROFESSIONAL SERVICES	$1,514	$ 970
90 UNALLOCATED CONTINGENCY	$ 478	$ 575
TOTAL: *	$7,229	$9,982

* Figures may not sum due to rounding

Assumptions:

Reflects the scope of CP 1, CP 2-3, CP 4 and SR99 projects in Central Valley between Madera Acres and Poplar Avenue as well as the balance of high-speed rail scope within these limits including track, systems and electrification. Passenger stations include high-speed rail station at Fresno and Kings/Tulare, and a temporary station in Madera. Heavy Maintenance Facility (HMF) is also accounted for (however not yet located) within this section.

Poplar Avenue to Bakersfield (~22 miles)

Table 18 Poplar Avenue to Bakersfield Cost by SCC

Standard Cost Category	2016 BP Cost (2017$, millions)	2018 BP Cost (2017$, millions)
10 TRACK STRUCTURES & TRACK	$ 644	$ 1,144
20 STATIONS, TERMINALS, INTERMODAL	$ 89	$ 196
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	$ 2	$ 28
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$ 941	$ 829
50 COMMUNICATIONS & SIGNALING	$ 38	$ 67
60 ELECTRIC TRACTION	$ 90	$ 88
80 PROFESSIONAL SERVICES	$ 227	$ 341
90 UNALLOCATED CONTINGENCY	$ 93	$ 112
TOTAL: *	$2,125	$2,805

* Figures may not sum due to rounding

Assumptions:

Based on Locally Generated Alternative (LGA) extending high-speed rail route from Poplar Avenue to Oswell Street in Bakersfield with the following major features:

- 10.8 miles of viaduct and bridge structures
- High-speed rail station in Bakersfield
- 5 grade separations

Bakersfield to Palmdale (~74 miles)

Table 19 Bakersfield to Palmdale Cost by SCC

Standard Cost Category	2016 BP Cost (2017$, millions)	2018 BP Cost (2017$, millions)
10 TRACK STRUCTURES & TRACK	$ 6,122	$ 6,887
20 STATIONS, TERMINALS, INTERMODAL	—	$ 229
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	$ 15	$ 260
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$ 1,855	$ 2,297
50 COMMUNICATIONS & SIGNALING	$ 180	$ 206
60 ELECTRIC TRACTION	$ 592	$ 524
80 PROFESSIONAL SERVICES	$ 1,038	$ 1,409
90 UNALLOCATED CONTINGENCY	$ 397	$ 478
TOTAL: *	$10,198	$12,290

* Figures may not sum due to rounding

Assumptions:

The baseline assumed Alternative 2 for cost estimating, and reflects the following major scope features as shown in preliminary engineering documents:

- 11.4 miles of viaduct and bridge structures
- 8.9 miles of tunnels
- 28 grade separations
- Light Maintenance/Maintenance of Infrastructure facility at Palmdale
- Includes roadway improvements under SCC 20

Palmdale to Burbank (~41 miles)

Table 20 Palmdale to Burbank Cost by SCC

Standard Cost Category	2016 BP Cost (2017$, millions)	2018 BP Cost (2017$, millions)
10 TRACK STRUCTURES & TRACK	$ 7,932	$ 9,647
20 STATIONS, TERMINALS, INTERMODAL	$ 327	$ 169
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	$ 20	$ 23
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$ 1,683	$ 2,174
50 COMMUNICATIONS & SIGNALING	$ 223	$ 256
60 ELECTRIC TRACTION	$ 471	$ 539
80 PROFESSIONAL SERVICES	$ 1,305	$ 1,485
90 UNALLOCATED CONTINGENCY	$ 466	$ 574
TOTAL: *	$12,428	$14,868

* Figures may not sum due to rounding

Assumptions:

The baseline reflects Alternative E1 as was defined in the Palmdale to Burbank Supplemental Alternative Analysis (SAA) adopted in June 2015. The major scope elements in this section include the following:

- 4.2 miles of viaduct and bridge structures
- 20.6 miles of tunnels
- 10 grade separations
- High-speed rail station in Palmdale
- High-speed rail station in Burbank

Since the adoption of the SAA in 2015, this section has been advanced to a draft design level. However, given the complexities associated with the major tunneling scope in this section which is still in early stages of the design development, the baseline capital cost estimate is based on the SAA Alternative E1a updated to reflect a projected 16 percent cost increase trend.

