



Business Plan

CAPITAL COST BASIS OF ESTIMATE REPORT



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SUBJECT: Approval Signature for the *2022 Business Plan Capital Cost Basis of Estimate* Report

DESCRIPTION OF ENCLOSED DOCUMENT(S): *2022 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 is being designed to run the approximately 500 miles from San Francisco 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 implemented a building block approach to deliver an electrified high-speed rail system and fulfill the Authority's mission as defined by Proposition 1A, the Safe, Reliable High-Speed Passenger Train Bond Act for the 21st Century, which was approved by a majority of voters in 2008.

This *2022 Business Plan Capital Cost Basis of Estimate Report*, summarizes two program developments that have occurred since the Board's adoption of the *2020 Business Plan* in March 2021:

1. The Board of Directors approval of an Expenditure Authorization request in the December 2021 Board meeting for an Interim Program Baseline total of \$17.937 billion to advance additional work -and augment construction contingencies.
2. Capital cost estimates were updated for two Southern California project sections (Bakersfield to Palmdale and Burbank to Los Angeles) following Board action on the environmental Records of Decision (ROD) for those sections.

More specifically, in December 2021, the Board of Directors approved an additional funding of \$2.3 billion to augment the previously approved Program Baseline to advance work on specified activities consistent with the budget discussed in the Revised *2020 Business Plan*. This represents an interim step pending the Legislature's action on the Authority's appropriation request for the remaining voter-approved Proposition 1A bonds requested in Governor Newsom's proposed budget.

The capital cost estimates for the Bakersfield to Palmdale, Burbank to Los Angeles San José to Gilroy and Gilroy to Carlucci Road project sections now reflect the final scope identified in their respective final environmental documents, including the approved Records of Decision. The scopes changed based on extensive interactions with local governments, community organizations, private entities, federal and state regulatory agencies and other stakeholders. The cost estimates and their cost estimate range have been updated as part of this report as a result of the final scope, quantities and cost changes.

2 BACKGROUND

The Interim Program Baseline establishes a snapshot in time that captures scope, schedule, budget, and risk against which program performance will be reported and measured on. Baseline Revision 1 was established after the *2019 Project Update Report* with a Board-approved Program Baseline of \$15.636 billion. The additional expenditure authorization of \$2.3 billion approved by the Board in December 2021 augmented the Program Baseline revision 1 (adopted in 2019), authorizing a capital program expenditure plan of \$17.937 billion (referred to as the Interim Program Baseline within this document). An Updated Program Baseline is expected to be completed once the Legislature acts on the remaining \$4.2 billion Proposition 1A bond request to bring electrified high-speed rail between Merced and Bakersfield.

It is important to differentiate between the scope that is contained in the Interim Program Baseline and the remaining unfunded program scope included in the Authority's planning documents (i.e., Phase 1 or Silicon Valley to Central Valley). Generally, the Interim Program Baseline scope includes budget authorization for the 119-mile Central Valley Segment, the environmental work to clear the full Phase 1 system, supporting regional bookend projects, advancing design work to Merced and Bakersfield, and other program wide costs. The unfunded scope outside the Interim Program Baseline includes project sections and elements that are still in environmental review and/or construction that is not yet fully funded. The estimating methodology is different depending on the category that contains the scope being estimated.

- For scope contained within the Interim Program Baseline, projects have advanced in design and/or construction, thereby reducing estimating uncertainty. For projects in progress (e.g., under construction or preparation of environmental documents), the estimating methodology is based on determining a project Estimate at Completion (EAC). Projects not yet in progress, however still contained within the Interim Program Baseline, 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 Interim Program Baseline, 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 its 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-cost estimates.

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. This project development and delivery evolution is represented by the Authority's recently implemented Staged Project Delivery process, which is often followed as a best practice in both the public and private sectors. 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 typically 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 final design, early works, 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 assumed 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 line linking the Silicon Valley to Central Valley and the full 500-mile Phase 1 system can only be developed once the funding and timing of construction is known.

