Transbay Corridor Hybrid Summary Comprehensive Multimodal Corridor Plan

San Francisco Bay Area
Rapid Transit District

In Accordance with the California Transportation Commission Solutions for Congested Corridors Program Guidelines

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1 Executive Summary

The Bay Area region of California is one of the largest regions in the state, and transit ridership to San Francisco's busy and dense downtown employment centers has grown rapidly over the past several years. This has led to a significant increase in transit demand within the Transbay Corridor, which is composed of two major pieces of infrastructure; the San Francisco-Oakland Bay Bridge, and BART's Transbay Tube. The corridor is served by several multimodal routes across the San Francisco Bay including heavy rail transit, bus, and ferry service.

This Hybrid Comprehensive Multimodal Corridor Plan (Corridor Plan) brings together two plans produced by the Metropolitan Transportation Commission (MTC), the Bay Area Core Capacity Transit Study (BACCTS) and Horizon Crossings Perspective Paper (Crossings), to supplement the San Francisco Bay Area Rapid Transit District's (BART) California SB-1 Solutions for Congested Corridors Program Cycle 2 application for the Train Control Modernization Program (TCMP). BART is submitting the application in partnership with the MTC and the California Department of Transportation (Caltrans).

This plan begins with an overview of the Transbay Corridor's capacity needs as well as current and future demand. The system's demand has already exceeded capacity and will continue unless significant investments in transportation throughout the corridor are made. The Train Control Modernization Program, the lynchpin of BART's Transbay Corridor Core Capacity Program, has been identified by BART as a method to increase capacity through the Transbay Corridor and the BART system as a whole. Both the BACCTS, which focuses on short- and medium-term investments, and Crossings paper, which focuses on long-term investments and needs, highlight the necessity of the TCMP as a cost-effective investment to increase transit capacity through the Transbay Corridor. With increased transit capacity, this highly traveled corridor will see reduced congestion by providing more transportation choices for travelers to the area while preserving the character of the local community and creating opportunities for neighborhood enhancement projects.

The two plans are similar in their guiding principles, using a comprehensive approach to addressing congestion and quality-of-life issues within the Transbay Corridor through investment in transportation and transit. The planning horizons of the two studies differ, and while the BACCTS includes analyses for the short-, medium-, and long-term, the Crossings paper expands the traditional long-term evaluation period and considers a wider range of factors than the BACCTS. Both studies place a large focus on different modes, considering the Transbay Corridor is serviced by several different transit operators in addition to heavy traffic from personal and commercial vehicles. The development of both studies involved extensive collaboration with state, regional, and local partners. While neither study went in depth for how the investments should be funded, both made recommendations on funding prioritizations and timelines for

implementation in order to adequately meet Transbay Corridor demand now and in the future.

This plan summarizes the multimodal impacts of each of the investment packages and crossing concepts on congestion, accessibility, and efficient land use. For the short- and medium-term, the focus of the BACCTS is on increasing transit capacity and reliability by implementing the TCMP and adding new rail cars to the BART system, while also expanding bus and ferry routes. In the long-term, the focus is on increasing transit capacity and ridership through a new BART Transbay crossing. Both studies anticipate large impacts on demand, and the ability to meet future demand if the right capacity investments are taken. The induced demand analyses of the studies are also summarized in addition to consideration of relevant performance metrics.

A summary of federal, state, and local planning activities that connect to the BACCTS and Crossings paper is discussed. The consistency of the Hybrid Plan with the goals and objectives of the Regional Transportation Plan (Plan Bay Area 2040) along with the inclusion of the TCMP in that and other planning activities is further evidence for the TCMP's need. Finally, the outcomes and recommended investments of both studies is discussed.

2 Introduction

Transit demand within the Transbay Corridor is at an all-time high and will continue to grow as the region responds to a strong and continually growing economy, worsening roadway congestion, and a preference for living in transit-oriented areas. However, as the region continues to develop and ridership continue to grow, the Transbay Corridor has become overburdened because infrastructure has not kept pace with increased demand. The Transbay Corridor is multimodal in nature and is composed of two major pieces of infrastructure; the San Francisco-Oakland Bay Bridge and BART's Transbay Tube. The corridor is served by a variety of transportation options using that infrastructure, including conventional automobiles traveling on the Bay Bridge, the BART Transbay Tube, AC Transit and WestCat buses, suburban buses, and WETA ferries. Without capacity-increasing investment, the Transbay Corridor will continue to face the same issues in the future.

This Hybrid Comprehensive Multimodal Corridor Plan brings together two studies that worked to address these Transbay Corridor deficiencies in the short-, medium-, and long-term. The Bay Area Core Capacity Transit Study (BACCTS), published in 2017, was a multi-agency effort led by the Metropolitan Transportation Commission, meant to identify the primarily short- and medium-term transit improvements necessary in order to meet Transbay Corridor demand. Crossings: Transformative Investments for an Uncertain Future (referred to as Crossings), was one in a series of Perspective Papers developed as a part of the Horizon initiative led by the Metropolitan Transportation Commission (MTC) and the Association of Bay Area Governments (ABAG).

As a part of the Solutions for Congested Corridors Program guidelines for funding, San Francisco Bay Area Rapid Transit District (BART) presents this Hybrid Comprehensive Multimodal Corridor Plan, developed in accordance with Cycle 2 guidelines, to supplement the grant application and demonstrate the necessity of the Train Control Modernization Program as it relates to these existing plans and the future of the Transbay Corridor as a whole.

This Hybrid Corridor Plan was developed with significant support and guidance from both MTC and the California Department of Transportation (Caltrans).

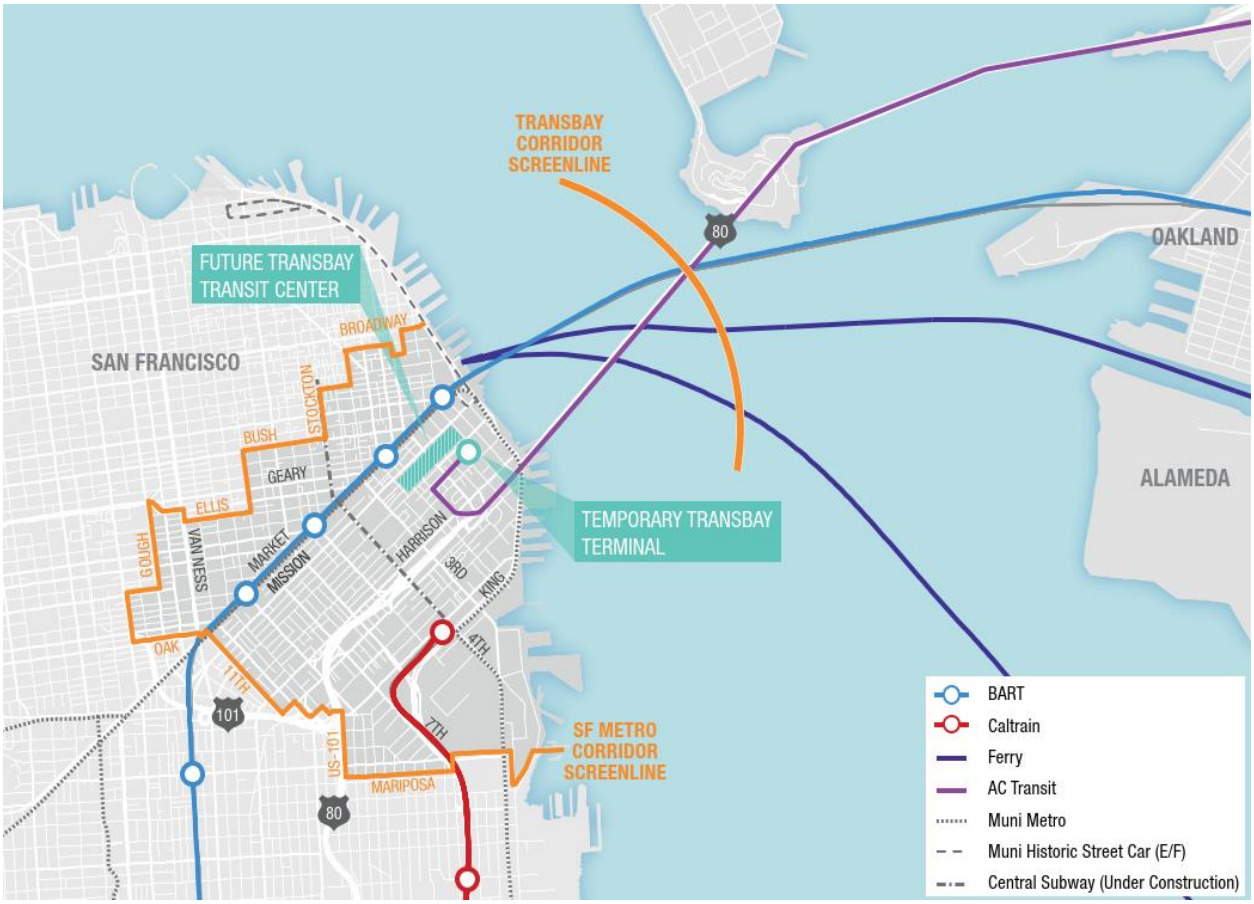
The following subsections give an overview of the Transbay Corridor and associated capacity and demand, future growth for the region, and an overview of the Train Control Modernization Program.

2.1 System Overview

The San Francisco Core (or simply, the Core, per the BACCTS) is the largest concentrated transit market west of Chicago. The Core represents an area larger than the traditional downtown or Financial District of San Francisco. The Core covers an area approximately bounded by 17th Street to the south, Gough and 11th Streets to the west, the San Francisco Bay to the east, and California Street and Pacific Avenue to the

north. This area expands the traditional central business district definition to include emerging job centers and defines subareas including the Financial District, South of Market (SoMa), Mid-Market, and Mission Bay. Travel to the Core is through two travel corridors; the Transbay Corridor and the San Francisco Metro Corridor. Each corridor is served by different transit operators and faces different service and infrastructure challenges. The Train Control Modernization Program (TCMP) project will directly affect the capacity potential in the Transbay Corridor and will be discussed in detail throughout the subsequent sections. Figure 2-1 depicts the screenlines for the Transbay and SF Metro Corridors, along with the transit agencies that support each corridor. As of August 2019, the Transbay Transit Center, now known as the Salesforce Transit Center, was completed and the Temporary Transbay Terminal was closed for use.