Burbank to Los Angeles Union Station (~12 miles)

Table 21 Burbank to Los Angeles Union Station Cost by SCC

Standard Cost Category	2016 BP Cost (2017$, millions)	2018 BP Cost (2017$, millions)
10 TRACK STRUCTURES & TRACK	$ 561	$ 172
20 STATIONS, TERMINALS, INTERMODAL	$ 538	$ 105
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	—	$ 38
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$ 226	$ 709
50 COMMUNICATIONS & SIGNALING	$ 44	$ 41
60 ELECTRIC TRACTION	$ 89	$ 50
80 PROFESSIONAL SERVICES	$ 179	$ 89
90 UNALLOCATED CONTINGENCY	$ 31	$ 49
TOTAL: *	$1,667	$1,252

* Figures may not sum due to rounding

Assumptions:

Based on the preliminary engineering documents (Alternative B) reflecting shared use of tracks with Metrolink commuter service, but assuming Burbank station to be at-grade. Also, assumes no impact to Metrolink Central Maintenance Facility (CMF). The major scope elements in this section include the following:

- Existing track relocations
- 1.1 miles on bridge structures
- 4 grade separations
- Modifications to Metrolink stations at Burbank and Glendale

Los Angeles to Anaheim (~31 miles)

Table 22 Los Angeles to Anaheim Cost by SCC

Standard Cost Category	2016 BP Cost (2017$, millions)	2018 BP Cost (2017$, millions)
10 TRACK STRUCTURES & TRACK	$ 963	$ 381
20 STATIONS, TERMINALS, INTERMODAL	$ 58	$ 45
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	$ 5	—
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	$ 729	$2,020
50 COMMUNICATIONS & SIGNALING	$ 137	$ 65
60 ELECTRIC TRACTION	$ 197	$ 233
80 PROFESSIONAL SERVICES	$ 257	$ 197
90 UNALLOCATED CONTINGENCY	$ 91	$ 100
TOTAL: *	$2,437	$3,040

* Figures may not sum due to rounding

Assumptions:

Based on the preliminary engineering documents (Alternative 2R) reflecting shared use of tracks with Metrolink commuter service, and includes the$500 million bookend contribution (under SCC 40) in Southern California. It was assumed that there will be no high-speed rail station at Norwalk eliminating aerial approach and tunnel under existing BNSF/Metrolink tracks. The major scope elements in this section include the following:

- Add 1 new track to the corridor (up to Fullerton)
- 1.5 miles of viaduct and bridge structures
- 4 grade separations
- High-speed rail station in Fullerton
- High-speed rail platform upgrades at ARTIC

Heavy Maintenance Facility and Vehicles

Table 23 Heavy Maintenance Facility and Vehicles Cost by SCC

Standard Cost Category	2016 BP Cost (2017$, millions)	2018 BP Cost (2017$, millions)
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	$1,300	$ 458
70 VEHICLES	$3,557	$4,493
TOTAL: *	$4,857	$4,951

* Figures may not sum due to rounding

Assumptions:

Assumes a combined contract packaging of the HMF/Rolling Stock. Includes HMF located within the Central Valley Segment with accommodation for initial 16 trainsets. Estimate includes 16 trainsets for the Silicon Valley to Central Valley Line initial operating system and 56 additional train sets for Phase 1 system (total of 72 trainsets). Assumes a phased implementation of the HMF to accommodate an initial 16 trainsets. Future expansion, and costs, to be determined by trainset manufacturer.

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Appendix A SCC CODING STRUCTURE

Table 24 SCC Coding Structure

10 TRACK STRUCTURES & TRACK	
10.01	Track structure: Viaduct
10.02	Track structure: Major/Movable bridge
10.03	Track structure: Under grade Bridges
10.04	Track structure: Culverts and drainage structures
10.05	Track structure: Cut and Fill (> 4' height/depth)
10.06	Track structure: At-grade (grading and subgrade stabilization)
10.07	Track structure: Tunnel
10.08	Track structure: Retaining walls and systems
10.09	Track new construction: Conventional ballasted
10.10	Track new construction: Non-ballasted
10.11	Track rehabilitation: Ballast and surfacing
10.12	Track rehabilitation: Ditching and drainage
10.13	Track rehabilitation: Component replacement (rail, ties, etc.)
10.14	Track: Special track work (switches, turnouts, insulated joints)
10.15	Track: Major interlocking
10.16	Track: Switch heaters (with power and control)
10.17	Track: Vibration and noise dampening
10.178	Other linear structures including fencing, sound walls
20 STATIONS, TERMINALS, INTERMODAL	
20.01	Station buildings: Intercity passenger rail only
20.02	Station buildings: Joint use (commuter rail, intercity bus)
20.03	Platforms
20.04	Elevators, escalators
20.05	Joint commercial development
20.06	Pedestrian / bike access and accommodation, landscaping, parking lots
20.07	Automobile, bus, van access ways including roads
20.08	Fare collection systems and equipment
20.09	Station security
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	
30.01	Administration building: Office, sales, storage, revenue counting
30.02	Light maintenance facility
30.03	Heavy maintenance facility