3 CAPITAL COST SUMMARY

The Authority’s Board of Directors historically adopts an annual fiscal year budget and a multiyear Program Baseline Budget after the approval of each Business Plan. However, the adoption of an Updated Program Baseline Budget is pending legislative action on the \$4.2 billion Proposition 1A appropriation (which was requested as part of the Governor’s Revised Budget in May 2021). This *2022 Business Plan Capital Cost Basis of Estimate Report* includes cost estimates and ranges for the full Phase 1 system, which have been adjusted to reflect the updated scope and costs reflected in the Bakersfield to Palmdale and Burbank to Los Angeles environmental documents and an Interim Program Baseline to account for the Board-adopted expenditure authorization in December 2021.

Table 1 provides cost summaries of the implementation phases presented in the *2022 Business Plan*, including the cost estimates for: (1) the Interim Program Baseline, (2) an electrified single and two-track initial operating segment connecting Merced, Fresno and Bakersfield, and (3) the full 500-mile statewide system (Phase 1).

Table 1 Summary Cost Estimate Ranges by Phase – 2022 Business Plan

Project Phase	Low (YOE\$ Billions)	2022 Base (YOE\$ Billions)	High (YOE\$ Billions)
Program Baseline	—	17.937	—
Merced to Bakersfield IOS (single track)	\$21.40	\$22.28	\$22.84
Merced to Bakersfield (Second track)	\$1.106	\$1.106	\$1.106
Phase 1¹	\$76.7	\$92.8 – 94.2	\$113.2

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

- Table 2: Interim Program Baseline
- Table 3: Merced to Bakersfield Initial Operating Segment Estimate
- Table 4: Full Phase 1 System Program Cost Estimate

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

Table 2 shows the Interim Program Baseline approved by the Board of Directors in December 2021. It generally includes the 119 miles of civil construction currently underway and costs to advance design on extensions north to Merced and south to Bakersfield. The scope elements include more specifically:

- 1) Complete 119-mile test track in the Central Valley (Madera to Poplar Avenue) and environmentally clear all Phase I system (San Francisco/Merced to Los Angeles/Anaheim)
- 2) Scope:
 - Regional Bookend Projects
 - Phase I Environmental Records of Decision (RODs)
 - Central Valley Segment
 - Civil Works
 - Single Track
 - Electrification and Systems
 - Trainset Certification Facility
 - Program Management Support
 - Preliminary Design Advancement
 - Merced & Bakersfield Extensions
 - Four Central Valley Stations

Table 2: Interim Program Baseline Cost Estimates by Scope Element

Scope Element	Cost Change* (\$M, YOE)	Total Contingency (\$M, YOE)
Baseline Revision 1 (2019)	15,636	—
CP 1	401	231
CP 2-3	320	210
CP 4	(53)	123
State Route 46	72	4
Right of Way for CP 1-4	152	68
Net other adjustments (Program support, stations, and other cost)	(95)	53
PD Changes	(156)	29
Subtotal (Baseline Rev1 Scope)	16,994	
Enhanced Scope for Program Wide Support	787	
Enhanced Scope to Advance Design - Merced and Bakersfield Extensions/Stations	155	
Interim Program Baseline Total	17,937	

Table 3 shows the incremental estimated cost to complete extensions to Merced and Bakersfield and construct the 171-mile Initial Operating Segment for passenger service. The current estimate assumes constructing the civil infrastructure and installing Track and Systems on the two extensions. It also assumes a phased-track approach, where initially the trains would operate on a single track, with the second track installed when the system is extended beyond the Central Valley into the Bay Area. The Authority intends to review this approach and made any modifications as necessary after it receives Track and Systems bids later this year. The estimate also assumes the procurement of high-speed rail trainsets and construction of a maintenance facility. Specific elements include:

- 1) Complete the Merced to Bakersfield Initial Operating Segment
 - a) Scope
 - i) Merced Extension
 - (1) Civil Works
 - (2) Single Track/Dual Track
 - (3) Electrification and Systems
 - ii) Bakersfield Extension
 - (1) Civil Works
 - (2) Single Track/Dual Track
 - (3) Electrification and Systems
 - iii) Six Trainsets