Figure 2-1: Transbay Corridor Screenlines



Source: Bay Area Core Capacity Transit Study

2.1.1 The Transbay Corridor

The Transbay Corridor encompasses travel between the East Bay and San Francisco and the Peninsula and is roughly defined as the area between the Bay Bridge and the San Mateo-Hayward Bridge to the southeast. Travel in the corridor is multi-

destinational, and includes travel between the counties to the east, including Alameda, Contra Costa and Solano counties, and the Sacramento Region, connecting with the West Bay destinations of the downtown San Francisco Core, San Francisco outside the downtown core, and travel through to the Peninsula. The Transbay Corridor is multimodal in nature and is composed of two major pieces of infrastructure; the San Francisco-Oakland Bay Bridge, and BART's Transbay Tube. The Transbay Corridor is served by a variety of transit service options, including Alameda-Contra Cost Transit District (AC Transit) buses on the San Francisco–Oakland Bay Bridge (the Bay Bridge), BART trains in the Transbay Tube, Water Emergency Transportation Authority's (WETA) San Francisco Bay Ferry terminals and routes, and other suburban bus operators on the Bay Bridge. Shaped by the geography of the bay, this corridor is defined by the individual routes that serve the Core. Transit access to the Core through the Transbay Corridor is achieved via the following:

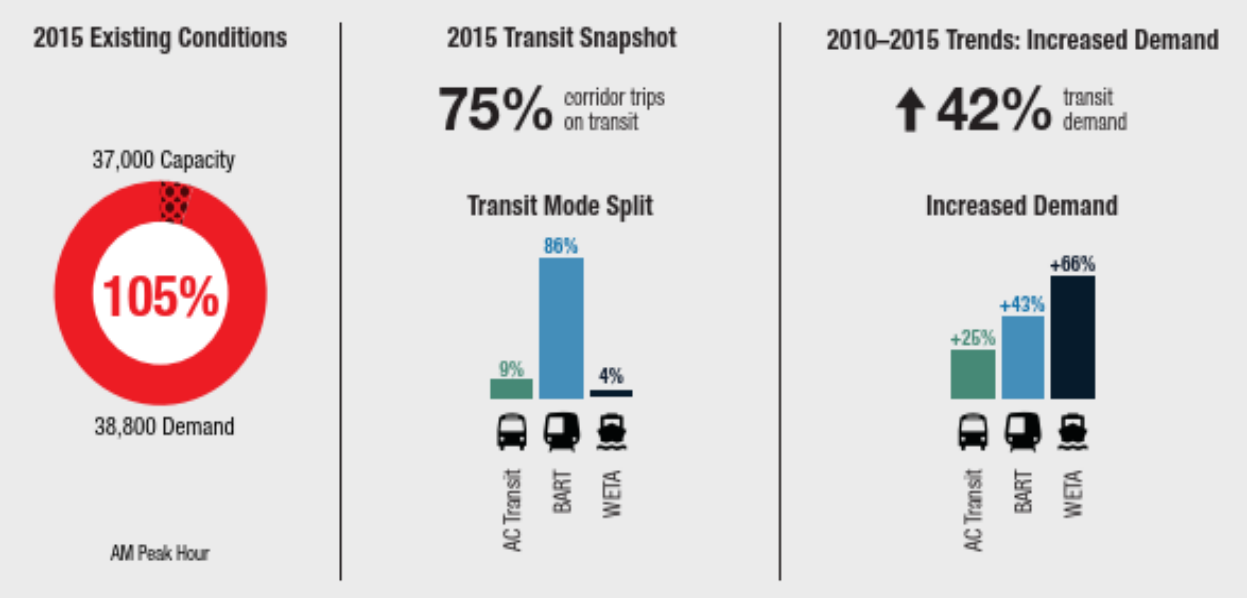
- BART Transbay Tube: This immersed twin-chamber tube incorporates one westbound and one eastbound track. The tube stretches 5.8 miles, from the Oakland Outer Harbor to the Embarcadero in San Francisco and is a key piece of infrastructure on the regional BART rail system.
- Bay Bridge: Buses use the Bay Bridge, and starting east of the toll plaza, they have dedicated queue-jump lanes and other priority measures for westbound travel.
- San Francisco Bay: Used by ferries, the bay is another transportation resource that provides additional capacity to the Core.

2.1.2 Transbay Corridor Capacity and Demand

The Transbay Corridor represents travel from the East Bay to San Francisco and is served by a variety of transit service options, including AC Transit buses on the San Francisco–Oakland Bay Bridge (the Bay Bridge), BART trains in the Transbay Tube, WETA's San Francisco Bay Ferry terminals and routes, and other suburban bus operators.

Bay Area residents make around 500,000 Transbay trips on a typical workday. The San Francisco-Oakland Bay Bridge carries approximately 270,000 vehicles per day, and BART's Transbay Tube transports approximately 230,000 passengers in the corridor. During 2018 peak hours, BART carried approximately two-thirds of the Transbay trips, with approximately 27,000 BART riders per hour, and approximately 14,000 people per hour on the Bay Bridge in cars and buses.

Figure 2-2: Transbay Corridor Snapshot AM Peak Hour

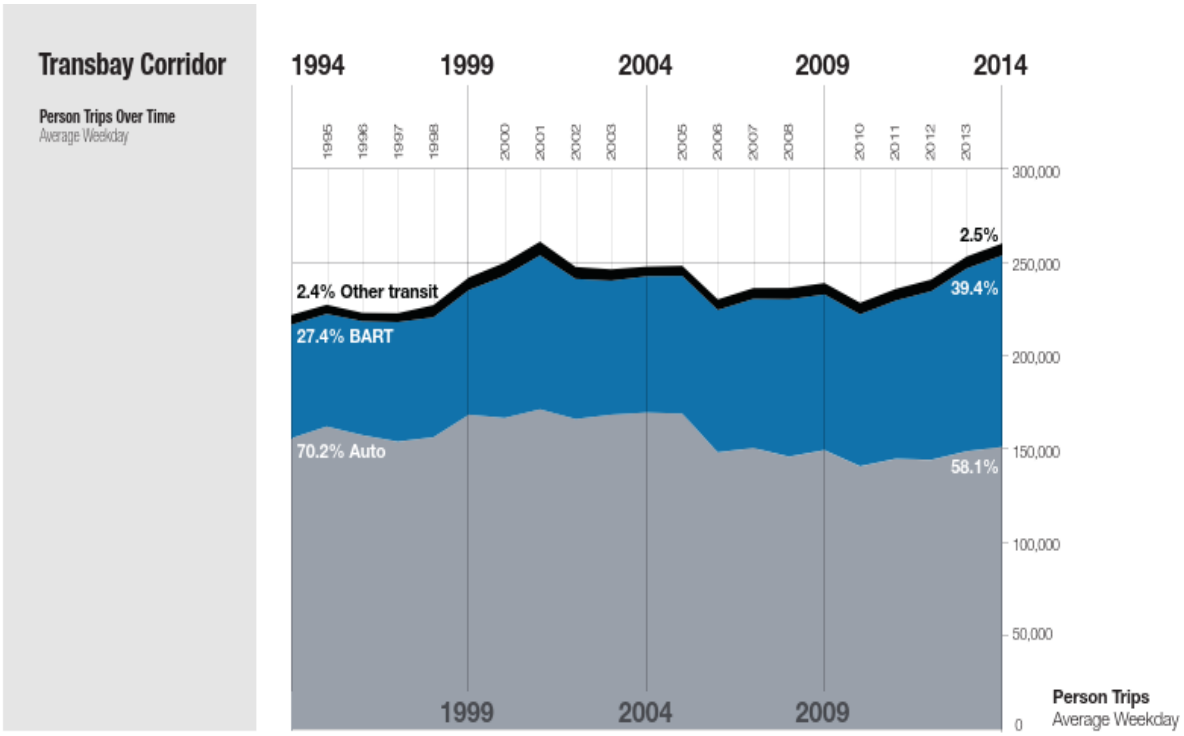


Source: Bay Area Core Capacity Transit Study

Travel demand in the Transbay Corridor has grown significantly over the past decade, resulting in overcrowded highways and transit systems. The Bay Bridge and BART are operating at or above capacity for much of the weekday peak hours, with the Bay Bridge and its approaches occupying the second spot on the region's list of most-congested freeway corridors as of 2018. The current level of travel demand in the corridor is placing significant strain on the transit network, particularly operators serving the Core. In 2015, overall peak-hour demand was 38,800 morning peak-hour trips, of which nearly 29,000 trips (75%) were on transit, an increase of 42% since 2010, as displayed in Figure 2-2.

Meanwhile, based on transit schedules and the operators' stated policy capacities per vehicle, the corridor had capacity for 37,000 peak-hour trips in 2015, of which 27,000 could be carried on transit; this means that demand exceeded capacity and the corridor had an occupancy rate of 105%. BART, which carries nearly two-thirds of all peak-hour trips in the corridor, operated at 110% of policy capacity. Figure 2-3 shows that over the last several decades, transit has carried an increasing share of trips in the corridor; almost 40% as of 2014. Additionally, ridership on AC Transit Transbay buses and WETA ferries nearly reached their policy capacity levels (94% and 96%, respectively). With the corridor operating over capacity, even minor incidents like service delays and breakdowns can trigger major ripple effects throughout the entire system.

Figure 2-3: Historic Transbay Corridor daily person trips by mode, 1994-2014



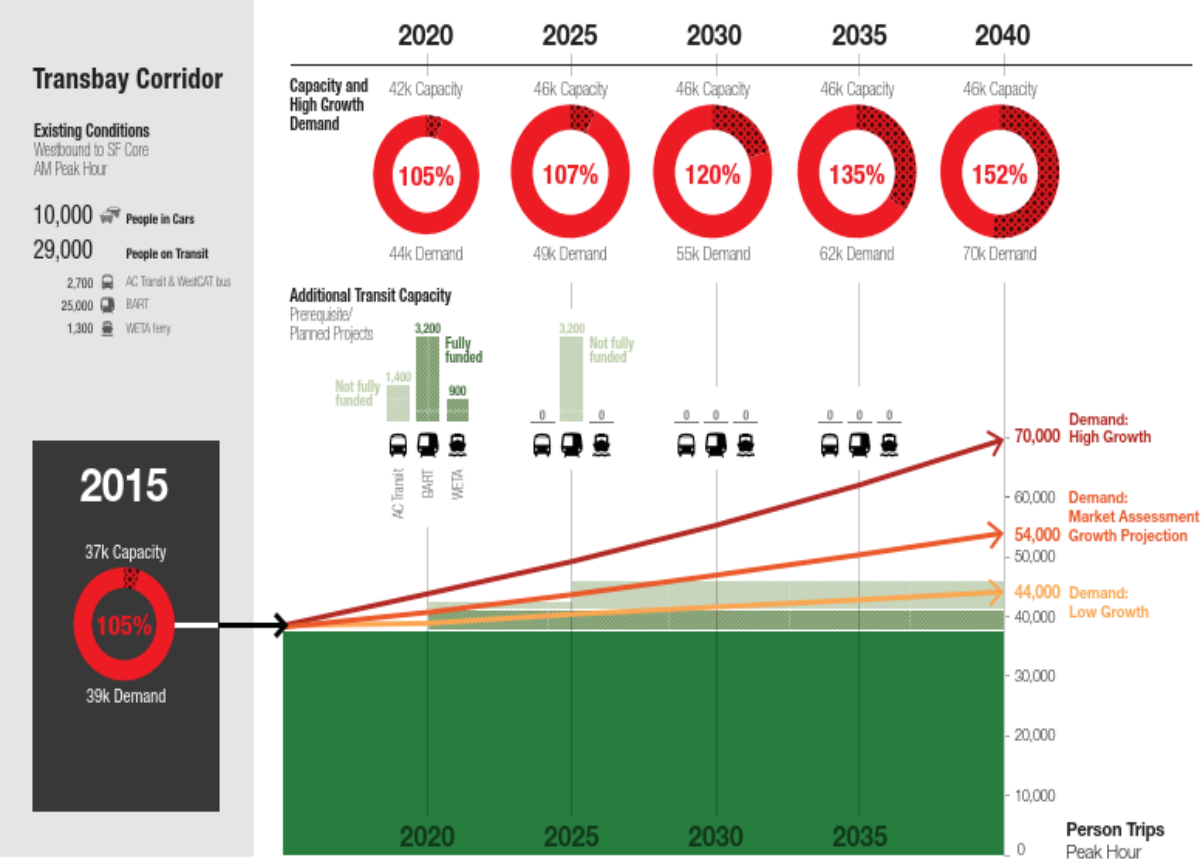
Source: Bay Area Core Capacity Transit Study

2.1.3 Future Growth

If transit demand in the corridor continues growing at a rate similar to 2010 through 2015, capacity will be inadequate to meet demand, even with planned prerequisite projects. Figure 2-4 illustrates how Transbay Corridor capacity compares to a range of potential growth in transit demand between 2015 and 2040. Past regional plans establish the upper and lower bounds for potential growth in demand, while the BACCTS identifies a medium ('Market Assessment') growth line of 1.35% annually, which reflects forecasted employment growth over the period.[1] This medium growth rate is also approximately the same as the rate used by the preferred scenario for Plan Bay Area 2040, the update to Plan Bay Area approved in 2017.