30.04	Storage or maintenance-of-way building/bases
30.05	Yard and yard track
40 SITEWORK, RIGHT OF WAY, LAND, EXISTING IMPROVEMENTS	
40.01	Demolition, clearing, site preparation
40.02	Site utilities, utility relocation
40.03	Hazardous material, contaminated soil removal/mitigation, ground water treatments
40.04	Environmental mitigation: wetlands, historic/archeology, parks
40.05	Site structures including retaining walls, sound walls
40.06	Temporary facilities and other indirect costs during construction
40.07	Purchase or lease of real estate
40.08	Highway/pedestrian overpass/grade separations
40.09	Relocation of existing households and businesses
50 COMMUNICATIONS & SIGNALING	
50.01	Wayside signaling equipment
50.02	Signal power access and distribution
50.03	On-board signaling equipment
50.04	Traffic control and dispatching systems
50.05	Communications
50.06	Grade crossing protection
50.07	Hazard detectors: dragging equipment high water, slide, etc.
50.08	Station train approach warning system
60 ELECTRIC TRACTION	
60.01	Traction power transmission: High voltage
60.02	Traction power supply: Substations
60.03	Traction power distribution: Catenary and third rail
60.04	Traction power control
70 VEHICLES	
70.00	Vehicle acquisition: Electric locomotive
70.01	Vehicle acquisition: Non-electric locomotive
70.02	Vehicle acquisition: Electric multiple unit
70.03	Vehicle acquisition: Diesel multiple unit
70.04	Vehicle acquisition: Loco-hauled passenger cars w/ ticketed space
70.05	Vehicle acquisition: Loco-hauled passenger cars w/o ticketed space
70.06	Vehicle acquisition: Maintenance of way vehicles
70.07	Vehicle acquisition: Non-railroad support vehicles
70.08	Vehicle refurbishment: Electric locomotive

70.09	Vehicle refurbishment: Non-electric locomotive
70.10	Vehicle refurbishment: Electric multiple unit
70.11	Vehicle refurbishment: Diesel multiple unit
70.12	Vehicle refurbished: Passenger loco-hauled car w/ ticketed space
70.13	Vehicle refurbished: Non-passenger loco-hauled car w/o ticketed space
70.14	Vehicle refurbishment: Maintenance of way vehicles
70.15	Spare parts
80 PROFESSIONAL SERVICES (applies to Cats. 10 60)	
80.01	Service Development Plan/Service Environmental
80.02	Preliminary Engineering/Project Environmental
80.03	Final design
80.04	Project management for design and construction
80.05	Construction administration & management
80.06	Professional liability and other non-construction insurance
80.07	Legal; Permits; Review Fees by other agencies, cities, etc.
80.08	Surveys, testing, investigation
80.09	Engineering inspection
80.10	Start up
90 UNALLOCATED CONTINGENCY	
100 FINANCE CHARGES	

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Appendix B TECHNICAL BASELINE DOCUMENTS

Table 25 List of Technical Baseline Documents

Geographic Segment	Alternative	Baseline Document
San Francisco to San Jose	Conceptual design reflected in 2016 BP estimate	2016 Business Plan - Capital Cost Basis of Estimate Report
San Jose to Gilroy	Alternative 2, UPRR Corridor Concept	Gilroy to San Jose UPRR Corridor Conceptual Track Chart; Preliminary Engineering for Project Definition, Draft - May 2017
Gilroy to Carlucci Rd.	Single alternative south of Gilroy and east of SR152	Preliminary Engineering for Project Definition, Draft - May 2017
Merced to Wye Legs 1	Hybrid Alignment	15% Design Submittal, Record Set, July 2011 (footprint as amended by Ranch Rd. to Merced re-examination)
Wye Legs 1	SR 152 to Road 11 Wye Alternative	15% Design Submittal, Record Set, August 2016
Carlucci Rd. to Madera (Wye Leg 2)	SR 152 to Road 11 Wye Alternative	15% Design Submittal, Record Set, August 2016
Madera to Poplar Rd.	CP1, CP2-3, CP4 Estimates at Completion	CP1, CP2-3, CP4 Estimates at Completion
Poplar Rd. to Bakersfield	Locally Generated Alternative	Record Set PEPD Submission, November 2016
Bakersfield to Palmdale	Alternative 2	Supplemental Alternative Analysis Submission, September 2016
Palmdale to Burbank	Alternative E1	Supplemental Alternative Analysis, June 2015
Burbank to Los Angeles	Alternative B	Draft Design Submittal, June 2016 (SR-134 to LAUS) Draft Design Submittal, Feb 6, 2017 (Burbank Station to SR-134)
Los Angeles to Anaheim	Alternative 2R	Draft Design Submittal, January 2017 Design Updates (8/3/17)
Heavy Maintenance Facility	Conceptual design reflected in 2016 BP estimate	2016 Business Plan - Capital Cost Basis of Estimate Report