Table 3: Merced to Bakersfield Initial Operating Segment (Phased Track Scenario)

Scope Element	Low*	Base*	High*
Merced Extension (single track) **	1,885	2,252	2,744
Bakersfield Extension (single track) **	940	1,297	1,469
Fresno & Kings/Tulare Station Construction		116	
4 Additional Trainsets	246	291	301
Subtotal	3,071	3,956	4,514
2 Trainsets & Simulator		390	
***Merced to Bakersfield (Second track)	1,106	1,106	1,106
Total	4,177	5,452	5,620

* Millions, YOES\$

** Includes Merced and Bakersfield station construction

*** The Authority's objective is to secure additional federal funding to deliver a dual track initial operating segment for Merced-Bakersfield

Table 4 shows the total cost estimate of completing the entire 500-mile Phase 1 System linking San Francisco/Merced to Los Angeles/Anaheim via the Central Valley. The table reflects two changes that have been highlighted in this report:

1. It shows the Interim Program Baseline (\$17.937 billion)
2. It reflects updated costs for the two Southern California project sections where environmental Records of Decision have recently been approved (Bakersfield to Palmdale and Burbank to Los Angeles). The estimates for these two sections reflect the final scope identified in the approved Preferred Alternatives which have changed since preliminary preferred alternatives were adopted in 2018. The scope changes are based on extensive interactions with local governments, community organizations, private entities, federal and state regulatory agencies and other stakeholders. Although the changes and mitigations increased the cost estimates, the projects are now better integrated into the communities through which the system will travel and address environmental impacts and future community plans.
3. It reflects an updated cost estimate for the San José to Merced project segment (shown in two project sections San José to Gilroy and Gilroy to Carlucci Road). The estimates for these two sections reflect the scope of the Preferred Alternative as identified in the San José to Merced Final EIR/EIS, which has changed since preliminary preferred alternatives were adopted in 2018. The scope changes are based on extensive interactions with local governments, community organizations, private entities, federal and state regulatory agencies and other stakeholders. Although the changes and mitigations increased the cost estimates, the projects are now better integrated into the communities through which the system will travel and address environmental impacts and future community plans.

All other cost items remain consistent with the *2020 Business Plan*.

Consistent with the estimates in the *2020 Business Plan*, regional bookend project costs and the costs to complete environmental documents, which were previously carried in the project section costs, are now accounted for in the Interim Program Baseline and were removed from the section cost estimates.

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. Specific elements include:

- 1) Interim Program Baseline
- 2) Merced and Bakersfield Extensions
- 3) Northern California project sections
- 4) Southern California project sections
- 5) Remaining Trainsets in Table 26
- 6) Heavy Maintenance Facility in Table 15

Table 4: Full Phase 1 Program Cost Estimate

Scope Element	Low*	Base*	High*
Interim Program Baseline	—	17,937	—
Trainsets (2 each)	—	390	—
Merced and Bakersfield Extensions (single track)	—	3,071 - 4,514	—
Central Valley			
Merced to Bakersfield (second track)	1,106	1,106	1,106
Northern California			
San Francisco to San Jose	1,307	1,650	2,123
**San Jose to Gilroy	4,075	6,020	8,733
**Gilroy to Carlucci Road	10,316	13,627	16,762
Central Valley Wye Balance	1,842	2,240	2,601
Preliminary Design - Northern California	—	213	—
Southern California			
**Bakersfield to Palmdale	14,703	18,378	22,238
Palmdale to Burbank	12,635	16,775	24,428
**Burbank to Los Angeles	2,201	2,935	3,405
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: *	76,655	92,767 – 94,210	113,201

* Millions, YOES\$

** Project section estimates updated following environmental Records of Decision

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 that is under construction, the current cost estimates are based on the preliminary engineering designs in support of the environmental reviews. These estimates assume an optimal procurement strategy, a fully funded schedule and cost-effective construction packaging.