[1] The high growth rate is based on MTC's Transportation 2035, while the low growth rate is based on *Plan Bay Area*

Figure 2-4: Forecast Transbay Corridor peak-hour capacity and demand 2015-2040



Source: Bay Area Core Capacity Transit Study

Growing at the medium rate from 2015, demand in the Transbay Corridor would increase by more than 14,000 trips by 2040. In the same period, planned projects, which include the TCMP, are expected to increase capacity by 12,000 trips, which when combined with the 2015 capacity shortfall, results in a 4,000-trip capacity shortfall. Future growth in demand will need to be met by transit due to capacity constraints on the bridge.

Growth in travel demand is driven by local, regional, and national demographic and real estate market trends. As the region has recovered from the Great Recession, the technology industry and related sectors have driven rapid and significant growth. Between 2010 and 2014 alone, San Francisco employment grew 25%, surpassing the projections from the last regional transportation plan, Plan Bay Area 2040. How and where employment growth occurs in the Core and the region will have significant impacts on long-term demand for transit service and thus where investments in expanded capacity will be necessary.

2.1.4 Train Control Modernization Program (TCMP)

The BART Train Control Modernization Program (TCMP) is a $1.14 billion investment to replace the existing train control system with a new communication-based train control system and associated train control power cables and interlock cables, allowing BART to achieve the shorter headways needed to operate 30 regularly scheduled trains per hour on the trunk line between Daly City and the Oakland Wye. The new communications-based train control system will be based on a moving block signaling approach throughout the existing system and will be installed within or adjacent to the existing BART trackway and wayside facilities. New zone controllers, interlocking controllers and wayside radio transponder tags will be installed throughout the trackside alignment, train control rooms and central control facilities. Cars and maintenance vehicles will be outfitted with processor-based controllers, transponders, communication equipment and location sensors.

The TCMP is a part of BART's Transbay Corridor Core Capacity Program, a comprehensive program of projects that will increase capacity, relieve congestion and crowding, increase transit ridership, and decrease greenhouse gas (GHG) emissions and vehicle miles traveled (VMT) by increasing the frequency and capacity of trains operating on the BART heavy rail system. The Core Capacity Program will allow the number of trains operating through the Transbay Tube to increase from 23 to 30 per hour, and peak hour train lengths to be increased from an average of 8.9 cars to 10, maximizing throughput capacity in the most heavily used and most congested travel corridor in the San Francisco Bay Area. BART's Transbay Corridor Core Capacity Program has four major project components:

1. Train Control Modernization Program (TCMP)
2. an additional 306 new rail cars;
3. additional vehicle storage at BART's Hayward Maintenance Complex (HMC); and
4. five new traction power substations.

The TCMP is the linchpin of BART's Transbay Corridor Core Capacity Program and is key to expanding capacity as well as enhancing system reliability and safety. In 2017, between 15 and 25 percent of all delayed trains were caused by problems with the existing train control system, which is over 45 years old. BART is proposing to completely replace its aging and obsolete equipment with a communications-based system which will allow trains to run closer together safely, thereby increasing system capacity. This new system is a fully tested and operational system and is used all over the world including New York, London, Paris, Hong Kong and Denmark.

2.2 Hybrid Comprehensive Multimodal Corridor Plan Development

Streets and Highways Code 2391 requires that Solutions for Congested Corridors Program (SCCP) funding "be available for projects that make specific performance improvements and are part of a comprehensive corridor plan designed to reduce

congestion in highly traveled corridors by providing more transportation choices for residents, commuters, and visitors to the area of the corridor while preserving the character of the local community and creating opportunities for neighborhood enhancement projects."

The California Transportation Commissions (CTC) 2018 Comprehensive Multimodal Corridor Plan guidelines, in recognition of the length of time needed to complete a comprehensive multimodal plan, have allowed agencies to conduct an integrated analysis of existing plans within a corridor, also known as a "Hybrid Plan" to define the corridor.

BART, as a part of the agency's SCCP funding application for the TCMP, has created this Hybrid Plan, bringing together the Bay Area Core Capacity Transit Study and the Horizon Crossings Perspective Paper. In both plans, the TCMP projects are described as a priority; projects that are necessary to increase capacity BART trains in order to meet the growing demand within the Transbay Corridor. The TCMP projects are also classified as priority projects within the California State Rail Plan, discussed in more detail in Section 5.2 of this plan.

2.2.1 Bay Area Core Capacity Transit Study (BACCTS)

The Bay Area Core Capacity Transit Study (BACCTS), published in 2017, was a collaborative multiagency effort to examine the Bay Area transit system's capacity limitations and identify and prioritize the major investments needed to address these limitations. While all the transit operators serving San Francisco independently consider various improvements to their respective systems, no prior study had brought the major transit operators together to address this regional issue in a comprehensive, coordinated manner. The purpose of the BACCTS was to determine what types of transit investments are necessary and when they are needed while being able to safely and reliably move a growing number of people to and from San Francisco's core job centers.

To answer this question, the BACCTS did the following:

1. Assessed current and future capacity and demand for travel to San Francisco's main job centers, both from within San Francisco and from the East Bay
2. Developed and assessed potential transit investment projects and Bay Bridge pricing proposals to address the challenges facing travelers, including transit congestion, bridge congestion, reliability, and redundancy
3. Identified a recommended set of transit investments, which included high level engineering and cost estimates, to address short- and medium-term challenges and bundled them into packages of investments; all packages considered followed a certain set of criteria, with each package containing certain prerequisite projects necessary to reach the assumed minimum baselines (including the BART TCMP)

4. Proposed potential long-term investment options to improve capacity and system resiliency in the future
5. Recommended a single package of short-and medium- term investment projects for each corridor (Transbay and SF Metro)

Based on the results of the analysis, the BACCTS concluded that any short- and medium-term package recommendation should reflect priorities of more service, supportive infrastructure to improve reliability, and toll increases to help manage queues and improve bus transit reliability, with transit fare adjustments to be considered on an as-needed basis. The proposed long-term investment options, which recommended a new Transbay crossing, were further refined in the *Horizon Crossings* plan, described in the following section.

2.2.2 Crossings: Transformative Investments for an Uncertain Future

The Crossings study, published in 2019, was one in a series of Perspective Papers developed as a part of the Horizon Initiative. Led by the Metropolitan Transportation Commission (MTC) and the Association of Bay Area Governments (ABAG), the Horizon Initiative is a planning effort that comprehensively addresses transportation, housing, economic development, and environmental resilience. Horizon considers three 'what-if' scenarios for the future of the nine-county region in order to expand the traditional long-range planning process and incorporate uncertainty from a wide range of external forces. These what-if scenarios include "Rising Tides, Falling Fortunes" in which the population of the Bay Area increases by just 1 million people over the next 30 years; a "Clean and Green Future" in which the region's population increases by a bit more than 3 million; and "Back to the Future" in which, by 2050, some 6 million more people call the Bay Area home. These scenarios are shown in Table 2-1.

Table 2-1: Horizon Futures Characteristics (Year 2050)

	Rising Tides, Falling Fortunes	Clean and Green	Back to the Future
Immigration and Trade	**Reduced** +20,000 Immigrants Annually	**Similar to Today** +80,000 Immigrants Annually	**Increased** +240,000 Immigrants Annually
National Growth	**Limited** +1.6% Annual Productivity +0.4% Annual U.S. Population	**Similar to Today** +2.8% Annual Productivity +0.7% Annual U.S. Population	**Rapid** +1.1% Annual U.S. Population +1.6% Annual Productivity
National Taxes and Funding	**Lower Funding** Due to Tax Cuts	**Higher Funding** Via Carbon Tax	**Similar to Today**
Land Use Preferences	**Housing More Urban**	**Housing More Urban**	**Housing More Dispersed**
	Jobs Similar to Today	**Jobs More Dispersed**	**Jobs More Urban**
National Environmental Policy	**Relaxed Regulations** +3-feet Sea Level Rise 10% Electric Vehicles	**Stricter Regulations** +1-foot Sea Level Rise 95% Electric Vehicles	**Stricter Regulations** +2-foot Sea Level Rise 75% Electric Vehicles
New Technologies	**More Limited** 10% Autonomous Vehicles 10% Telecommute Share	**Widespread** 95% Autonomous Vehicles 30% Telecommute Share	**Widespread** 75% Autonomous Vehicles 15% Telecommute Share
LEGEND	LOWER	SIMILAR TO TODAY	HIGHER

Source: Crossings: Transformative Investments for an Uncertain Future

The Crossings Perspective Paper was developed to test the extent to which potential new crossings of the San Francisco Bay can be expected to perform in each of these scenarios. The Crossings paper accomplishes this by making observations about the relative merits of seven different potential Transbay crossings with respect to mode and performance under these different scenarios and includes recommendations about which crossings should be analyzed further. The Crossings report does not provide specific conclusions about the selection of any specific crossing but will be used to inform the development of Plan Bay Area 2050, the region's long-term planning document for transportation, housing, the economy, and the environment.

The Crossings report picked up where the BACCTS left off, incorporating a study of a possible new Transbay crossing into the Horizon framework and ultimately informing the inclusion of a potential crossing in Plan Bay Area 2050. Seven crossing concepts were selected for evaluation in the Crossings paper, including two auto-only concepts, two BART-only concepts, one conventional rail concept, one combined auto and BART concept, and one combined BART and conventional rail concept. A map of these concepts can be seen in Figure 2-5.

Figure 2-5: Map of Crossing Concepts

Source: Crossings: Transformative Investments for an Uncertain Future

These 21 “build” models (seven concepts, each with three Horizon futures) were compared against three “no-build” scenarios that simulated the impacts across all three futures of not adding a new crossing. A summary of the seven crossing concepts can be seen in Table 3-3. The Crossings paper recommended that the three transit-only crossing concepts be advanced for further analysis, along with the paired BART/auto and BART/Rail concepts. The Crossings study also concluded that phased delivery of interim capital improvements and service enhancements to the existing corridor, such as the TCMP, could provide near-term mobility upgrades and help lay a foundation for later construction of a new crossing.

3 Plan Comparison

3.1 Corridor Plan Principles

The BACCTS and Crossings paper were both created to align with certain guiding principles that informed the packages and concept development of each plan respectively. The BACCTS principles establish transit as the priority mode for capacity investments into the San Francisco Core while emphasizing cohesive operations, customer convenience and safety, and system resilience to unplanned events. Used as an evaluation criterion in the study, the BACCTS principles can be described by answering the following questions:

- **Capacity**: How many more people can be carried by transit?
- **Utilization**: How much of the capacity offered is expected to be used?
- **Reliability**: To what degree is variability in travel time reduced, in order to make the transit trip more attractive and competitive for users?
- **Efficiency**: How much will it cost?

The Crossings plan is guided by five principles, depicted in Figure 3-1.

Figure 3-1: Horizon Crossings Guiding Principles

AFFORDABLE	All Bay Area residents and workers have sufficient housing options they can afford – households are economically secure.	Does the project increase travel costs for lower-income residents?
CONNECTED	An expanded, well-functioning, safe and multimodal transportation system connects the Bay Area – fast, frequent and efficient intercity trips are complemented by a suite of local transportation options, connecting communities and creating a cohesive region.	Does the project increase travel times or eliminate travel options?
DIVERSE	The Bay Area is an inclusive region where people from all backgrounds, abilities and ages can remain in place – with full access to the region's assets and resources.	Does the project displace lower-income residents or divide communities?
HEALTHY	The region's natural resources, open space, clean water and clean air are conserved – the region actively reduces its environmental footprint and protects residents from environmental impacts.	Does the project significantly increase emissions or collisions?
VIBRANT	The Bay Area is an innovation leader, creating quality job opportunities for all and ample fiscal resources for communities.	Does the project eliminate jobs?

Source: Crossings: Transformative Investments for an Uncertain Future

The following subsections highlight the connections between the guiding principles of both studies.

