



Business Plan

CAPITAL COST BASIS OF ESTIMATE REPORT



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ACRONYMS AND ABBREVIATION

AACE	Association of the Advancement of Cost Engineers
BNSF	Burlington Northern Santa Fe Railroad
CCNM	César Chávez National Monument
EAC	Estimate at Completion
EIR	Environmental Impact Report
DTX	Downtown Rail Extension
FRA	Federal Railroad Administration
HMF	Heavy Maintenance Facility
LGA	Locally Generated Alternative
LMF	Light Maintenance Facility
MOWF	Maintenance of Way Facility
MOWS	Maintenance of Way Siding
OCS	Overhead Catenary System
PEPD	Preliminary Engineering for Project Definition
ROW	Right of Way
SCC	Standard Cost Category
UPRR	Union Pacific Railroad
V2V	Silicon Valley to Central Valley Line
YOES	Year of Expenditure Dollars

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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.

The Authority has defined a building block implementation plan to bring the Phase 1 and Phase 2 to reality and satisfy the Authority's mission as defined by Proposition 1A, the Safe, Reliable High-Speed Passenger Train Bond Act for the 21st Century, as described in the *Revised Draft 2020 Business Plan*.

A Performance Management Baseline (PMB) is set for the Program, which establishes a snapshot in time that captures scope, schedule, budget and risk against which Program performance is measured. The current PMB (Baseline Revision 1) was established after the *2019 Project Update Report* with a Board-approved Program budget of \$15.636 billion. An updated PMB (Baseline 2021) is expected to be established after the Board adopts the final *2020 Business Plan* and submits it to the Legislature, which is scheduled on or before April 15, 2021.

The differentiation between the scope that is contained in the PMB and the remaining scope in the implementation plan is important because the estimating methodology is different depending on the category that contains the scope being estimated. For scope contained within the PMB, projects have advanced in design and/or construction, thereby reducing estimating uncertainty. For projects in progress (e.g., under construction or environmental documents), the estimating methodology is based on determining an Estimate at Completion (EAC). Projects not yet in progress, however still contained within the PMB, have advanced in design maturity enough to justify a quantities-based methodology, which leads to narrower ranges commensurate with an Association for the Advancement of Cost Engineering (AACE) Class 3 estimate. A description of AACE Classes is shown in Chapter 3 of this report (Approach and Methodology).

For scope outside the PMB, the estimating methodology is based on that which was established under the *2018 Business Plan Capital Cost Basis of Estimate Report*, where the Authority initiated the new approach of expressing capital cost estimates as ranges. These cost ranges were based on the comprehensive update to the capital cost estimate for the *2018 Business Plan*, which was primarily parametric in nature. The ranges are consistent with (AACE) Class 4 estimates, which reflect risks, opportunities and design uncertainty associated with the stage of project development and complexity to be managed moving forward. The ranges are shown in a Low, Base and High estimate.

Prior to the *2018 Business Plan*, the Authority's practice was to update program estimates based on updated design quantities and risk profiles, and without considering maximum potential savings due to design optimizations or potential advantages brought by design-build contractors competitive construction means and methods. These estimates were based on the Authority's best assessment to complete the program, incorporating direct costs, professional services, contingency and escalation, and assuming a fully funded implementation schedule.

Capital costs of high-speed rail projects 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 cost estimates become more certain and risk factors become more defined, supporting contingency management and schedule confidence.

Capital cost estimates for public transportation projects whose construction spans multiple years are shown in (1) current year dollars, where inflation is not a factor, and (2) year of expenditure (YOE) dollars. Year of expenditure dollars illustrate the effect of projected inflation on cost estimates over the duration of a project delivery schedule. The delivery schedule is used as a basis to inflate capital costs from current year dollars to year of expenditure dollars.

For developing the year of expenditure estimates, the Authority assumes the project is financially unconstrained and that after the environmental Record of Decision, the project is ready to advance into early works, final design, and then construction. The cost estimates are loaded into the project delivery schedule and then escalated based on projected future inflation factors. This is the approach that has been used consistently in developing year of expenditure estimates.

It is important to note that a financially unconstrained schedule is not realistic given that the Authority does not have full funding to complete the program. Absent any other basis for projecting when and over what timeframe additional funding may become available, this is the most reasonable option for calculating year of expenditure estimates. An implementation timetable for delivering the Silicon Valley to Central Valley Line or the Phase 1 system can only be developed once the timing and amount of funding is known.

This *Revised Draft 2020 Business Plan Capital Cost Basis of Estimate Report* incorporates the cost ranges presented in the *2018 Business Plan*, while reflecting the following changes (see Table 1):

1. Includes Board-approved transition from 119-mile Central Valley Segment (\$12.3B) to the budget for Federal/State Regional Commitments per the 2019 Project Update Report (\$15.6B), which became the Revision 1 Baseline.
2. Merced and Bakersfield Extensions reflect the *2019 Project Update Report* and the *Draft 2020 Business Plan* (issued in February 2020) recommendation to include extensions to Merced and to Bakersfield for interim service.
3. The *Revised Draft 2020 Business Plan* proposes cost mitigations as well to address increased costs. In order to mitigate risk, the Authority is proposing to change the timing, approach to construction and phasing of the track installation by initially laying a single track. A second track is not necessary to achieve the operational benefits of the proposed Merced to Bakersfield interim service.
4. The Phase 1 cost estimates reflect other cost changes; specifically, regional bookend project costs and costs to complete environmental documents, which were previously carried in the project section costs, are now accounted for in the Program Baseline and have been removed from the section cost estimates as summarized in the Phase 1 Balance discussion in Chapter 4.2.4.