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Appendix C APPLIED CONTINGENCIES (OUTSIDE OF CENTRAL VALLEY PROJECTS)

Table 26 Applied Contingencies

Categories for Detailed Capital Cost Budget		Applied Contingency
10 Track Structures and Track		
10.01	Track structure: Viaduct	20.0%
10.02	Track structure: Major/Movable bridge	20.0%
10.03	Track structure: Undergrade Bridges	—
10.04	Track structure: Culverts and drainage structures	19.0%
10.05	Track structure: Cut and Fill (> 4' height/depth)	25.0%
10.06	Track structure: At-grade (grading and subgrade stabilization)	19.0%
10.07	Track structure: Tunnel	31.0%
10.08	Track structure: Retaining walls and systems	20.0%
10.09	Track new construction: Conventional ballasted	11.0%
10.10	Track new construction: Non-ballasted	11.0%
10.11	Track rehabilitation: Ballast and surfacing	11.0%
10.12	Track rehabilitation: Ditching and drainage	—
10.13	Track rehabilitation: Component replacement (rail, ties, etc.)	—
10.14	Track: Special track work (switches, turnouts, insulated joints)	11.0%
10.15	Track: Major interlockings	—
10.16	Track: Switch heaters (with power and control)	—
10.17	Track: Vibration and noise dampening	—
10.18	Other linear structures including fencing, sound walls	15.0%
20 Stations, Terminals, Intermodal		
20.01	Station buildings: Intercity passenger rail only	0.0%
20.02	Station buildings: Joint use (commuter rail, intercity bus)	21.0%
20.03	Platforms	—
20.04	Elevators, escalators	—
20.05	Joint commercial development	—
20.06	Pedestrian / bike access and accommodation, landscaping, parking lots	21.0%
20.07	Automobile, bus, van accessways including roads	21.0%
20.08	Fare collection systems and equipment	—
20.09	Station security	—
30 Support Facilities: Yards, Shops, Admin. Bldgs		
30.01	Administration building: Office, sales, storage, revenue counting	—

Categories for Detailed Capital Cost Budget		Applied Contingency
30.02	Light maintenance facility	21.0%
30.03	Heavy maintenance facility	21.0%
30.04	Storage or maintenance-of-way building/bases	21.0%
30.05	Yard and yard track	20.0%
40 Sitework, Right of Way, Land, Existing Improvements		
40.01	Demolition, clearing, site preparation	21.0%
40.02	Site utilities, utility relocation	29.0%
40.03	Hazardous material, contaminated soil removal/mitigation	45.0%
40.04	Environmental mitigation: wetlands, historic/archeology, parks	48.0%
40.05	Site structures including retaining walls, sound walls	21.0%
40.06	Temporary facilities and other indirect costs during construction	19.0%
40.07	Purchase or lease of real estate	26.0%
40.08	Highway/pedestrian overpass/grade separations	25.0%
40.09	Relocation of existing households and businesses	—
50 Communications & Signaling		
50.01	Wayside signaling equipment	11.0%
50.02	Signal power access and distribution	11.0%
50.03	On-board signaling equipment	11.0%
50.04	Traffic control and dispatching systems	11.0%
50.05	Communications	11.0%
50.06	Grade crossing protection	11.0%
50.07	Hazard detectors: dragging equipment high water, slide, etc.	11.0%
50.08	Station train approach warning system	11.0%
60 Electric Traction		
60.01	Traction power transmission: High voltage	11.0%
60.02	Traction power supply: Substations	11.0%
60.03	Traction power distribution: Catenary and third rail	11.0%
60.04	Traction power control	11.0%
70 Vehicles		
70.02	Vehicle acquisition: Electric Multiple Unit	20.0%
80 Professional Services (applies to Cats. 10-60)		
80.01	Service Development Plan/Service Environmental	13.0%
80.02	Preliminary Engineering/Project Environmental	13.0%
80.03	Final design	13.0%
80.04	Project management for design and construction	13.0%

Categories for Detailed Capital Cost Budget		Applied Contingency
80.05	Construction administration & management	13.0%
80.06	Professional liability and other non-construction insurance	13.0%
80.07	Legal; Permits; Review Fees by other agencies, cities, etc.	13.0%
80.08	Surveys, testing, investigation	13.0%
80.09	Engineering inspection	13.0%
80.10	Start up	13.0%

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