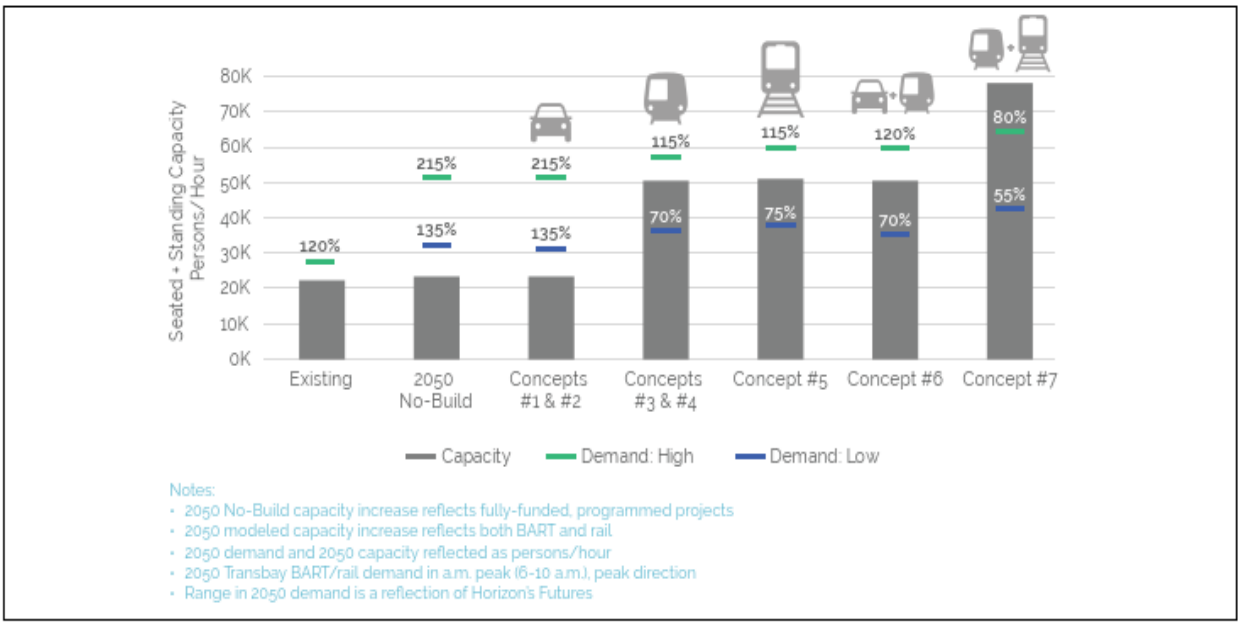
3.1.1 Capacity

The first guiding principle of the BACCTS notes that “transit will be the preferred mode to supply increased capacity for travel between the East Bay and the San Francisco Core, and for trips within San Francisco”.

The BACCTS identified three types of projects that can improve capacity: more transit service, new transit-priority infrastructure, and policy changes. By adding more transit service in the corridor, overall passenger throughput is increased, especially during peak periods when transit carries a significantly higher share of person trips than automobiles on the Bay Bridge. Service can be augmented by increasing vehicle frequencies and fleet size, both of which are accomplished through the TCMP. Investments in transit-priority infrastructure can be implemented to increase speed, improve travel time reliability and ultimately help the system maximize person throughput. Improvements such as adding transit priority to surface streets and adding direct freeway access ramps reduce the impacts of congestion on bus travel and make transit a more appealing competitor to driving. Finally, policy changes that affect automobile tolls and fares can be implemented to influence travel behavior and reduce congestion by encouraging travelers to switch their travel mode or change the time of day when they travel. The BACCTS considered each of these types of projects in order to increase capacity along the Transbay Corridor.

For the Crossings paper, the seven crossing concepts represent both modernization and expansion improvements. Modernization projects involve upgrading existing assets with infrastructure that provides more service or more capacity, while expansion projects involve physically extending a rail line or adding lanes to a roadway. The Crossings paper modeled 2050 Transbay transit capacity versus modeled 2050 transit demand for each of the different crossing concepts. The results, shown in Figure 3-2 below, indicated that in 2050, the two auto-only crossing concepts (#1 and #2) would provide little to no relief for crowding in the existing BART tube, while the transit-only crossing concepts (#3, #4, and #5) would ease transit crowding. Lastly, while Concept #7 reduces crowding, it also may deliver more capacity than needed in 2050 in any of the three Horizon futures.

Figure 3-2: Transbay BART/Conventional Rail - 2050 Modeled Capacity vs. Demand



Source: Crossings: Transformative Investments for an Uncertain Future

The Crossings paper, by addressing capacity as it relates to future transportation needs, accomplishes its guiding principle of “Connected” by prioritizing a transit system that decreases travel times and increases travel options for people traveling through the Transbay Corridor.

Clearly, both studies place a large focus on capacity building, and the need to meet future demand in the Transbay Corridor. The TCMP plays an essential part in this, as it will increase the capacity of BART trains by reducing headways and increasing peak hour train lengths from an average of 8.9 to 10.

3.1.2 Other Corridor Principles

Other than increasing capacity along the Transbay Corridor, the BACCTS and Crossings studies use several other guiding principles to determine the recommended transportation investments for the region.

The BACCTS used utilization, reliability, and efficiency to determine which of the short- and medium-term investment options would be best suited for the corridor. In order to address these objectives, the BACCTS required that each investment package evaluate a combination of additional transit service (new bus and ferry fleet), new infrastructure (new transit priority right-of-way, yards, and terminals), and small to medium toll increases.

The utilization objective was addressed by evaluating current and future demand needs of the Bay Area. Prior to modeling travel demand, MTC conducted a Market Assessment for San Francisco to develop a range of future growth scenarios based on

historical employment, market, and land use trends. These trends were used to inform the analysis conducted on future travel demand in the San Francisco Core. Using MTC's regional travel demand model and a toll bridging queue model, the BACCTS was able to understand the impacts of each package of improvements on travelers' mode and route choices, estimating future regional trips using MTC's 2030 population and employment forecasts, thereby ensuring that any proposed package will be utilized. For the recommended package, the BACCTS noted that in addition to the prerequisite and recommended projects, each operator will need to increase the size of its fleet in order to meet the BACCTS utilization objective.

Every package within the BACCTS addresses reliability in some manner. Package 1, which suggests small, medium, and large peak-period auto toll increases, improves bus service reliability by reducing auto congestion along the toll plaza. Package 2 combines an increase in auto tolls with additional transit; increasing AC Transit Transbay bus service and ferry service from Oakland, Alameda, and Vallejo during the peak hour for more service reliability. Both Packages 3 and 4 increase service reliability in similar ways.

In terms of efficiency, and how much the proposed improvements will cost, the BACCTS evaluates the cost of the recommended improvement, a modified version of Package 3. This analysis also includes evaluation of potential cost of the prerequisite projects, including the TCMP. In total, the proposed packages improvements are $4.8 billion, with annual operating costs of $85 million.

As a part of the Transbay crossing concept evaluation, the Crossings paper scored each concept on its ability to align with each of the Crossings principles using specific project focused criteria, outlined in Figure 3-1. The results are shown in Figure 3-3 below. The two auto-only Concepts (#1 and #2) do not support the Healthy principle due mainly to the added number of vehicle trips induced by a new auto crossing and by the expected increase in emissions and collisions. The transit and conventional rail concepts by contrast are expected to reduce emissions and collisions, while also aligning with the Affordable, Connected, Diverse, and Vibrant principles. The TCMP is an integral part of any crossing concept involving BART, as it will increase capacity and reliability of the existing system in the short- and medium-term, while opening a path for a new Transbay crossing to be built in the long-term.

Figure 3-3: Crossing Concepts: Alignment with the Guiding Principles

Mode	Crossing	Affordable	Connected	Diverse	Healthy	Vibrant
	Concept #1	–	–	–	✗	–
	Concept #2	–	–	–	✗	✗
	Concept #3	–	–	–	–	–
	Concept #4	–	–	–	–	–
	Concept #5	–	–	*	–	*
	Concept #6	–	–	✗	–	–
	Concept #7	–	–	*	–	*

✗ Does not Support Principle

* Impacts to this Guiding Principle occur outside the Transbay corridor due to grade separations on the Peninsula, which are required to maximize frequencies through a conventional rail crossing.

Source: Crossings: Transformative Investments for an Uncertain Future

3.2 Planning Horizons

3.2.1 Short- and Medium-Term

The BACCTS placed a considerable amount of focus on the prerequisite, short-, and medium-term needs of the region by developing packages of projects that have the potential to address the gap in demand in the short- and medium-term. The analysis concluded with the identification of a recommended package.

Each package uses a different combination of projects to address capacity shortfalls in a distinct way, with the major types of projects being service, infrastructure, tolling, and transit fare adjustments. The packages are focused on improving transit capacity in the short term (within five years) and medium term (within 15 years). The packages consist of three types of projects:

1. **Prerequisite projects:** Planned projects in the corridor with full or partial funding commitments identified by operators and the plan as necessary to be fully funded and implemented. This category includes BART's TCMP.
2. **Projects common to all packages:** Projects identified by the Project Management Team (PMT) as important to include in every package under consideration
3. **Package-specific projects:** The headline projects that define the package theme and differentiate the corridor packages from one another

Certain improvement projects are classified as both prerequisites and common projects because they are critical to the Transbay Corridor no matter which package is recommended. In particular, the BACCTS noted that it is essential that the following projects be fully funded as a basis for moving forward:

- New and replacement BART cars
- New train control (TCMP) and power system
- New and expanded maintenance facility

The prioritization of the TCMP in the BACCTS further highlights the essential nature of this project to increasing capacity along the Transbay Tube. Once these prerequisite projects had been identified, the different investment packages were created, summarized in Table 3-1.

Table 3-1: Summary of BACCTS Short- and Medium-Term Investment Packages

#	Package	Summary	Key features
1	Tolls only	Manage Bay Bridge travel demand with increased peak-period auto tolls	• Raise tolls to reduce queues during peak commute periods • Reduce queues enough to ensure buses can access the high-occupancy vehicle (HOV) lanes leading to the bridge
2	Transit and tolls	Add new bus and ferry service and improve Transbay bus service reliability by raising Bay Bridge automobile tolls to reduce toll plaza queues	• Package 1 elements • Add 50 peak-hour bus trips • Increase ferry frequencies to 15- and 30-minute headways • If needed, adjust transit fares to balance passenger loads
3	Infrastructure, transit, and tolls	Add new transit infrastructure to the toll plaza to improve service reliability, implement additional bus and ferry service, and improve Transbay bus service reliability by raising Bay Bridge automobile tolls	• Package 1 and 2 elements (raise tolls, increase bus and ferry service) • Refurbish an old Key System tunnel to create a separate, dedicated bus access route to toll plaza • Make surface street improvements (such as bus lanes and priority features) to reduce bus travel time
4a	Contraflow lane, infrastructure, transit, and tolls	Provide a dedicated bus lane on the lower deck of the bridge in the morning, add new transit infrastructure to the toll plaza to improve service reliability, implement additional bus and ferry service, and improve Transbay bus service reliability by raising Bay Bridge automobile tolls	• Package 1, 2, and 3 elements (raise tolls, increase bus and ferry service, provide dedicated bus access route to toll plaza, improve surface streets to reduce bus travel time) • Raise tolls to reduce queues and increase bus and ferry service as above • Convert one lane of the Bay Bridge lower deck for morning westbound Transbay bus traffic
4b	Bus-only / bus + HOV lane, infrastructure, transit, and tolls	Provide a dedicated bus or bus + HOV lane on the upper deck of the bridge, add new transit infrastructure to the toll plaza to improve service reliability, implement additional bus and ferry service, and improve Transbay bus service reliability by raising Bay Bridge automobile tolls	• Package 1, 2, and 3 elements (raise tolls, increase bus and ferry service, provide dedicated bus access route to toll plaza, improve surface streets to reduce bus travel time) • Raise tolls to reduce queues and increase bus and ferry service as above • Convert one lane of the Bay Bridge upper deck for westbound Transbay buses or bus + HOVs

Source: Bay Area Core Capacity Transit Study

The Crossings paper does not include any detailed analysis on short- and medium-term investments for the Transbay Corridor, but rather highlights the importance of the investments outlined in the BACCTS. The short- and medium-term investments, including the TCMP, are considered a critical step towards long-term investments in the Transbay Corridor, discussed further in the next section.