Table 1 Summary Cost Estimate Ranges by Phase - Revised Draft 2020 Business Plan

Project Phase	Low (YOE\$ Billions)	2020 Base (YOE\$ Billions)	High (YOE\$ Billions)
Revision 1 Baseline ¹	—	\$15.6	—
Proposed Enhanced Program Baseline 2021	—	\$18.3	—
Merced to Bakersfield IOS (single track)	\$21.3	\$21.3-22.8	\$22.8
Phase 1 ²	\$69.1	\$82.4-83.8	\$99.9

Delivering the high-speed rail program involves the implementation of a series of highly complex, integrated mega-projects. As the program moves forward, there are, and will continue to be, uncertainties around cost, schedule and funding. Apart from the 119-mile Central Valley Segment under final design and construction, the current cost estimates are based on the preliminary engineering designs in support of the environmental

¹ Includes Central Valley Segment, all Phase 1 Environmental Documents & Bookend Projects

² Phase 1 - YOES based on completion date of 2033.

reviews. These estimates assume optimal procurement strategy, a fully funded schedule and cost-effective construction packaging.

The capital cost estimates for each segment in support of the *Revised Draft 2020 Business Plan* are presented in ranges and YOE dollars in Section 4.2

2 CAPITAL COST SUMMARY

The tables below contain estimates for the following implementation plan building blocks:

- 1) Table 2: Baseline Revision 1 EAC (Phased Track Scenario)
 - a. Initiate 119-mile test track in the Central Valley (Madera to Poplar Avenue) and environmentally clear all Phase I system (San Francisco to Los Angeles/Anaheim)
 - b. Scope:
 - i. Central Valley Segment (single track)
 - ii. Phase I Environmental Records of Decision (RODs)
 - iii. Regional Bookend Projects

- 2) Table 3: Estimate - Proposed Program Baseline Additions
 - a. Complete 119-mile test track, FRA certification and initiate next segment design
 - b. Scope
 - i. Two Trainsets
 - ii. Trainset Certification Facility
 - iii. Driving Simulator
 - iv. Program Management Support
 - v. Preliminary design: Merced & Bakersfield Extensions
 - vi. Preliminary design: 4 Central Valley stations

- 3) Merced to Bakersfield Initial Operating Segment (IOS) Estimate
 - a. Complete the Merced to Bakersfield IOS
 - b. Scope
 - i. Merced Extension (single track)
 - ii. Bakersfield Extension (single track)
 - iii. Four Additional Trainsets

- 4) Phase 1 Balance
 - a. Northern California
 - b. Central Valley Balance
 - c. Southern California
 - d. Heavy Maintenance Facility) and Remaining Trainsets

Table 2: Baseline Revision 1 Estimate at Completion (EAC) (Phased Track Scenario)

Scope Element	Cost Change*	Additional Contingency*
Baseline Revision 1	15,636	-
CP 1	294	348
CP 2-3	44	418
CP 4	(24)	92
Right of Way for CP 1-4	156	82
Net other adjustments** (Program support, stations and other cost)	(276)	150
Total Cost/Contingency Changes**	193	1,090
	15,829	1,090
Estimate at Complete (EAC)		16,919

* Millions, YOES\$

**These figures differ from those shown in Table 5.1 in the Revised Draft 2020 Business Plan; this table includes the costs and contingency for environmental Records of Decision.

Table 3: Proposed Program Baseline Additions

Scope Element	Base*
2 Trainsets + Simulator	389
Program Management Support	787
Preliminary Design Merced and Bakersfield Extensions	119
Preliminary Design – 4 Stations	36
Total	1,331

* Millions, YOES\$

Table 4: Merced & Bakersfield Extensions to Achieve Initial Operating Segment/Interim Service

Scope Element	Low*	Base*	High*
Merced Extension (single track) **	1,885	2,252	2,744
Bakersfield Extension (single track) **	940	1,297	1,469
4 Additional Trainsets	246	291	301
Fresno & Kings/Tulare Stations		116	
Total	3,071	3,956	4,514

* Millions, YOES\$

** Includes Merced and Bakersfield stations

Because the level of design in each of the environmental sections outside of the Central Valley Segment are still at preliminary stages of project development, they carry different levels of design uncertainty and 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 during design or any schedule impacts that may result from those changes.

Table 5: Remaining Phase 1 Scope

Scope Element	Low*	Base*	High*
Rev1 EAC + Proposed Baseline Additions		18,250	
Merced and Bakersfield Extensions (single track)		3,071 – 4,514	
Northern California			
San Francisco to San Jose	1,307	1,649	2,123
San Jose to Gilroy	2,162	3,194	4,633
Gilroy to Carlucci Road	7,871	10,397	12,789
Central Valley Wye Balance	1,842	2,240	2,601
Preliminary Design - Northern California		213	
Central Valley			
Merced to Bakersfield (second track)	1,106	1,106	1,106
Southern California			
Bakersfield to Palmdale	12,601	15,684	18,901
Palmdale to Burbank	12,635	16,775	24,428
Burbank to Los Angeles	1,161	1,360	1,571
Los Angeles to Anaheim	2,478	2,918	3,352
Preliminary Design - Southern California		382	
Heavy Maintenance Facility & Remaining Trainsets			
Heavy Maintenance Facility Balance	433	481	529
Trainsets	4,161	4,643	5,084
Total: *	69,078	82,363 – 83,806	99,881

* Millions, YOES

The Authority continues to review and update our estimates as we advance design, complete environmental reviews, and make decisions (e.g., final alignments) while keeping track of the associated cost trends, which are discussed in more detail in Section 4.2 of this report. A comparison of *the Revised Draft 2020 Business Plan* capital cost estimates with the *2018 Business Plan* estimates for each geographic segment is also provided in Section 4.2, along with major scope assumptions, optimizations and current trends.