The Authority continues to review and update the estimates as the design advances, 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 5.2 of this report along with the capital cost estimates for each project section.

4 APPROACH AND METHODOLOGY

4.1 Overview

The 2022 *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 5 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 5 Estimate Classifications by AACE International²

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.

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 to Phase 1 cost estimates vary depending on the complexity of the project scope elements, maturity of underlying technical baseline information and the inclusion of appropriate contingencies.

² AACE International – Association of the Advancement of Cost Engineers (<https://web.aacei.org/>).

4.2 Total Forecast Methodology for Ongoing Projects

The Total Forecast methodology for the major contracts in the construction package projects involves taking the current contract value and subtracting the expenditures to date resulting in remaining work. The certain portion of Pending Change Orders, Potential Change Orders and Trends are added to this remaining work balance to arrive at the Total Contract Forecast. This methodology assumes that the physical work complete is directly commensurate with the expenditures to date.

In addition to determining the Total Contract Forecast, 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.

Total Forecast 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 on factors such as schedule uncertainty, escalation uncertainty and other factors specific to the scope of work being estimated.

4.3 Estimating Approach & Methodology for Future Projects

4.3.1 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 2022 *Business Plan* capital cost estimate is included in Appendix A.

4.3.2 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 estimate. 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

4.3.3 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.

4.3.3.1 Environmental Mitigation

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

4.3.3.2 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*.

4.3.3.3 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.

4.3.3.4 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

4.3.4 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, key risks were analyzed, 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 Appendix B, with the 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.

4.3.4.1 Allocated and Unallocated Contingencies

Contingency is divided into two categories for this Program—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 Appendix B. Generally, the contingencies are 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 as their design progress is still in the conceptual level and identification of all the utilities are not yet 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.

4.3.5 Review and Optimization

Upon completion of the initial draft 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 capital cost estimate and are further described in Section 5.2.

4.3.6 Year of Expenditure

Preparing business plans involves developing a range of forecasts and estimates, including not just capital costs but also ridership and revenue forecasts, greenhouse gas analysis, operations and maintenance cost estimates, life cycle cost estimates and others. The estimates and forecasts are based on a common set of assumptions and inputs. Since the *2016 Business Plan*, the Authority has structured these estimates around two fundamental phasing milestones—the development of an operating line connecting the Silicon Valley to the Central Valley and the completion of the entire Phase 1 system. This serves as a framework for organizing the forecasts and estimates shown in Chapter 5 of the *2022 Business Plan*. This framework

has also been used for preparing year of expenditure cost estimates. The capital cost estimates were escalated to year of expenditure dollars based on the phasing approach as described below:

- **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 for purposes of developing a YOE estimate 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 except Bakersfield to Palmdale 2020 dollars and Burbank to Los Angeles in 2021 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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5 ASSUMPTIONS, EXCLUSIONS AND RECONCILIATION

5.1 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 A: 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 6 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. This report now includes updated estimates for the Bakersfield to Palmdale, Burbank to Los Angeles, San José to Gilroy and Gilroy to Carlucci Road project sections based upon the final approved environmental documents. As future environmental reviews are approved the capital cost estimates for these segments will be updated.

Table 6 Design Development Stages

Project Segments	Design Development Stage
San Francisco to San José	Preliminary*
San José to Gilroy	Preliminary
Gilroy to Carlucci Road	Preliminary
Central Valley Wye Balance	Preliminary
Merced to Madera Extension	Preliminary
Construction Package 1	Final
Construction Package 2-3	Final
Construction Package 4	Final
Bakersfield LGA Extension	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: (1) Interim Program Baseline, (2) Merced to Bakersfield Extension, and (3) the remainder of Phase 1.

5.2 Estimate General Assumptions and Exclusions

5.2.1 General

The following summarizes the sources and general assumptions reflected in the *2022 Business Plan* estimate. Since 2020, the estimate has been partially updated. For ongoing work, the *2022 Business Plan* capital cost estimate recognizes modifications based upon approved change orders, pending change orders and contingency based on an updated risk profile for the Interim Program Baseline. Estimates have been updated for those segments which have achieved Environmental Records of Decision since the final *2020 Business Plan*.