3.2.2 Long-Term

In addition to developing packages of projects to increase transit capacity to the San Francisco Core over the short and medium term, the BACCTS also developed options

to address potential capacity shortfalls over the long term for the Transbay Corridor. In order to address opportunities in the long term, the BACCTS considered a different set of issues and concerns compared with the short and medium term. The study focused on several topic areas in developing the long-term options, including new transit markets, system redundancy, technical and operational considerations, and issues of governance and ownership. The long-term options were designed to be large-scale in nature, reflecting the continued need to provide additional transit capacity into the long term. Four long-term options were developed, summarized in Table 3-2.

Table 3-2: BACCTS Long-Term Transbay Corridor Options

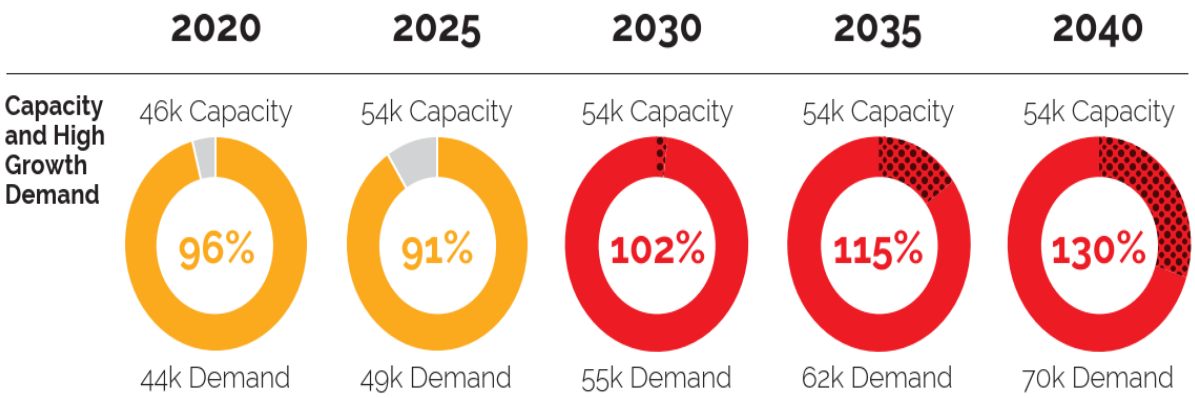
#	Option	Summary	Key features	Key opportunities and challenges
1	Maximize existing assets	Maximize and/or improve the Transbay Corridor's existing infrastructure assets, including maximizing utilization of the Transbay Transit Center capacity, increasing BART station capacity at Embarcadero and Montgomery Stations, and creating a more robust ferry network	• More Transbay bus service • More transit-priority infrastructure • More ferry service • BART side platforms* at Embarcadero and Montgomery stations	Opportunities: • Maximizes use of Transbay Transit Center • Maximizes existing bus and ferry services • Less capital cost compared to other long-term options Challenges: • Requires additional fleet and infrastructure to maintain reliability and new service levels • Amount of estimated new capacity may be fully utilized by opening day
2	BART Market Street redundancy	Provide redundancy for BART in the Market Street corridor serving the Financial District, providing BART with similar access and service to the Core's most job-dense subarea, and capacity relief to existing stations	Third Street suboption: • Serves new markets in SoMa • Station connection feasibility at Powell Station • Independent line • Utilizes either I-980 or Broadway corridor option in East Bay	Opportunities: • Creates transfer opportunity to Market Street corridor • Provides new East Bay access to Mission Bay/SoMa • Provides highest estimated capacity of all long-term options • Potential to serve major new corridor in San Francisco Challenges: • Lengthy connection to Montgomery Station • May not relieve crowding at Embarcadero and Montgomery stations as much as the Mission Street suboption
			Mission Street suboption: • Could serve Transbay Transit Center • Independent line • Utilizes either I-980 or Broadway corridor option in East Bay • Could serve new markets outside of downtown	Opportunities: • Creates redundant Market Street corridor service and transfer opportunity to Transbay Transit Center • Provides highest estimated capacity of all long-term options Challenges: • Does not open to new markets in downtown San Francisco
3	BART new markets	Provide new regional transit access to areas of the Core not currently served by BART	Brannan Street suboption: • Includes merge/breakout concept • Potential need for side platforms at Embarcadero and Montgomery • Utilizes either I-980 or Broadway corridor option in East Bay	Opportunities: • Provides direct connection to Market Street • Provides new East Bay access to Mission Bay/SoMa Challenges: • Breakout option reduces overall capacity through the Market Street corridor and provides less new capacity when compared to the independent line • Breakout option creates significant capacity constraints and potentially unacceptable operational constraints
			Mission Bay suboption: • Includes merge/breakout concept • Potential need for side platforms at Embarcadero and Montgomery • Utilizes either I-980 or Broadway corridor option in East Bay	
4	Greater regional rail connection	Provide a conventional rail crossing centered on the new Transbay Transit Center, transitioning it to a run-through terminal and connecting Peninsula rail to East-Bay-and-beyond rail service	• In San Francisco, connects to Caltrain corridor via planned Downtown Extension • In the East Bay, utilizes the I-980 corridor and connects to BART service at MacArthur Station and Amtrak/Capitol Corridor service in Emeryville	Opportunities: • Increases rail capacity of Transbay Transit Center • Connects to proposed Downtown Extension connection through SoMa and Mission Bay Challenges: • Complex governance and ownership issues • Amount of estimated new capacity may be fully utilized by opening day if implemented without BART improvements • Significant operational (slot) challenges on both Peninsula and Capitol Corridor, no right-of-way, and requirement for completely new station on the East Bay side

Source: Bay Area Core Capacity Transit Study

Prior to developing potential alignments and station locations in the long term, the BACCTS advanced specific engineering studies and market assessments in order to identify and address any fatal flaws in the early stages of option development. This provided needed information at the onset while also reducing future analysis efforts during later stages of the study.

The primary focus of the Crossings Perspective Paper is to develop a set of options for a new Transbay crossing in order to meet future demand in the region. The study notes that even though BARTS near-term improvements, such as the TCMP, will provide some relief to the system, it will only help the region buy some time, as shown in Figure 3-4.

Figure 3-4: Transbay Corridor Capacity and Demand with Short- and Medium-Term Improvements recommended in the BACCTS



Source: Crossings: Transformative Investments for an Uncertain Future

Development of the Crossings study began with a long list of concepts based on several sources including the BACCTS, followed by BART, Caltrans and other transportation agency refinement to a shorter list of those concepts that best demonstrated benefits in relieving congestion and increasing accessibility in the Transbay Corridor while also providing a diversity of travel modes and geographic spread. The Crossings analysis intentionally excluded concepts focused on ferry service and/or bus expansion, given that those improvements were already reflected in the short- and medium-term investment priority list from the BACCTS (more in Section 3.3).

The Crossings paper evaluation included a performance assessment under each of the three future scenarios envisioned under the Horizon initiative. Each of these futures have certain characteristics, seen in Table 2-1, that are meant to expand the traditional long-range planning process and incorporate uncertainty from a wide range of external forces.

The first Horizon future scenario “Rising Tides, Falling Fortunes” describes a 2050 in which immigration is reduced from 80,000 to 20,000 people annually, and annual

productivity and national population growth are reduced to 1.6% and 0.4% respectively. This future also envisions lowered national funding availability, more urban housing, increased sea level rise and less than expected prevalence of electronic and autonomous vehicles. This future addresses the scenario in which the federal government cuts spending and reduces regulations, leaving more policy decisions up to states and regions.

The second Horizon future scenario "Clean and Green" addresses a future in which new technologies and a national carbon tax enable greater telecommuting and distributed job centers. In this future, immigrants to the country remain similar to today at 80,000 people annually, along with annual productivity and annual nationwide population growth. A carbon tax implemented at the national level leads to higher funding, while housing becomes more urban, but jobs are more dispersed. In this future, stricter environmental relations limit sea level rise to 1 foot, and the electrification and automation of vehicles becomes almost universal.

In the final Horizon future, "Back to the Future," an economic boom and new transportation options spur a new wave of development. In this future, immigration, annual nationwide population growth, and annual productivity all increase significantly by 2050. National taxes and funding remain similar to today, but housing becomes more dispersed while jobs become more urban. Strict environmental regulations limit sea level rise to 1 foot, and electric and autonomous vehicle use becomes widespread.

Each of the crossing concepts (Table 3-3) developed were run in each of these future scenarios, with 21 total model runs (seven concepts multiplied by three Horizon futures) compared against three more "no-build" runs that simulated the impacts across all three futures of not adding a new Transbay crossing. Rather than envisioning new development plans, the Crossings evaluation assumed a continuation of the region's existing focused growth strategy, adopted in both the original Plan Bay Area (2013) and Plan Bay Area 2040 (2017). This strategy encourages infill growth in Priority Development Areas (PDAs) – locations supported by high quality transit and identified by city or county governments as preferred locations for new housing and commercial construction.

The BACCTS and Crossings studies evaluated long-term investments needed for the Transbay Corridor, with both studies concluding the need for a new Transbay crossing in order to adequately meet future demand. Both studies came to similar conclusions; that this proposed new Transbay crossing would need to include expansion to the BART system. In order for BART to meet a standard that will allow the agency to expand capacity in the long-term, it must first meet the needs of the short- and medium-term, further emphasizing the importance of the TCMP to achieving capacity goals for the region now and in the future.

Table 3-3: Horizon Crossings Transbay Crossing Concepts

#	Concept Name	SUMMARY	KEY FEATURES IN 2050	CAPITAL COST RANGE ESTIMATES (2019 DOLLARS)
1	New San Mateo-Hayward Bridge	The San Mateo-Hayward Bridge is rebuilt, increasing the number of auto travel lanes in each direction from three to four. The CA-92/US-101 freeway interchange is rebuilt, along with expansion of CA-92 in Foster City and in Hayward.	• 4 general purpose lanes in each direction • Bridge toll assumptions align with Bay Bridge in RM3 ($9 peak hour toll)	$10-$15B • Crossing: 95% • Landside Projects: 5%
2	Mid-Bay Bridge	New auto bridge connects I-380 in San Bruno to I-880 and I-238 in San Lorenzo. I-880/I-238 interchange is rebuilt to accommodate new connection point, and North Access Road near San Francisco International Airport ("SFO") is redesigned to accommodate a new connection to US-101/I-380.	• 2 general purpose lanes in each direction • HOV lane (3+) in each direction • Bridge toll assumptions align with Bay Bridge in RM3 ($9 peak hour toll)	$15-$20B • Crossing: 87% • Landside Projects: 13%
3	BART Market Street Redundancy	New BART crossing connects Oakland and other East Bay cities with San Francisco. New Franklin Street tunnel serves downtown Oakland and Jack London Square, converging in Alameda with a new tunnel from the San Antonio district before crossing to San Francisco. Downtown San Francisco is served by a new Mission Street tunnel. New service extends into western San Francisco and connects to existing BART mainline at Daly City.	• 15 new stations (5 East Bay, 10 San Francisco) • 8-minute headways in peak/15-minute off peak	$32B-$48B • Crossing: 17% • Foundational Projects: 5% • Landside Projects: 64% • Vehicles: 14%
4	BART New Markets	New BART crossing connects Oakland and other East Bay cities with San Francisco. New Franklin Street tunnel serves downtown Oakland and Jack London Square, converging in Alameda with a second tunnel from the San Antonio district before crossing to San Francisco and a new Third Street tunnel serving Mission Bay, South Beach and Downtown San Francisco. New service extends into western San Francisco and connects to existing BART mainline at Daly City.	• 16 new stations (5 East Bay, 11 San Francisco) • 8-minute headways in peak/15-minuteoff peak	$33B-$49B • Crossing: 16% • Foundational Projects: 5% • Landside Projects: 65% • Vehicles: 14%
5	Greater Regional Rail	New conventional rail crossing connects Oakland and other East Bay cities with San Francisco and Peninsula/ South Bay cities by integrating Caltrain and Capitol Corridor service through the Salesforce Transit Center. Integrated service includes a standardized and reduced fare structure. Caltrain service is extended to Salesforce Transit Center and improvements are made along existing corridor to accommodate more frequent service. Frequent service extends north to Richmond and south to a new East Bay Hub near Fremont, providing a one-seat ride from South Bay/ Peninsula to East Bay. Additions include new multimodal stations at Jack London Square and at East Bay Hub, plus infrastructure improvements at Salesforce Transit Center.	• 16 Peninsula trains per hour from San Jose to Salesforce Transit Center • 12 Transbay trains per hour from Salesforce Transit Center to Jack London Square • 4-minute headways in peak at Salesforce Transit Center	$43B-$49B • Crossing: 12% • Foundational Projects: 73% • Landside Projects: 13% • Vehicles: 2%
6	BART + Auto ("Southern Crossing")	New paired BART and auto crossing connects Oakland and other East Bay cities with San Francisco. New BART and auto tunnels connect the East Bay to India Basin, Mission Bay and South of Market. New BART service extends into western San Francisco and connects to existing BART mainline at Daly City. New auto tunnel connects I-880 and I-980 in Oakland to I-280 in San Francisco, requiring new interchanges at both connection points.	• Auto: 2 lanes in each direction • BART: 17 new stations (5 East Bay, 12 San Francisco) • BART: 8-minute headways in peak/15-minute off peak	$39B-$53B • Crossing: 27% • Foundational Projects: 4% • Landside Projects: 58% • Vehicles: 11%
7	BART New Markets plus Regional Rail	A new paired BART and conventional rail crossing connects Oakland and other East Bay cities with San Francisco and Peninsula/South Bay cities. The crossing combines the alignments from Concept 4 (BART New Markets) and Concept 5 (Greater Regional Rail).	• BART: 16 new stations (5 East Bay, 11 San Francisco) • BART: 8-minute headways in peak/15-minute off peak • Rail: 4-minute headways in peak at Salesforce Transit Center	$76B-$98B • Crossing: 14% • Foundational Projects: 41% • Landside Projects: 38% • Vehicles: 8%