3 APPROACH AND METHODOLOGY

3.1 Overview

The *Revised Draft 2020 Business Plan* capital cost estimates for future work are predominately considered Class 4 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 (AACE). The exception is the Central Valley Track and Systems Estimate, which is considered a Class 3 estimate.

After RODs are complete for the Phase 1 segments, the Authority proposes to advance design in order to achieve Class 3 estimates, which 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 International³

Estimate Class	Maturity Level of Project Definition Deliverables (Expressed as % of complete definition)	End Usage (Typical Purpose of estimate)	Methodology (Typical estimating method)	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 takeoff	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with forced detailed takeoff	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 Silicon Valley to Central Valley Line 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 AACE International – Association of the Advancement of Cost Engineers (<https://web.aacei.org/>).

3.2 Estimate at Complete Methodology for Ongoing Projects

The Estimate at Complete (EAC) methodology for the major contracts in the construction packages involves taking the current contract value and subtracting the expenditures to date resulting in remaining work. The certain portion of Potential Change Orders and Trends are added to this remaining work balance to arrive at the contract EAC. This methodology assumes that the physical work complete is directly commensurate with the expenditures to date.

In addition to determining the contract EAC, allocated contingency is estimated by building a stochastic risk model based on the uncertain portion of potential change orders, trends and risks. Monte Carlo simulations are run against the stochastic model to arrive at recommended contingency values across a range of confidence levels. The Authority has chosen the P70 confidence level to estimate contingency budget levels.

EAC for smaller support contracts is based on an aggregate burn rate across the contracts for a given scope element within a project. This burn rate was extended to accommodate the period of performance of the project being supported. Contingency is calculated based factors such as schedule uncertainty, escalation uncertainty and other factors specific to the scope of work being estimated.

3.3 Estimating Approach & Methodology for Future Projects

3.3.1 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 *Revised Draft 2020 Business Plan* capital cost estimate is included in 6.

3.3.2 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 separations, etc., that are referred to as Unit Price Elements.

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; 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 contractors' home office overhead and margin. A 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 percent
- Home Office Overhead: 0.5 percent
- Margin: 3.0 percent
- Design Coordination: 2.5 percent

- **Total: 12.0 percent**

3.3.3 Allowances and 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.

3.3.3.1 Environmental Mitigation

Allowance for environmental mitigation is based on the estimating methodology presented in the *2018 Business Plan*.

3.3.3.2 Temporary Facilities

An allowance was used to account for the cost of temporary facilities, indirect costs and mobilizations, which are based on the *2018 Business Plan*.

3.3.3.3 Right of Way

Right of Way (ROW) requirements, including permanent acquisitions and temporary easements, are based on preliminary engineering design documents and available land valuations.

3.3.3.4 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 and 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
- Third-Party Agency Reviews and Permits: 0.5 percent
- Start-Up and Testing: 0.5 percent

3.3.4 Risk Assessment

Risk and uncertainty are a typical part of the estimating process because 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 applied on the estimated base costs are presented in 5, with an exception of the Central

Valley projects, where contingencies are based on remaining Board-approved project contingencies as well as trends and risks identified by the project team.

3.3.4.1 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 cost category. The exact percentage selected for each cost category is included in 7. 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, such as 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 third-party allowances for the segments issued for final design and construction.

3.3.5 Review and Optimization

Upon completion of the draft baseline estimate following the steps outlined above, a series of workshops were held assessing major scope changes, cost trends, and other influencing factors in each geographic section. It was recognized that although 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; and
- 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.

3.3.6 Year of Expenditure

The capital cost estimate 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. Estimated completion of this implementation phase for purposes of developing a YOE estimate is by 2031.
- Extension to Merced**— includes construction of civil infrastructure from the northern terminus of the Central Valley Segment in Madera to the Merced high-speed rail station at Martin Luther King Jr. Way, completing track, stations and systems elements to make it fully operable, as well as acquisition of additional four trainsets. 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 52 trainsets, and completion of the heavy maintenance facility are also included with Phase 1 implementation. 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 Proposition 1A funds in the south. There is also a \$550 million contribution towards Downtown Rail Extension (DTX) project in San Francisco. 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 2019 dollars to determine Fiscal Year expenditures. Fiscal Year expenditures are then escalated based on the following projected future inflation factors:

Fiscal Year	2019/2020 to 2024/2025	2025-2026	2026/2027 to 2033/2034
Inflation Factor	2.25%	2.625%	3.00%

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

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4 ASSUMPTIONS, EXCLUSIONS AND RECONCILIATION

4.1 Design Development Stages

All Phase I geographical segments have advanced to Preliminary Engineering design development stage, with many segments still undergoing refinement in support of environmental reviews (see Appendix B: Technical Baseline Documents). This cost estimate includes assumptions on those segments currently under review outside of the CP 1, CP 2-3 and CP 4 projects. Table 7 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 reviews are completed and preferred alternatives are approved as informed by these reviews, the capital cost estimates for these segments will continue to change.

Table 7 Design Development Stages

Project Segments	Design Development Stage
San Francisco to San José	Preliminary*
San José to Gilroy	Preliminary
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	Preliminary
Burbank to Los Angeles Union Station	Preliminary
Los Angeles Union Station to Anaheim	Preliminary
*Preliminary design is generally in support of EIR documents and assumes approximately 15% design completion	

The following sections are organized in the same structure as work is progressing through the Authority's implementation plan with three primary sections: Updated Program Baseline plus Program Enhancements, Merced to Bakersfield Extension and the remainder of Phase 1.