General Assumptions

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

- Interim Program Baseline
 - The Authority's Project Construction Management firms are responsible for contract management of the Design-Builders
 - Every Authority contract has a State assigned resource as the Contract Manager
 - Track/Systems RFQ.
 - Updated estimates derived from:
 - Preliminary Engineering for Project Definition documents for ROD's approved documents.
- Phase 1 Balance (phase 1 scope is everything outside the Interim program baseline mentioned above)
 - The *2020 Business Plan*
 - Preliminary Engineering for Project Definition documents

Merced and Bakersfield Extension Construction and Phase 1 Balance estimates have remained unchanged from the *2020 Business Plan* with the exception of scope shifts from one area to another. Because this document is using the *2018 Business Plan* for these segments, the estimates from the *2020 Business Plan* are shown for comparison purposes.

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 section 6.
- Unallocated contingency is 5 percent of the construction cost, except were adjusted to reflect approved project contingencies for CP 1, CP 2-3 and CP 4 projects.

Exclusions:

- Costs associated with Authority state administration activities.
- Finance charges, if applicable.

5.2.2 Interim Program Baseline

5.2.2.1 Program Base Scope

The *2022 Business Plan* provides an estimate based on the foundation established in the *2020 Business Plan* with some minor adjustments to scope. The Program Baseline has the following objectives, which remain unchanged:

- Complete the 119-mile Central Valley construction segment and lay track.
- Provide electrified highspeed rail along the 119-mile Central Valley Segment.
- Environmentally clear all segments in Phase 1.
- Complete the regional bookend projects.
- Continue project development activities to enable construction of additional segments as funding becomes available.

To accomplish these objectives, the Interim Program Baseline scope includes the following projects and scope elements:

- Bookend Projects:
 - Caltrain Electrification
 - San Mateo Grade Separation
 - Los Angeles Union Station and Link Union Station Project
 - Rosecrans/Marquardt Grade Separation
- Environmental Record of Decision (ROD) Projects:
 - San Francisco to San Jose
 - San Jose to Central Valley Wye
 - Central Valley Wye
 - Fresno to Bakersfield
 - Bakersfield Locally Generated Alternative (LGA)
 - Bakersfield to Palmdale
 - Palmdale to Burbank
 - Burbank to Los Angeles
 - Los Angeles to Anaheim
 - Heavy Maintenance Facility
- Project Development Projects:
 - Merced Extension Project Development
 - Bakersfield Extension Project Development
 - Station Project Development:
 - Merced

- Fresno
- Kings/Tulare
- Bakersfield
- Civil Projects:
 - State Route 99
 - Construction Package 1
 - Construction Package 2-3
 - Construction Package 4
 - State Route 46
 - Historic Fresno Station Renovation
- Rail Projects:
 - Central Valley Segment Rail (119-mile test track):
 - Track and Systems
 - Train Certification Facility
 - High Voltage Substations
- Program Wide Support (through the end of Civil Construction Packages)

Assumptions:

The estimate assumes a single track along the entire 119-mile Central Valley 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).

Since the *2020 Business Plan*, new projects were created for the following scope of work:

- Historic Downtown Fresno Station Renovation
- Preliminary Engineering for Merced Station Relocation:
 - Previous location: 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 (at grade)
 - New location: Adjacent with Merced Amtrack Station (elevated)
 - Includes change in track alignment leading up to the new elevated Merced Station
- SR-46 (Grade separation in Wasco, CA)
- Downtown San Francisco Extension Design (to be managed by TransBay Joint Powers Authority)

Exclusions:

The following scope elements are not included in the Interim Program Baseline's scope of work; however, these items are necessary to satisfy program objectives above

- 2 Trainsets for FRA Certification of the 119-mile test track.