Source: Crossings: Transformative Investments for an Uncertain Future

3.3 Multimodal Considerations and Approach

The Transbay Corridor is multimodal in nature (Figure 2-1) and is served by a variety of transportation options including conventional automobiles traveling on the Bay Bridge, the BART Transbay Tube, AC Transit and WestCat buses, suburban buses, and WETA ferries. In order to bridge the gap in the bike network, BART, Transbay buses and ferry boats all provide bike accommodation. In addition, Caltrans also provides a peak-hour bike shuttle across the Bay Bridge between BART's MacArthur Station and downtown San Francisco. The following subsections detail the approaches and considerations the BACCTS and Crossings studies had when evaluating these different modes. The multimodal impacts of the studies are described in Section 4.1 of this plan. As mentioned earlier, the Crossings study intentionally excluded concepts focused on ferry service and/or bus service expansion, given that those improvements were already reflected in the short- and medium-term investment priority list from the BACCTS.

3.3.1 Personal Vehicles

In the Transbay Corridor, the Bay Bridge crossing is at capacity saturated with vehicles, leaving it highly constrained and making transit projects the preferred options for increasing capacity in the corridor. As can be seen in Figure 2-3, in 2014, auto travel in the corridor accounted for 58 percent of person trips on an average weekday. One of the BACCTS considerations to improve capacity along the corridor was to look at policy changes that would affect automobile tolls to influence travel behavior and reduce congestion. Adjusting tolls can achieve multiple outcomes, including shifting demand from automobiles to transit and high-occupancy vehicles (HOVs), influencing the time of day people travel, and reducing queues and travel time variability. The BACCTS analyzed several levels of toll adjustments to forecast drivers' sensitivity to price, based on 2030 conditions. The analysis tested how driver behavior—in terms of shifting peak travel demand to other times and modes—would change at various levels of toll increases.

In addition to including toll increases as a part of each investment package, the BACCTS included the Bay Bridge Forward program as a prerequisite project for the investment packages. This program includes several investments on the Bay Bridge, including adding an HOV/Bus only lane, integrating and optimizing traffic management systems, and commuter parking to name a few.

Of the seven crossing concepts evaluated in the Crossings paper, the first two were auto only concepts, and the sixth concept paired auto with changes to the BART system. These considered auto crossings included a rebuilt San Mateo-Hayward Bridge, a new Mid-Bay auto bridge, and a Transbay auto tunnel. The paper also analyzed the extent to which any of the crossing concepts would relieve auto congestion in the San Francisco-Oakland Bay Bridge Corridor in 2050.

3.3.2 Rail

When considering different modes of transit, both studies distinguished between the BART system and conventional rail. Conventional rail is defined as a standard-gauge, heavy-rail system, such as Amtrak and Caltrain, that is not compatible with the BART system and operates on the national rail network. In developing its suite of short- and medium-term investment options, the BACCTS did not include conventional rail, but did include the mode in one of its long-term options for the corridor.

When considering which types of projects would increase capacity in the short- and medium-term, the BACCTS prioritized adding more transit service in the corridor. Adding more service increases overall passenger throughput capacity and can be further augmented by increasing vehicle frequencies and fleet size. The BACCTS also considered transit fare adjustments to help distribute demand among modes, transit operators, and times of day. The goal would be to shift demand from overburdened operators such as BART to those with more availability or more ability to increase service such as bus and ferry services.

All the recommended changes to BART in the BACCTS are contained in the suite of prerequisite projects that are common to every investment package. These improvement projects are classified as such because they are considered critical to the Transbay Corridor no matter which package was recommended by the BACCTS. These projects include new and replacement BART cars, the TCMP, a new power system, and a new and expanded maintenance facility. The study noted that once these projects are complete, BART will have very little ability to add more peak-hour capacity in the Transbay Corridor because it will reach the maximum throughput of the Transbay Tube, after which a second Transbay crossing will be necessary to increase BART capacity.

Three out of the four long-term options evaluated in the BACCTS include improvements to rail, including BART Market Street redundancy, new markets for BART, and greater regional rail connection. There is no hybrid conventional rail and BART option evaluated in the BACCTS; that option is evaluated further in the Crossings paper.

Five out of the seven crossing concepts evaluated in the Crossings Perspective Paper include some form of rail (Table 3-3). Transbay rail transit use was evaluated for each of the crossing concepts using modeled Transbay rail transit use in 2050 (Figure 3-2). To further assess the benefits of each crossing, the benefits of each option were monetized and measured for their impacts on accessibility, transit-crowding, freeway reliability, vehicle ownership, health, safety, and the environment. Because each Horizon future makes different assumptions about overall growth rates and other key factors, which in turn would create different levels of demand on the transportation system, the Crossings paper analysis measured the per-capita benefit of each crossing concept across the three Horizon futures to assess the effects of these external forces. To better measure the relationship between transit ridership and development patterns and density, the Crossings study analyzed whether ridership demand would rise or fall if new rail stations

were in PDAs, or if the stations were in areas that do not carry a PDA designation. The proposed crossings were also evaluated using the Horizon initiatives equity-scoring methodology (described in Appendix B of the Crossings study) to determine the crossing concepts' impact on lower-income communities' ability to reach their destinations compared to higher-income communities. Finally, the Crossings study evaluated benefit-cost ratios for each of the concepts over the 2025 to 2080 time period using the benefit and cost methodologies discussed earlier. Projects with expected benefit/cost ratios of 1.0 or greater were considered especially strong, while those with ratios below 0.5 ranked at the lower end of the scale.

Using these approaches and considerations, the BACCTS and Crossings study were able to determine the recommended set of strategies for both conventional rail and BART in order to improve capacity throughout the Transbay Corridor. These approaches further emphasize the importance of the TCMP to increasing capacity in the corridor; as a prerequisite project, the TCMP is an essential first step to accomplishing regional transportation goals. Any future transportation investments are reliant on BART reaching its limits on capacity, which cannot be accomplished without a modernized train control system.

3.3.3 Bus

Although the Crossings study does not address bus transit in its evaluation framework, bus investments are an integral part of the BACCTS. Three types of projects related to buses were included in the approach for determining short- and medium-term investments to improve capacity; increased transit service, new transit priority infrastructure, and transit fare adjustments.

The BACCTS noted that adding more transit service in the corridor increases overall passenger throughput capacity. Service can also be augmented by changing vehicle frequencies and fleet size. However, the roadway infrastructure must be able to accommodate such service increases in order to reap the full benefits of investment in service. For instance, simply adding more vehicles to an already congested roadway will result in less realized capacity per hour due to delays. In order to accommodate this, the study evaluated transit priority infrastructure. These investments can be implemented to increase speed, improve travel time reliability, and ultimately help the system maximize person throughput. Improvements such as adding transit priority to surface streets and adding direct freeway access ramps were considered to reduce the impacts of congestion on bus travel and make transit a more appealing competitor to driving. In addition to more transit service and transit-priority infrastructure, adjusting the relative cost of transit was a tool considered to help distribute demand among modes, transit operators, and times of day. Changing fares can help shift demand from overburdened operators to those with more availability or more ability to increase service—such as from BART to bus and ferry services.

In crafting the Transbay Corridor packages, the BACCTS focused on the following strategies to improve capacity and service reliability as it related to bus transit:

- Increasing transit capacity by augmenting bus service, including expanded fleets and the necessary infrastructure to support the service
- Improving service reliability with new bus-priority infrastructure to the toll plaza and on surface streets leading up to it
- Improving service reliability to the Core with new bus-priority infrastructure on the Bay Bridge
- Managing travel demand on the Bay Bridge by adjusting Bay Bridge tolls
- Managing transit demand across transit modes by adjusting transit fares

Every package developed in the BACCTS includes investments related to bus expansion because of the following prerequisite bus projects:

- AC Transit Bus Ramp to Transbay Transit Center
- AC Transit Fleet Expansion (40 buses)
- AC Transit Richmond Facility Reopening
- AC Transit New Bus Facility
- Bay Bridge Forward
- I-80 Integrated Corridor Mobility

Most of the bus improvements in the investment packages were focused on reducing vehicle queues at the toll plaza to help provide more reliable transit service, including the addition of bus only lanes across the Bay Bridge.

3.3.4 Ferry

Although the Crossings study does not address ferries in its analysis, the BACCTS includes many investment options for ferries in the Transbay Corridor. Using a similar strategy to buses (more service, expanded fleets, and transit fare adjustments), the BACCTS was able to develop investment options that would increase ferry capacity and incentivize use of the mode. These options are simple and aim to increase capacity in the short- and medium-term. The following list includes all ferry investments considered to be prerequisite projects:

- WETA Maintenance Facilities Alameda, Vallejo
- WETA Richmond–SF Ferry Service
- WETA SF Ferry Terminal Expansion
- WETA SF Fleet Replacement & Expansion

Beyond those prerequisite projects, the BACCTS included more ferry service, new ferry routes, terminals, and feeder service in three of the four investment packages. All strategies are aimed at increasing capacity across the Bay and relieving some of the demand placed on the BART system.

3.4 Stakeholders and Community Outreach

The BACCTS and Horizon Crossings study were widely collaborative efforts, engaging transportation stakeholders in the region as well as the public whenever possible. The following subsections detail stakeholders for both plans, as well as overall steps for community outreach taken when conducting both studies.

3.4.1 Stakeholders and Partners

The development of the BACCTS involved direct participation of seven state, regional, and local agencies, with a Project Management Team (PMT) made of members from each of these agencies. The PMT guided the study's day-to-day development through regular meetings and review of the studies work products. Executives from each study partner formed an Executive Team (ET) to provide direction and guidance to the PMT. The study partners were led by the Metropolitan Transportation Commission (MTC) and included the following agencies:

- Alameda-Contra Costa Transit District (AC Transit)
- Bay Area Rapid Transit District (BART)
- Caltrain
- San Francisco Bay Area Water Emergency Transportation Authority (WETA), operator of the San Francisco Bay Ferry
- San Francisco Municipal Transportation Agency (SFMTA)
- San Francisco County Transportation Authority (SFCTA, funding and planning partner)

The BACCTS also formed a Technical Advisory Committee (TAC) with a wider group of 18 stakeholders (including Caltrans and the City of Oakland) to advise the PMT and offer diverse perspectives and insights on the study's development. The BACCTS was the first study in the region to bring together the relevant operating, planning, and funding partners to study this topic and identify challenges and solutions from a regional perspective, rather than leaving operators to work individually. The Transbay Corridor is served by multiple operators, so a joint study was necessary in order to produce comprehensive recommendations that reflect the needs and priorities of all the operators.