4.2 Estimate General Assumptions and Exclusions

4.2.1 General

The following summarizes the sources and general assumptions reflected in the *Revised Draft 2020 Business Plan* estimate. Since 2012, the estimate has been updated in several ways. For ongoing work, the *Revised Draft 2020 Business Plan* capital cost estimate recognizes modifications based upon approved change orders, pending change orders and contingency based on an updated risk profile. It also includes the increases associated with known cost escalation for the 119-mile Madera to Poplar Avenue segment identified in the *2019 Project Update Report* and as adopted in the 2019 Baseline Budget.

The summary provided for each of the following sections provides the basis on which the estimate is derived, and assumptions and elements known, as of 30 September 2020.

General Assumptions

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

- Program – Revision 1 Baseline
 - Project/Construction Management Team responsible for the Project
 - Contract Managers assigned to contracts
 - Track/Systems procurement documentation
- Program Baseline Enhancements & Merced/Bakersfield Extensions
 - Updated estimates derived from
 - Preliminary Engineering for Project Definition documents
 - Quotes received
- Phase 1 Balance
 - The *2018 Business Plan*;
 - Preliminary Engineering for Project Definition documents; and the
 - *2019 Project Update Report*.

Merced Extension Construction, Bakersfield Extension Construction and Phase 1 Balance estimates have remained mostly unchanged from the *2018 Business Plan* with the exception of scope that was moved from one area to another. Because this document is using basis from the *2018 Business Plan* for these segments, the estimate from the *2018 Business Plan* are shown for comparison purposes. Scope differences between the *2018 Business Plan* and *2020 Business Plan* are indicated in the assumptions and exclusions section for each applicable segment.

Other general assumptions include:

- 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;

- Allocated contingencies in the range of 10 to 50 percent of the construction costs as noted in reviews. 5; and
- 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 projects.

Exclusions:

- Costs associated with Authority administration; and
- Finance charges.

4.2.2 Updated Program Baseline plus Program Enhancements

4.2.2.1 Program – Revision 1 Baseline

The 2018 *Business Plan* provided an estimate for scope contained only within the Central Valley Segment. However, the *Revised Draft 2020 Business Plan* has transitioned to providing an estimate based on the Revision 1 Performance Management Baseline (PMB) as well as proposed additional scope that would form the 2021 Baseline. The Program – Revision 1 Baseline has the following objectives:

- Complete the 119-mile Central Valley construction segment and lay track
- Provide electrified highspeed rail system along the 119-mile Central Valley Segment
- Environmentally clear all segments in Phase I
- Complete the “bookend” projects
- Continue project development activities to enable construction of additional segments as funding becomes available

The Authority still tracks the Estimate at Complete (EAC) for the Central Valley Segment (Table 8), which is a subset of the overall PMB EAC.

Table 8 Central Valley Segment EAC

	2020 Business Plan (YOE\$, Millions)
TOTAL:	13,691⁴

As the Program objectives indicate, in addition to the Central Valley Segment scope, the Program – Revision 1 Baseline contains:

- Bookend Projects
- Environmental RODs
- Merced and Bakersfield Pre-Construction Activities
- Program Management to support the above activities
- Program Unallocated Contingency

The following table is the Program – Revision 1 Baseline Estimate at Complete (EAC)

Table 9 Baseline Revision 1 EAC

	Rev 1 Baseline Budget (YOE\$, Millions)	Rev 1 EAC (YOE\$, Millions)
TOTAL:	15,636	16,919

⁴ This estimate differs from the \$13.8 billion shown in the *Revised Draft 2020 Business Plan* because it includes project development and excludes program unallocated contingency.

Assumptions:

This EAC reflects the scope of CP 1, CP 2-3, CP 4 and SR-99 projects in the Central Valley between Madera Acres and Poplar Avenue, as well as the high-speed rail scope within these limits including track, systems and electrification and incorporates Board approved Revision 1 Baseline. The estimate assumes a single track along the entire segment with the exception of passing track at the station sites. Track switches will be installed in anticipation of the future second track. Electrification of the 119 miles will require PG&E to install two (2) high voltage substations (#9 & #10).

In the *2018 Business Plan*, budget was allocated to set up an initial Heavy Maintenance Facility (HMF). However, this amount was inadequate to satisfy the requirements for receiving trainset and executing the final assembly. A value engineering exercise was completed resulting in the recommendation that the HMF be replaced by a Trainset Certification Facility (TCF), which could satisfy these requirements for less budget. The TCF is assumed to be located within the Fresno Works Maintenance of Way Facility (MoWF). The HMF has been deferred until revenue service begins.

Exclusions:

Since stations are not required for the 119-mile test track, neither station design nor station construction is included in this EAC for the Fresno or Kings/Tulare Station.

Current cost trends in this section include potential increases due to additional ROW parcels being added by the Construction Package Design Builders as a result of progressing toward completion of final design.

4.2.2.2 Program Baseline Enhancements

Having an electrified track is not sufficient to obtain Federal Railroad Administration (FRA) certification. Some additions must be added to the Program Baseline to accomplish this objective. This includes the addition of trainsets, driving simulator and additional program management to support the program through the extended Program period of performance. In addition to obtaining FRA certification, design must be started on the next building block of the implementation plan such that there is no unnecessary delay in completing the Merced to Bakersfield Initial Operating Segment. This design includes the Merced Extension, the Bakersfield Extension and the four stations in the Merced to Bakersfield line.

4.2.2.2.1 Trainsets for Certification**Table 10 Trainsets for Certification**

	2020 Business Plan (YOE\$, Millions)
2 Trainsets	372
Driving Simulator	17

Assumptions:

See Section 4.2.4.3.1 for further information on the rolling stock phased approach and associated assumptions.