Risks:

- Delays to construction
- Unknown-Unknowns

5.2.2.2 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 additional program management to support the program through the extended Program period of performance. Note that the two trainsets that were included in the 2020 Program Baseline Enhancements are excluded from 2021 Funded Program scope of work. At least two trainsets will be necessary for dynamic testing on the 119-mile test track. 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 for the Merced to Bakersfield Line.

5.2.2.2.1 Program Management & Support

Table 7 Program Management & Support

	2022 Business Plan (YOE\$, Millions)
TOTAL:	787

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.

5.2.2.2.2 Advancing Design: Merced & Bakersfield Extensions plus 4 Stations

Table 8 Advancing Design: Merced & Bakersfield Extensions plus 4 Stations

	2022 Business Plan (YOE\$, Millions)
TOTAL:	155

Assumptions:

This estimate includes continuing Preliminary Design to ~30% (or configured footprint) 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 2021 baseline for the following items:

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

5.2.3 Merced and Bakersfield Extensions

The objective of extending to Merced and Bakersfield is to start service on an Interim Operating Segment 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 performance objectives
- 1 additional high voltage substation for the increased power demand
- Initial heavy maintenance facility to perform light maintenance

5.2.3.1 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 *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 *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 *2020 Business Plan* for the overall WYE is covered in Section 5.2.4.1.4.

Table 9 Merced Extension Cost Estimate

	2020 Business Plan (YOE\$, Millions)	2022 Business Plan (YOE\$, Millions)
TOTAL:	2,252	2,252

Assumptions:

The Merced to Madera estimate is based on the installation of a single track with the expectation that a second track will 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 to accommodate power requirements.

5.2.3.2 Bakersfield Extension

Table 10 Poplar Avenue to Bakersfield Cost Estimate

	2020 Business Plan (YOE\$, Millions)*	2022 Business Plan (YOE\$, Millions)*
TOTAL:	1,297	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 21.

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.

5.2.3.3 *Trainsets for Certification*

Table 11 Trainsets for FRA Certification

	2022 Business Plan (YOE\$, Millions)
*2 Trainsets	372
*Driving Simulator	18
TOTAL:	390

* Not included in the Interim Program Baseline, trainset scope is pending Legislative action on the remaining Proposition 1A appropriation

Assumptions:

See Section 5.2.4.3.1 for further information on the rolling stock phased approach and associated assumptions.

5.2.3.4 *Trainsets for Initial Operating Segment*

Table 12 Trainsets for Initial Operating Segment Cost Estimate

	2022 Business Plan (YOE\$, Millions)
TOTAL:	291

Assumptions:

See Section 5.2.4.3.1 for further information on the rolling stock phased approach and associated assumptions.

5.2.3.5 *Central Valley Stations*

Table 13 Central Valley Station Cost Estimate

	2022 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

5.2.3.6 Merced to Bakersfield – Future Second Track

Table 14 Future Second Track Cost Estimate

	2020 Business Plan (YOE\$, Millions)	2022 Business Plan (YOE\$, Millions)
TOTAL:	1,106	1,106

Assumptions:

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

- Second track – ballast and sleepers or concrete slab track
- Second rail
- Second rail electrification

The current estimate assumes that the second track 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.

5.2.3.7 Heavy Maintenance Facility (HMF)

Table 15 HMF Cost Estimate

Heavy Maintenance Facility	2020 Business Plan (YOE\$, Millions)	2022 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.

5.2.4 Phase 1 Balance

5.2.4.1 Northern California

5.2.4.1.1 San Francisco to San José (~43 miles)

Table 16 San Francisco to San José Cost Estimate

San Francisco to San Jose	2020 Business Plan (YOE\$, Millions)	2022 Business Plan (YOE\$, Millions)
TOTAL:	1,649	1,650

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 in Santa Clara. 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 *2022 Business Plan* estimate for this segment does not include:

- Environmental ROD
- Post ROD preliminary engineering to 30%
- Final cost estimates for real estate and hazardous materials
- Program management to support the above exclusions
- Caltrain Electrification Project
- San Mateo Grade Separation Project