The development of the Crossings study was led by the MTC and ABAG as a part of the Horizons initiative. These regional agencies created the Horizon Initiative as the first planning effort in the Bay Area to comprehensively address transportation, housing, economic development, and environmental resilience. This was done to expand the traditional long-range planning process and incorporate uncertainty from a wide range of external forces in order to better serve people and stakeholders in the region.

3.4.2 Community Outreach

In February 2017, the MTC's BACCTS PMT hosted two public workshops to discuss the study's evaluation criteria and project packages with project stakeholders including BART, Muni, AC Transit, Caltrain, and WETA. The workshops were held at the San Francisco Bay Area Planning and Urban Research Association (SPUR) offices in San Francisco and Oakland, and between 30 and 50 people attended each event. The purpose of the public meetings was to provide participants an overview of the BACCTS background and obtain feedback on short, medium and long-term transit enhancement concepts. Breakout groups allowed participants to share their thoughts on, concerns with, and suggestions for the various evaluation criteria and project packages.

The development of the Crossings paper included extensive outreach and coordination events with local communities and agencies. Public outreach for the Crossings paper was done through the Horizon Initiative; MTC staff members visited all nine Bay Area counties to get community input for the initiative, stopping at farmers markets, flea markets, libraries, shopping centers, schools, conferences, festivals and transit hubs. Concept development and refinement began with an interagency workshop with 12 regional agencies, followed by an update given to the staffs of U.S. Senator Feinstein and Congressman DeSaulnier. Several lunchtime forums were conducted throughout the development period with SPUR. The MTC Commission and Policy Advisory Council, Bay Area Partnership Board, and the MTC/ABAG Regional Advisory Working Group conducted several workshops with the study team as well. Through these outreach activities, the Crossings paper was able to address a diverse set of needs from various parts of the community.

3.5 Funding and Timeline

When determining a recommended set of investments, understanding the funding needs and timeline for implementation are essential factors that need to be considered. The following sections detail the funding prioritizations and timeline for implementations considered in the two studies for the recommended sets of projects and investments. More detail on the recommended suite of investments can be found in Section 6 of this plan.

3.5.1 Funding Prioritizations

As mentioned previously, the BACCTS prerequisite projects are considered critical to operators' ability to increase transit capacity in the Transbay Corridor, but not all projects are fully funded. However, the TCMP, upon receipt of SCCP funds, will be fully funded and moved to be implemented in the Transbay Tube. More information on this can be found in the SCCP grant narrative, attached to this document. The BACCTS package analysis concluded that any short- and medium-term package recommendation should reflect priorities of more service, supportive infrastructure to improve reliability, and toll increases to help manage queues and improve transit

reliability. A modified version of Package 3 (Infrastructure, Transit, and Tolls) was chosen as the recommended package of investments. The BACCTS then determined the total capital and operating costs of the proposed package, including prerequisite projects, displayed in Table 3-4 and Table 3-5.

Table 3-4: Transbay Corridor Recommended Package Capital Improvement Cost

Projects by operator		Unfunded cost
AC Transit		
1	Fleet: 110 buses	$90m
2	New Bus Facility	$100m
3	Infrastructure: • Park-and-ride, bus transitway, surface-street transit priority, bus tunnel	$240m
4	Ferry feeder service fleet	$15m
	Subtotal AC Transit	$445m
WETA		
1	WETA 15-30 Plan • Fleet: 11 vessels • Enhanced terminals: Alameda Main Street, Harbor Bay, Oakland • New terminals: Berkeley, Downtown North Basin, Mission Bay, Seaplane Lagoon	 $206m $46m $122m
	Subtotal WETA	$374m
BART		
1	Transbay Core Capacity Project* • Fleet: 306 railcars • Train control, traction power, Hayward Maintenance Complex Phase 2	$3.5bn
2	BART Metro*	$362m
3	Other supportive projects • Montgomery and Embarcadero platform screen doors, vertical circulation • Glen Park pocket track	$180m
	Subtotal BART	$4.0bn
Total recommended package		**$4.8bn**

Source: Bay Area Core Capacity Transit Study

Table 3-5: Transbay Corridor Recommended Package Annual Operating Costs

Improvements	Unfunded cost†
Bus: Transbay service	$33m/yr
Bus: Ferry feeder service	$13m/yr
Ferry: WETA 15-30 Plan service	$23m/yr
BART: Additional Transbay service	$16m/yr
Total annual operating costs	**$85m/yr**

Source: Bay Area Core Capacity Transit Study

The BACCTS noted that the necessary immediate action is to advance the recommended package toward implementation, including programming them into

regional and state funding plans for prioritization. In particular, the BACCTS noted that it is critical that unfunded prerequisite projects are prioritized for funding, and suggested funding plans that included Plan Bay Area 2040, future bridge toll increases, and California SB-1.

While the Crossings study does not conduct specific analysis on funding prioritizations for any specific project, the benefit/cost analysis discussed in Section 4.3.2 can be considered a starting point for determining which crossing to incorporate into future planning and funding processes.

3.5.2 Timeline

As discussed in Section 3.2, the BACCTS primary focus was on improving transit capacity for the short- and medium-term. The short-term in the context of the study was considered to be within five years, while medium-term was considered to be within 15 years. Any projects recommended through the BACCTS short- and medium-term packages, including prerequisite projects, would need to be implemented before 2030.

The Crossings study expands the traditional long-term planning process by considering several different futures, but primarily uses 2050 as a horizon year for when the recommended crossing concepts should be implemented. However, as can be seen in Figure 4-3 and other instances in the Crossings study, analyses are also conducted for years far beyond 2050.

4 Performance Impacts and Metrics

4.1 Multimodal Impacts

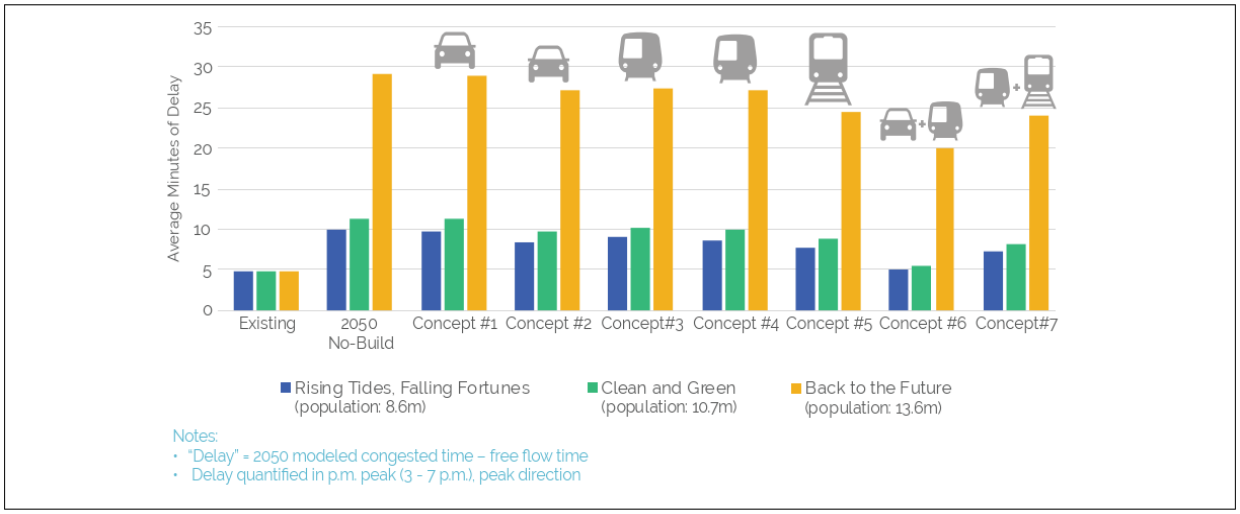
The Transbay Corridor is multimodal in nature and is served by a variety of transit operators. As discussed in Section 3.3, each of these modes are widely considered by both the BACCTS and Crossings paper for opportunities to increase capacity along the corridor. The following subsections detail the multimodal impacts of each of the investments considered in the studies; note the Crossings Perspective Paper does not consider investments related to buses and ferries.

4.1.1 Personal Vehicles

Each of the short- and medium-term investment packages considered by the BACCTS included some form of toll increases in the Transbay Corridor (Section 3.3.1). The primary impact on personal vehicles would be a reduction in vehicle queues at the toll plaza, while also service as an incentive for carpooling. Package 4b in the BACCTS proposes the largest impact to vehicles in the form of a bus plus HOV lane across the Bay Bridge in addition to a toll increases and a bus park-and-ride, intended to further incentivize carpooling.

Three of the seven crossing concepts presented in Horizon Crossings include impacts related to automobiles. The first two Concepts presented are auto-only concepts (Table 3-3), while Concept #6 is paired with a new BART crossing. Concept #1 proposes a new San Mateo-Hayward bridge which would increase the number of auto travel lanes in each direction from three to four. This concept would also rebuild the CA-92/US-101 freeway interchange and expand CA-92 in Foster City and in Hayward. Concept #2 proposes a new auto bridge that connects I-380 in San Bruno to I-880 and I-238 in San Lorenzo. The I-880/I-238 interchange would be rebuilt to accommodate the new connection point, and North Access Road near San Francisco International Airport (SFO) would be redesigned to accommodate a new connection to US-101/I-380. Major impacts of this crossing would be two general purpose lanes and an HOV (3+) lane in each direction. Finally, in crossing Concept #6, a new paired BART and auto crossing would be built connecting Oakland and other East Bay cities with San Francisco. New BART and auto tunnels would connect the East Bay to India Basin, Mission Bay and South of Market, with the new auto tunnel connecting I-880 and I-980 in Oakland to I-280 in San Francisco. Out of the three crossing concepts involving automobiles, Concept #6 provides the greatest reduction in Bay Bridge vehicle delay in each of the 2050 scenarios, displayed in Figure 4-1.

Figure 4-1: Bay Bridge Vehicle Delay - US-101 northbound and I-80 eastbound from Cesar Chavez to Treasure Island Tunnel



Source: Crossings: Transformative Investments for an Uncertain Future

Although Concept #6 is best suited to relieve congestion-related delays through the Bay Bridge Corridor in 2050, the results also highlight the impact of latent demand for limited roadway space. When compared to current conditions, any new crossing may be unable to deliver meaningful congestion relief under any of the Horizon futures. The most effective way to relieve congestion-related delays would be a combination of a new crossing and more aggressive complementary transportation-demand strategies.

4.1.2 Rail

Many of the substantive impacts to both BART and conventional rail systems in the short- and medium-term are contained in the BACCTS prerequisite projects. These projects include the following:

- BART Additional Railcars – Core Capacity
- BART Additional Railcars – Fleet Transition
- BART Hayward Maintenance Complex Phases 1 and 2
- BART Metro Program
- BART Traction Power System
- BART Train Control Modernization Program (TCMP) Projects

These projects are meant to increase capacity and reliability on the BART system, allowing the system to meet Transbay Corridor demand up to 2025 (Figure 3-4). Impacts related to conventional rail in the BACCTS are only considered in regard to long-term investments and are discussed in more detail in the Crossings study.

Five of the seven crossing concepts discussed in the Crossings study involve some form of rail. Concepts #3 and #4 are BART only concepts, Concept #5 is a conventional

rail concept, Concept #6 is a BART and auto concept, and Concept #7 is a paired conventional rail and BART concept.