4.2.2.2 Program Management & Support

Table 11 Program Management & Support

	2020 Business Plan (YOE\$, Millions)
TOTAL:	747

Assumptions:

Program Management Support is a level of effort element that extends to the period of performance finish date of the work being supported. The program management support for the Revision 1 Baseline ended in 2022, which was not adequate to support the remaining systems work in the Baseline. This estimate extends program management support to the updated completion date of FRA certification for the 119-mile test track.

4.2.2.2.3 Advancing Design: Merced & Bakersfield Extensions plus 4 Stations

Table 12 Advancing Design: Merced & Bakersfield Extensions plus 4 Stations

	2020 Business Plan (YOE\$, Millions)
TOTAL:	155

Assumptions:

This estimate includes continuing Preliminary Design to ~30% such that the Authority can reduce uncertainty and risk when proceeding to Early Works (such as ROW procurement, third-party agreements and utility relocations)

This design work will commence on approval of the enhanced 2021 baseline for the following items:

- Merced Extension
- Bakersfield Extension
- 4 Stations: Merced, Fresno, Kings/Tulare & Bakersfield

4.2.3 Merced and Bakersfield Extensions

The objective of extending to Merced and Bakersfield is to start Initial Operating Service (IOS) between downtown Merced, Fresno and Bakersfield. This requires the following additional scope elements:

- Construction of 4 stations for passenger boarding
- 4 additional trainsets to meet IOS performance objectives
- 1 additional high voltage substation for the increased power demand
- Initial heavy maintenance facility to perform light maintenance

4.2.3.1 Merced Extension

The Merced Extension consists of the following sub-segments:

- Merced to WYE (Ranch Road)
- WYE Leg 1 (excluding the north-west leg)
- WYE Leg 2 (Road 13 where it connects with WYE Leg 1 to Avenue 19 at Madera Acres)

In the *2016 Business Plan*, the assumption was that after the Central Valley Segment (119 miles) was completed, the Authority would extend to San Jose (IOS-North), then extend to Merced. Due to this strategy, the Central Valley Wye (WYE) was split into 3 segments: WYE Leg 1, WYE Leg 2 and Merced to WYE Leg 1. The reason the WYE was split into these segments was that the segment extending to San Jose included WYE Leg 2 and the then-future extension to Merced included the other two WYE segments.

However, the *Revised Draft 2020 Business Plan* strategy changed by extending to Merced before continuing to San Jose and San Francisco. Because of this, the WYE is broken down into 2 segments in the *Revised Draft 2020 Business Plan*: Merced Extension and Central Valley WYE Balance. The following describes assumptions and exclusions for the Merced Extension. The Central Valley WYE Balance and comparison with the *2018 Business Plan* for the overall WYE is covered in Section 4.2.4.1.4.

Table 13 Merced Extension Cost Estimate

	2020 Business Plan (YOE\$, Millions)
TOTAL:	2,252

Assumptions:

The Merced to Madera estimate is based on the installation of a single track with the expectation that a second track would be installed in the future. In this scenario, track switches would be installed in the single track in anticipation of the future second track.

Merced to WYE (~9m)

Based on the amended Hybrid Alternative reflected in the preliminary engineering documents from Merced Station to Ranch Road. The high-speed rail station in Merced is expected to be located adjacent to State Route 99 and the Union Pacific Railroad line on Martin Luther King Jr. Way / Highway 59 and the State Route 99 interchange. The station is assumed to be at-grade. The major scope elements include the following:

- 0.6 miles of viaduct and bridge structures

- Merced station at-grade
- 1 grade separation

WYE Leg 1 (~11m)

Based on the SR 152 to Road 11 Wye Alternative reflected in the Preliminary Engineering for Project Definition documents including Leg 1 of the Central Valley Wye scope from Ranch Road to the Leg 2 of the WYE but excluding the north-west leg of Leg 1 WYE. The major scope elements include the following:

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

WYE Leg 2 (~14m)

Based on the SR 152 to Road 11 Wye Alternative reflected in the Preliminary Engineering for Project Definition documents. Includes a segment of the Leg 2 of the Central Valley Wye from Road 13 where it connects with WYE Leg 1 to Avenue 19 at Madera Acres (northern terminus of CP1). The major scope elements include the following:

- 0.6 miles of viaduct and bridge structures
- 7 grade separations
- 4 roadway modifications
- 10 roadway closures

Current cost trends in this section include potential increases due to the possible addition of another high voltage substation (#7) provided by PG&E in order to accommodate power requirements.

4.2.3.2 Bakersfield Extension

Table 14 Poplar Avenue to Bakersfield Cost Estimate

	2020 Business Plan (YOE\$, Millions)*
TOTAL: *	1,297
* Reflects Merced to Bakersfield capital cost updates presented in the 2019 Project Update Report.	

Assumptions:

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

- 6.3 miles of viaduct and bridge structures
- Bakersfield Station
- 5 grade separations

Costs from the Bakersfield F Street Station to Oswell Street have been shifted to Bakersfield to Palmdale as shown in Table 24.

The Bakersfield extension also assumes an additional high voltage substation (#12) to be installed by PG&E.

There are no additional notable cost trends in this section.

4.2.3.3 Trainsets for Initial Operating Section

Table 15 Trainsets for IOS Cost Estimate

	2020 Business Plan (YOE\$, Millions)
TOTAL:	291

Assumptions:

See Section 4.2.4.3.1 for further information on the rolling stock phased approach and associated assumptions.