5.2.4.1.2 San José to Gilroy (~39 miles)

Table 17 San Jose to Gilroy Cost Estimate

San Jose to Gilroy	2020 Business Plan (YOE\$, Millions)	2022 Business Plan (YOE\$, Millions)
TOTAL:	3,194	6,020

Assumptions:

Alternative 4 in the San Jose to Merced Project Section assumes an at-grade approach and station at Diridon, use of the existing Caltrain corridor through Control Point Lick and use of UPRR right of way from Control Point Lick through Gilroy Station to US Highway 101. The costs included in this section cover the high-speed rail route from Scott Blvd. in Santa Clara to 5 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)
- ~1 mile of viaduct and 12 bridge modifications in Caltrain and UPRR right of way to accommodate high-speed rail and UPRR tracks
- 29 grade crossings alterations (e.g., quad-gates or other improvements)
- Upgrades to 10 existing grade separations
- San Jose Diridon Station at-grade
- Gilroy Station at-grade
- Upgrades to Caltrain stations (to be developed by others)

This estimate now includes the scope of the Preferred Alternative as identified in the San Jose to Merced Final EIR/EIS.

Exclusions:

The *2022 Business Plan* estimate for this segment does not include:

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

5.2.4.1.3 Gilroy to Carlucci Road (~49 miles)

Table 18 Gilroy to Carlucci Road Cost Estimate

Gilroy to Carlucci Road	2020 Business Plan (YOE\$, Millions)	2022 Business Plan (YOE\$, Millions)
TOTAL:	10,397	13,627

Assumptions:

Alternative 4 in the San Jose to Merced Project Section of the high-speed rail route extends through Pacheco Pass toward the Central Valley, starting from 5 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
- 6 grade separations

This estimate now includes the scope of the Preferred Alternative as identified in the San Jose to Merced Final EIR/EIS.

Exclusions:

The *Draft 2022 Business Plan* estimate for this segment does not include:

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

5.2.4.1.4 Central Valley WYE Balance (~25m)

Table 19 Central Valley WYE Balance Cost Estimate

	2020 Business Plan (YOE\$, Millions)	2022 Business Plan (YOE\$, Millions)
TOTAL:	2,240	2,240

Below are assumptions and exclusions for the *2022 Business Plan* WYE Balance segment.

Assumptions:

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 *2022 Business Plan* estimate for this segment does not include:

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

5.2.4.1.5 Advancing Design in Northern California

Table 20 Northern California Advance Design Cost Estimate

	2022 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)

5.2.4.2 Southern California

5.2.4.2.1 Bakersfield to Palmdale (~79 miles)

Table 21 Bakersfield to Palmdale Cost Estimate

Bakersfield to Palmdale	2020 Business Plan (YOE\$, Millions)*	2022 Business Plan (YOE\$, Millions)**
TOTAL:	15,684	18,378

2022 Business Plan Update:

This alignment is generally consistent with the alignment identified as part of the statewide Phase 1 high-speed rail program in the *2020 Business Plan*. However, this estimate now includes scope changes at Caesar Chavez National Monument (CCNM) adopted as part of the final environmental Preferred Alternative adopted by the Board in August 2021, not included in the *2020 Business Plan*. This includes increases related to viaduct, earth works, tunnel and ROW costs due to alignment revisions to minimize impact on residential/commercial disruptions.

Assumptions:

Assumes the Refined CCNM Design Option from Chester Avenue in Bakersfield to Spruce Court in Palmdale, reflecting the following major scope features as shown in preliminary engineering documents:

- 16 miles of viaduct and bridge structures
- 10.8 miles of tunnels
- 12 grade separations
- Bakersfield Station (balance)
- Maintenance of way facility (MOWF) at Avenue M
- LMF at Palmdale
- Caesar Chavez National Monument (CCNM) alignment change

This estimate now includes scope changes at CCNM adopted as part of the environmental Record of Decision adopted by the Board of Directors in August 2021, which was not included in the *2020 Business Plan*. This includes increases related to viaduct, earth works, tunnel and right-of-way costs due to alignment revisions to minimize residential and commercial and other disruptions.