4.2.3.4 Central Valley Stations

Table 16 Central Valley Station Cost Estimate

	2020 Business Plan (YOE\$, Millions)
TOTAL:	116

Assumptions:

This includes construction of the Fresno and Kings/Tulare stations. There is the potential for a Madera 'stop'; however, this will be funded by other agencies outside of the Authority.

In the *2019 Revision 1 Baseline Report*, the station strategy was a time-phased implementation scaled to increasing ridership demand. Minimal station infrastructure at the outset to mitigate costs; phased improvements made to stations over time.

Station scope in Revision 1 Baseline included station platforms and canopies and very minimal land-side infrastructure (i.e. no buildings). Since this budget is being deferred to the Merced & Bakersfield extensions, the same scope assumptions apply.

Current cost trends in this section include potential increases in cost due to incorporation of land-side facilities that meet initial ridership needs and local community agreements.

Exclusions:

This estimate assumes the following has been completed:

- Footprint environmental clearance
- Preliminary design
- Procurement of footprint Right of Way

4.2.3.5 Merced to Bakersfield – Future Second Track

Table 17 Future Second Track Cost Estimate

	2020 Business Plan (YOE\$, Millions)
TOTAL:	1,106

Assumptions:

Installation of second track from Merced to Bakersfield is required in order to begin Valley to Valley revenue service. This estimate assumes the following elements will be installed to complete the second rail:

- Ballast for second rail
- Second rail
- Second rail electrification

The current estimate assumes that the second rail is installed prior to any revenue service and unit rates for labor and materials remain the same.

Current cost trends in this section include potential increases in cost due to second track installation during revenue service.

4.2.4 Phase 1 Balance

4.2.4.1 Northern California

4.2.4.1.1 San Francisco to San José (~43 miles)

Table 18 San Francisco to San José Cost Estimate

San Francisco to San Jose	2018 Business Plan (YOE\$, Millions)	2020 Business Plan (YOE\$, Millions)
TOTAL:	2,074	1,649

Assumptions:

Alternative A assumes completion of the Salesforce Transit Center and the DTX Project and includes high-speed rail station upgrades at the Caltrain 4th and King station in support of Silicon Valley to Central Valley operation, and a high-speed rail station at Millbrae. The costs included in this section cover the high-speed rail route from 4th and King station to Scott Blvd north of San José. Shared use of tracks with Caltrain commuter service including the following improvements:

- Light Maintenance Facility (LMF) at Brisbane
- Caltrain station modifications
- Grade crossing safety upgrades
- Communications (non-vital)
- Curve straightening and overhead catenary system (OCS) modifications
- Salesforce Transit Center station (by others)
- 4th and Townsend station (by others)

Current cost trends in this section include potential increases in real estate acquisitions and hazardous materials removals.

Exclusions:

The *Revised Draft 2020 Business Plan* estimate for this segment does not include:

- Environmental ROD
- Post ROD preliminary engineering to 30%
- Program management to support the above exclusions

4.2.4.1.2 *San José to Gilroy (~39 miles)*

Table 19 San Jose to Gilroy Cost Estimate

San Jose to Gilroy	2018 Business Plan (YOE\$, Millions)	2020 Business Plan (YOE\$, Millions)
TOTAL:	3,217	3,194

Assumptions:

Alternative 4 assumes an at-grade approach and station at Diridon, shared use of tracks with Caltrain commuter service through Tamien and use of UPRR right of way from Tamien through Gilroy Station to US Highway 101. The costs included in this section cover the high-speed rail route from Scott Blvd. north of San José Station to 8 miles south of Gilroy Station (Miller Canal) and include the following scope elements:

- 2 high-speed rail tracks and 1 freight track corridor from San José 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

Current cost trends in this section include potential increases in real estate acquisitions, earthwork, utility relocations and the MOWF.

Exclusions:

The *Revised Draft 2020 Business Plan* estimate for this segment does not include:

- Environmental ROD
- Post ROD preliminary engineering to 30%
- Program management to support the above exclusions

4.2.4.1.3 Gilroy to Carlucci Road (~49 miles)

Table 20 Gilroy to Carlucci Road Cost Estimate

Gilroy to Carlucci Road	2018 Business Plan (YOE\$, Millions)	2020 Business Plan (YOE\$, Millions)
TOTAL:	10,249	10,397

Assumptions:

Consistent with Alternative 4, the high-speed rail route extends through Pacheco Pass toward the Central Valley, starting from 8 miles south of Gilroy Station (Miller Canal) terminating at Carlucci Road with the following major scope elements:

- 16.1 miles of viaduct
- 15.2 miles of tunnels
- 7 grade separations

Current cost trends in this section include potential increases in environmental mitigation and real estate acquisitions, as well as decreases in professional services.

Exclusions:

The *Revised Draft 2020 Business Plan* estimate for this segment does not include:

- Environmental ROD
- Post ROD preliminary engineering to 30%
- Program management to support the above exclusions

4.2.4.1.4 Central Valley WYE Balance (~25m)

Because of the differences in how the WYE was divided in the *2018 Business Plan* and the *Revised Draft 2020 Business Plan*, estimate comparison between the 2018 WYE segments and 2020 WYE segments is not practical. However, the comparison between the business plan estimates can be made by rolling up to include the entire WYE, which is presented in

Table 21 Central Valley WYE Cost Estimate

	2018 Business Plan (YOE\$, Millions)	2020 Business Plan (YOE\$, Millions)
TOTAL:	4,778	4,694

Below are assumptions and exclusions for the *Revised Draft 2020 Business Plan* WYE Balance segment.

Table 22 Central Valley WYE Balance Cost Estimate

	2020 Business Plan (YOE\$, Millions)
TOTAL:	2,240

Assumptions:

Merced to WYE (~9m)

Based on the SR 152 to Road 11 Wye Alternative reflected in the Preliminary Engineering for Project Definition documents. Includes a segment of the Leg 2 of the Central Valley Wye from Carlucci Road to where it connects with WYE Leg 1 at Road 13. It also includes the north-west leg of Leg 1 WYE. The major scope elements include the following:

- 3.2 miles of viaduct and bridge structures
- 8 grade separations

There are no notable cost trends in this section.

Exclusions:

The *Revised Draft 2020 Business Plan* estimate for this segment does not include:

- Environmental ROD
- Post ROD preliminary engineering to 30%
- Program management to support the above exclusions

4.2.4.1.5 Advancing Design in Northern California

Table 23 Northern California Advance Design Cost Estimate

	2020 Business Plan (YOE\$, Millions)
TOTAL:	213

Assumptions:

This estimate includes continuing Preliminary Design to ~30% such that the Authority can reduce uncertainty and risk when proceeding to Early Works (such as ROW procurement, third-party agreements and utility relocations)

This design work will commence when the segment environmental ROD has been obtained for the following segments:

- San Francisco to San Jose
- San Jose to WYE (which combines San Jose to Gilroy, Gilroy to Carlucci Road and Central Valley Wye Balance)

4.2.4.2 Southern California

4.2.4.2.1 Bakersfield to Palmdale (~79 miles)

Table 24 Bakersfield to Palmdale Cost Estimate

Bakersfield to Palmdale	2018 Business Plan (YOE\$, Millions)*	2020 Business Plan (YOE\$, Millions)**
TOTAL:	16,345	15,684
<p>* 2018 Business Plan costs reflect 74-mile long section from Oswell Street in Bakersfield and Avenue O in Palmdale. ** Revised Draft 2020 Business Plan costs reflect the addition of the Bakersfield F Street to Oswell Street costs.</p>		

Assumptions:

Based on the Locally Generated Alternative (LGA) between F Street Station and Oswell Street in Bakersfield, and Alternative 2 from Oswell Street to Avenue O in Palmdale, reflecting the following major scope features as shown in preliminary engineering documents:

- 16 miles of viaduct and bridge structures
- 9.2 miles of tunnels
- 17 grade separations
- Bakersfield Station (balance)
- LMF at Palmdale
- MOWF at Lancaster
- Includes roadway improvements

Current cost trends in this section include potential increases in viaducts, environmental mitigation, real estate acquisitions, and LMF, as well as decreases in earthwork, retaining walls and professional services.

Exclusions:

The *Revised Draft 2020 Business Plan* estimate for this segment does not include:

- Environmental ROD
- Post ROD preliminary engineering to 30%
- Program management to support the above exclusions

4.2.4.2.2 Palmdale to Burbank (~41 miles)

Table 25 Palmdale to Burbank Cost Estimate

Palmdale to Burbank	2018 Business Plan (YOE\$, Millions)	2020 Business Plan (YOE\$, Millions)
TOTAL:	17,546	16,775

Assumptions:

Based on Refined SR-14 Alternative. The major scope elements in this section include the following:

- Tunnels (27.2 miles)
- Trenches (1.6 miles)
- Grade separations (8 ea.)
- High-speed rail station in Palmdale
- High-speed rail station in Burbank
- Metrolink station modifications

Current cost trends in this section include potential increases in tunnels, demolition and hazardous material, environmental mitigation, utility relocations and real estate acquisitions, as well as decreases in earthwork, retaining walls and trench structures, and professional services.

Exclusions:

The *Revised Draft 2020 Business Plan* estimate for this segment does not include:

- Environmental ROD
- Post ROD preliminary engineering to 30%
- Program management to support the above exclusions

4.2.4.2.3 Burbank to Los Angeles Union Station (~13 miles)

Table 26 Burbank to Los Angeles Union Station Cost Estimate

Burbank to Los Angeles	2018 Business Plan (YOE\$, Millions)	2020 Business Plan (YOE\$, Millions)
TOTAL:	1,478	1,360

Assumptions:

Based on Option B Refined Alternative, reflecting shared use of tracks with Metrolink commuter service. The major scope elements in this section include the following:

- Shared Corridor (125 mph)
- Metrolink station modifications
- Grade separations (7 ea. and alterations)

Current cost trends in this section include potential increases in tunnels, trench structures, retaining walls, utility relocations and real estate acquisitions.

Exclusions:

The *Revised Draft 2020 Business Plan* estimate for this segment does not include:

- Environmental ROD
- Post ROD preliminary engineering to 30%
- Program management to support the above exclusions

4.2.4.2.4 Los Angeles to Anaheim (~31 miles)

Table 27 Los Angeles to Anaheim Cost Estimate

Los Angeles to Anaheim	2018 Business Plan (YOE\$, Millions)	2020 Business Plan (YOE\$, Millions)
TOTAL:	3,587	2,918

Assumptions:

Based on the High-Speed Rail Project Alternate reflecting shared use of tracks with Metrolink commuter service, and assuming no high-speed rail station at Norwalk. The cost estimate also assumed no new grade separations south of Fullerton. The major scope elements in this section include the following:

- Shared corridor to Fullerton (110 mph)
- Shared Use south of Fullerton (110 mph)
- Fullerton station
- Anaheim station
- Metrolink station modifications
- Grade separations (3 each and alterations)
- Grade crossing safety upgrades

Current cost trends in this section include potential increases in viaducts, trench structures, yard tracks and real estate acquisitions.