Exclusions:

The *2022 Business Plan* estimate for this segment does not include:

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

5.2.4.2.2 Palmdale to Burbank (~41 miles)

Table 22 Palmdale to Burbank Cost Estimate

Palmdale to Burbank	2020 Business Plan (YOE\$, Millions)	2022 Business Plan (YOE\$, Millions)
TOTAL:	16,775	16,775

Assumptions:

This alignment is generally consistent with the alignment identified as part of the statewide Phase 1 program in the *2020 Business Plan*.

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 *2022 Business Plan* estimate for this segment does not include:

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

5.2.4.2.3 Burbank to Los Angeles Union Station (~14 miles)

Table 23 Burbank to Los Angeles Union Station Cost Estimate

Burbank to Los Angeles	2020 Business Plan (YOE\$, Millions)	2022 Business Plan (YOE\$, Millions)
TOTAL:	1,360	2,935

2022 Business Plan Update:

This alignment is generally consistent with the alignment identified as part of the Phase 1 program in the *2020 Business Plan*. The *2020 Business Plan* did not reflect the scope changes primarily associated with the tunnel/trench south of Burbank Airport which were approved as part of the final environmental Record of Decision adopted by the Board of Directors in January 2022. The estimate incorporates tunnel/trench guideways to minimize residential/commercial disruptions.

Assumptions:

Based on the Preferred 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
- Five grade separations

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

Exclusions:

The *2022 Business Plan* estimate for this segment does not include:

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

5.2.4.2.4 Los Angeles to Anaheim (~31 miles)

Table 24 Los Angeles to Anaheim Cost Estimate

Los Angeles to Anaheim	2020 Business Plan (YOE\$, Millions)	2022 Business Plan (YOE\$, Millions)
TOTAL:	2,918	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 (ARTIC)
- 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 2022 Business Plan estimate for this segment does not include:

- Environmental ROD
- Post ROD preliminary engineering to 30%
- Program management to support the above exclusions
- Los Angeles Union Station Link Union Station Project
- Rosecrans/Marquardt Grade Separation Project

5.2.4.2.5 Advancing Design in Southern California

Table 25 Southern California Advance Design Cost Estimate

	2022 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

5.2.4.3 Other System Costs

5.2.4.3.1 Rolling Stock Balance

Table 26 below describes the phased approach to trainset procurement to satisfy interim objectives from FRA certification to full Phase 1 operations.

Table 26 Rolling Stock Cost Estimate

Vehicles	2020 Business Plan (YOE\$, Millions)	2022 Business Plan (YOE\$, Millions)	Notes
2 Trainsets	372	372	FRA Certification
4 Trainsets + Startup	291	291	Merced to Bakersfield IOS service
Rolling Stock Balance	4,669	4,669	66 trainsets for NorCal & SoCal service
TOTAL (72 trainsets):	5,332	5,332	Ultimate Phase 1 System

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 Program Baseline scope does not include any trainsets for FRA certification as of December 2021. It is assumed that the two trainsets required for FRA certification of the 119-mile test track will be procured with sufficient time to manufacture the trainsets such that there is no delay to dynamic testing on the 119-mile test track.

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.

6 APPENDIX A: TECHNICAL BASELINE DOCUMENTS

Table 27 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 DV1	Record PEPD, November 2021; Record of Decision Approved
Gilroy to Carlucci Rd.	Alternative 4 DV14	Record PEPD, November 2021; Record of Decision Approved
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), October 2020; Record of Decision Approved
Palmdale to Burbank	Refined SR14 Alternative	Draft PEPD, February 2019
Burbank to Los Angeles	Option B Refined	PEPD Record Set, April 2021; Record of Decision Approved
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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7 APPENDIX B: APPLIED CONTINGENCIES (OUTSIDE OF CENTRAL VALLEY PROJECTS)

Table 28 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	21.0%
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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