Exclusions:

The *Revised Draft 2020 Business Plan* estimate for this segment does not include:

- Environmental ROD
- Post ROD preliminary engineering to 30%
- Program management to support the above exclusions

4.2.4.2.5 Advancing Design in Southern California

Table 28 Southern California Advance Design Cost Estimate

	2020 Business Plan (YOE\$, Millions)
TOTAL:	382

Assumptions:

This estimate includes continuing Preliminary Design to ~30% such that the Authority can reduce uncertainty and risk when proceeding to Early Works (such as ROW procurement, third-party agreements and utility relocations)

This design work will commence when the segment environmental ROD has been obtained for the following segments:

- Bakersfield to Palmdale
- Palmdale to Burbank
- Burbank to Los Angeles
- Los Angeles to Anaheim

4.2.4.3 Other System Costs

4.2.4.3.1 Rolling Stock Balance

Table 29 below describes the phased approach to trainset procurement to satisfy interim objectives from FRA certification to full Phase 1 operations.

Table 29 Rolling Stock Cost Estimate

Vehicles	2018 Business Plan (YOE\$, Millions)	2020 Business Plan (YOE\$, Millions)	Notes
2 Trainsets	251	372	FRA Certification
4 Trainsets + Startup	291	291	Merced to Bakersfield IOS service
2 Trainsets Deferred*	134	-	
Rolling Stock Balance	4,587	4,669	66 trainsets for NoCal & SoCal service
TOTAL (72 trainsets):	5,263	5,332	Ultimate Phase 1 System
* 2019 Baseline Report contained budget for 8 trainsets; however, only 6 are required for M-B IOS; in <i>Revised Draft 2020 Business Plan</i> , budget for the remaining 2 has been deferred to the rolling stock balance.			

Assumptions:

The estimate reflects an initial order of two trainsets for Central Valley Segment FRA certification and additional four trainsets and line operations in support of the interim operations between Merced and Bakersfield, and procurement of the balance 66 trainsets for the ultimate Phase 1 system (total of 72 trainsets).

The trainset estimate was derived from the cost of 15 other high-speed rail programs around the world, adjusted for U.S. dollar currency and inflation.

The initial two trainsets include Non-Recurring Engineering (NRE) costs for the design and manufacturing setup for the remainder of the trainsets.

The estimate also assumes 100% Buy America (no waivers) and that subsequent trainsets beyond the initial two will be purchased within a specified time period to avoid additional NRE costs on the subsequent purchases due to demobilization and remobilization of manufacturing facilities and crews.

Trainset procurement is expected to be part of the Rolling Stock design build contract.

Future costs to be further estimated by the selected trainset manufacturer and validated by the Authority.

4.2.4.3.2 Heavy Maintenance Facility (HMF)

Table 30 HMF Cost Estimate

Heavy Maintenance Facility	2018 Business Plan (YOE\$, Millions)	2020 Business Plan (YOE\$, Millions)
TOTAL:	481	481

Assumptions:

The HMF is expected to be part of the Rolling Stock design build contract, which is combined with trainset procurement and other operations/maintenance facilities.

- HMF will be located at a branch end for operational efficiency
- HMF footprint has been environmentally cleared
- Phased implementation of the HMF to accommodate initial operations between Merced and Bakersfield and expanding to support V2V and ultimately Phase 1 operations

Current cost trends in this section include potential increases in real estate acquisitions, third party agreements and hazardous materials removals.

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5 APPENDIX A: TECHNICAL BASELINE DOCUMENTS

Table 31 List of Technical Baseline Documents

Geographic Segment	Alternative	Baseline Document
San Francisco to San Jose	Alternative A	Record PEPD, April 2019
San Jose to Gilroy	Alternative 4	Record PEPD, March 2019
Gilroy to Carlucci Rd.	Alternative 4	Record PEPD, March 2019
Merced to CV Wye	Hybrid Alignment	15% Design Submittal, Record Set, July 2011 (footprint as amended by Ranch Rd. to Merced re-examination)
CV Wye Legs 1	SR 152 to Road 11 Wye Alternative	15% Design Submittal, Record Set, August 2016
Carlucci Rd. to Madera (CV Wye Leg 2)	SR 152 to Road 11 Wye Alternative	15% Design Submittal, Record Set, August 2016
Madera to Poplar Rd. (Civil)	Hybrid Alternative BNSF Alternative with Corcoran and Allensworth Bypass	CP1, CP2-3, CP4, SR99 - Project Estimates at Completion, Baseline Optimization 1
Madera to Poplar Ave. (Balance)	Hybrid Alternative BNSF Alternative with Corcoran and Allensworth Bypass	Merced – Fresno 15% Design Submittal, Record Set, July 2011 Fresno – Bakersfield 15% Design Submittal, Record Set, January 2014
Poplar Rd. to Bakersfield	Locally Generated Alternative	Record Set PEPD Submission, November 2016
Bakersfield to Palmdale	Alternative 2	Revised Record Submittal (CCNM Design Option), March 2019
Palmdale to Burbank	Refined SR14 Alternative	Draft PEPD, February 2019
Burbank to Los Angeles	Option B Refined	PEPD Record Set, March 2018
Los Angeles to Anaheim	High-Speed Rail Project Alternative	PEPD Record Set, March 2018
Heavy Maintenance Facility	Conceptual design reflected in 2018 BP estimate	<i>2018 Business Plan - Capital Cost Basis of Estimate Report</i>

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6 APPENDIX B: APPLIED CONTINGENCIES (OUTSIDE OF CENTRAL VALLEY PROJECTS)

Table 32 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 access ways, including roads	21.0%
20.08	Fare collection systems and equipment	—
20.09	Station security	—
30 Support Facilities: Yards, Shops, Admin. Buildings		
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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