Concept #3 proposes a new BART crossing connecting Oakland and other East Bay cities with San Francisco. A new Franklin Street tunnel serving downtown Oakland and Jack London Square would converge in Alameda with a new tunnel from the San Antonio district before crossing to San Francisco. Downtown San Francisco would be served by a new Mission Street tunnel, with new service extending into western San Francisco and connecting to the existing BART mainline at Daly City. This overall concept would include 15 new stations and 8-minute headways in peak and 15-minute headways off peak.

Concept #4 proposes a similar crossing to #3, with a new Franklin Street tunnel serving downtown Oakland and Jack London Square and converging in Alameda with a second tunnel from the San Antonio district before crossing to San Francisco and a new Third street tunnel serving Mission Bay, South Beach and Downtown San Francisco. New service would extend into Western San Francisco and would connect to the existing BART mainline at Daly City. Overall, this concept would include 16 new stations and 8-minute headways in peak and 15-minute headways off peak.

Concept #5 proposes a new conventional rail crossing connecting Oakland and other East Bay cities with San Francisco and Peninsula/South Bay cities by integrating Caltrain and Capitol Corridor service through the Salesforce Transit Center. Integrated service would include a standardized and reduced fare structure. Caltrain service would be extended to the Salesforce Transit Center and improvements would be made along the existing corridor to accommodate more frequent service. Frequent service would extend north to Richmond and south to a new East Bay Hub near Fremont, providing a one-seat ride from South Bay/Peninsula to East Bay. Additions would include new multimodal stations at Jack London Square and at East Bay Hub, plus infrastructure improvements at Salesforce Transit Center. Overall, Concept #5 would include 16 Peninsula trains per hour from San Jose to Salesforce Transit Center, 12 Transbay trains per hour from Salesforce to Jack London Square, and 4-minute headways in peak hours at Salesforce Transit Center.

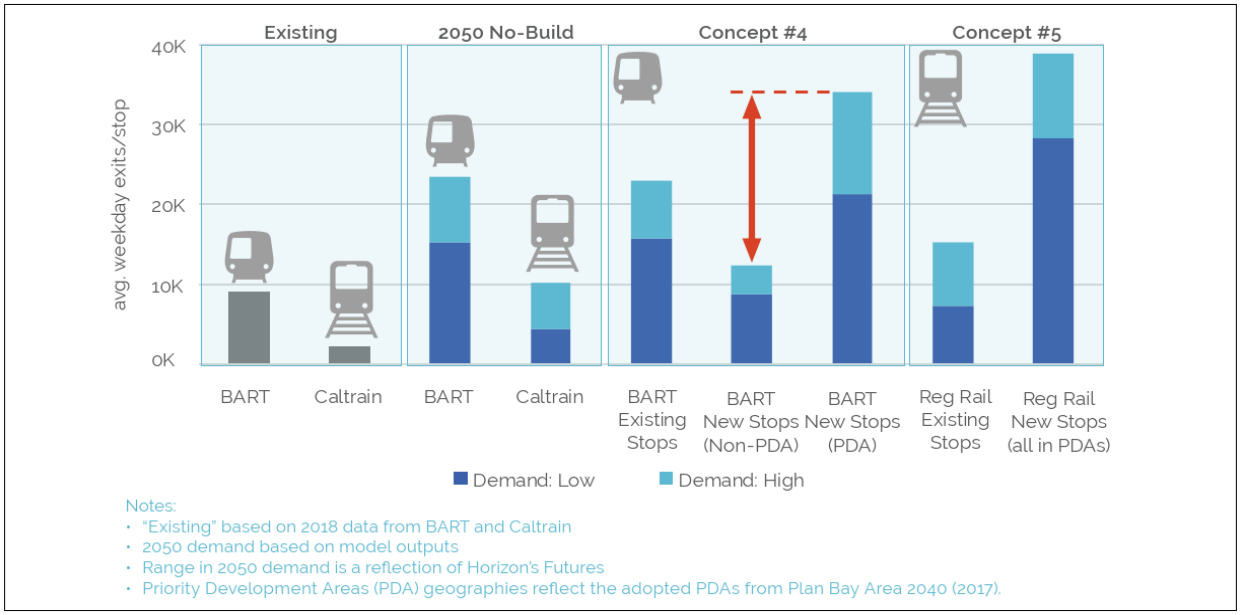
Concept #6 proposes a combined auto and BART crossing. The BART additions would include an extension of service into western San Francisco and a connection to the existing BART mainline at Daly City. Overall, this concept includes 17 new BART stations and 8-minute headways in peak and 15-minute headways off peak.

Lastly, Concept #7, a paired BART and conventional rail concept, would connect Oakland and other East Bay cities with San Francisco and Peninsula/South Bay cities. The crossing would combine the alignments from Concept #4 and Concept #5. For BART, this concept includes 16 new stations and 8-minute headways in peak and 15-minute headways off peak. For conventional rail, this crossing includes 4-minute headways in peak hours at Salesforce Transit Center.

For all the concepts described above, the impacts on Transbay Corridor rail transit use can be seen in Figure 3-2. These results indicate that in 2050, Concepts #3, #4, #5, and #6 would be able ease to transit-crowding and meet the lower end of expected demand. While Concept #7 also reduces crowding, it may also deliver more capacity than needed in 2050 in any of the three Horizon futures.

The rail crossing concepts evaluated in the Crossings paper all include increases to BART and conventional rail stations. The Crossings study evaluated station locations' impacts on ridership in order to better understand how transit ridership is influenced by the proposed investments (more information in Section 3.3.2). The results are displayed in Figure 4-2 compares Concept #4 (BART) with new stations in both all-PDA and non-PDA locations, and an all-PDA configuration of Concept #5 (conventional rail). The figure illustrates that locating stations in areas that are likely to see new development will be critical to attracting higher ridership across all three of the Horizon futures.

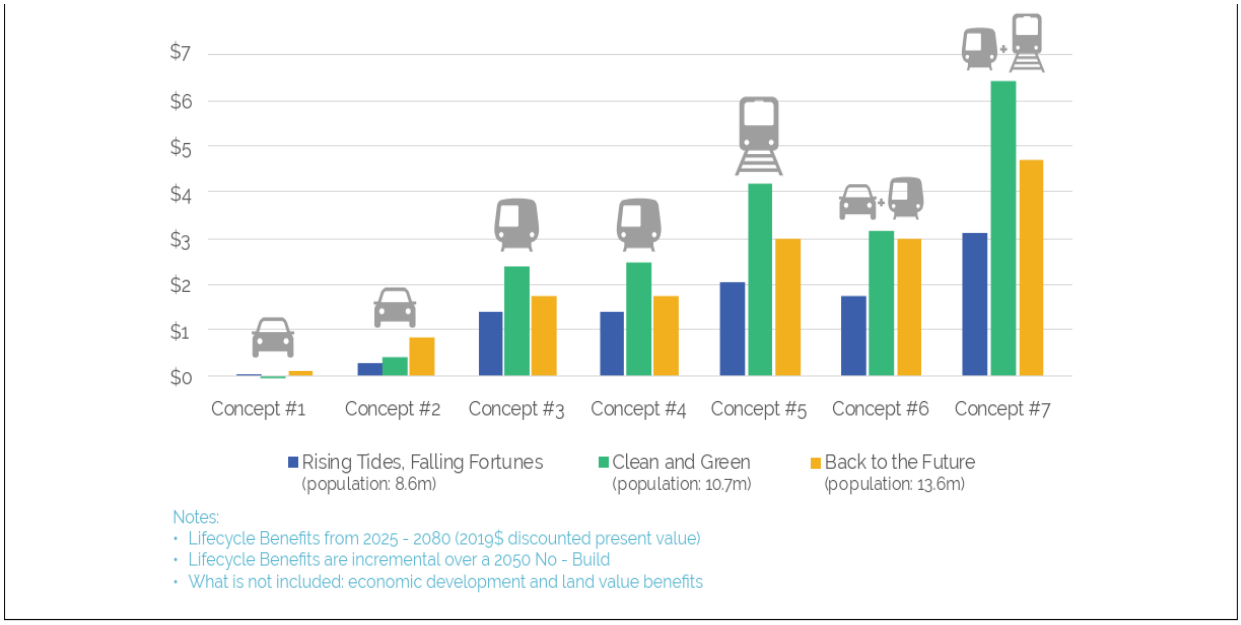
Figure 4-2: Stop Location Impacts on Ridership - Demand at Non-PDA vs. PDA Stops



Source: Crossings: Transformative Investments for an Uncertain Future

The Crossings study also evaluated the per capita benefits of each of the crossing concepts, the results of which are presented in Figure 4-3 below. The findings show that rail only crossings (Concepts #3, #4, #5, and #7) in the "Clean and Green" future deliver the highest per-capita benefits, due in part to the higher auto operating costs associated with a national carbon tax that increases the cost of driving.

Figure 4-3: Per-Capita Benefits ($000s) across Horizon Futures



Source: Crossings: Transformative Investments for an Uncertain Future

The Crossings paper used the Horizon initiatives equity-scoring methodology to assess the seven crossing concepts' impact on lower-income communities' ability to get to destinations as opposed to higher-income communities. Figure 4-4 displays the results of this analysis and shows that while none of the proposed concepts make the transportation system more equitable, Concepts #3 through #7 would provide benefits evenly to all population groups across the three Horizon futures.

Figure 4-4: Impacts of Project Level Accessibility Benefits Across Income Groups

Mode	Crossing	Rising Tides, Falling Fortunes	Clean and Green	Back to the Future
	Concept #1	Challenges	Challenges	Even
	Concept #2	Even	Challenges	Even
	Concept #3	Even	Even	Even
	Concept #4	Even	Even	Even
	Concept #5	Even	Even	Even
	Concept #6	Even	Even	Even
	Concept #7	Even	Even	Even

Equity Score: Challenges Equity: <40% | Even Distribution: 40-60% | Advances Equity: >60%

Source: Crossings: Transformative Investments for an Uncertain Future

4.1.3 Bus

Every package for short- and medium-term investment considered in the BACCTS places a focus on reducing queues at the toll plaza on the Bay Bridge during peak periods in order to ensure buses can quickly access HOV lanes with minimal delay, leading to more reliable transit service. Because of the limited ability to increase capacity on the BART system, the BACCTS focused many of its transit-oriented impacts on buses in the region. The following projects were prerequisite bus projects for all the packages in the BACCTS:

- AC Transit Bus Ramp to Transbay transit Center
- AC Transit Fleet Expansion (40 buses)
- AC Transit Richmond Facility Reopening
- AC Transit New Bus Facility

The following bus projects were considered common to Packages 2-4:

- Increase Transbay Bus Service
- I-580 Bus Transitway
- Transbay Bus Park-and-ride facilities

Package 2 proposed increasing transit service and tolls in addition to the above common and prerequisite projects. The main impacts of this package would include increased AC Transit Transbay bus service during the peak hour for more service reliability, and reduced vehicle queues at the toll plaza allowing buses to quickly access

HOV lanes with minimal delay. Package 3 is similar to Package 2 but includes implementation of new surface-street transit-priority lanes to the bridge and the refurbishment of the old Key System tunnel to provide direct bus access to the toll plaza; all of which would increase capacity through the Transbay Corridor. Finally, Package 4 proposes providing continual direct bus right-of-way across the Bay Bridge, with a bus-only or bus plus HOV lane, a refurbished bus tunnel, and new surface-street transit-priority lanes from the East Bay to Transbay Transit Center.

4.1.4 Ferry

Similar to buses, in order to increase capacity in the Transbay Corridor, the BACCTS proposed increasing transit capacity by augmenting ferry service, including expanded fleets. The following are prerequisite and common ferry projects for the BACCTS packages:

- Ferry Feeder Bus Services
- WETA Maintenance Facilities Alameda, Vallejo
- WETA Richmond-SF Ferry Service
- WETA SF Ferry Terminal Expansion
- WETA SF Fleet Replacement and Expansion
- Implement WETA 15-30-minute plan

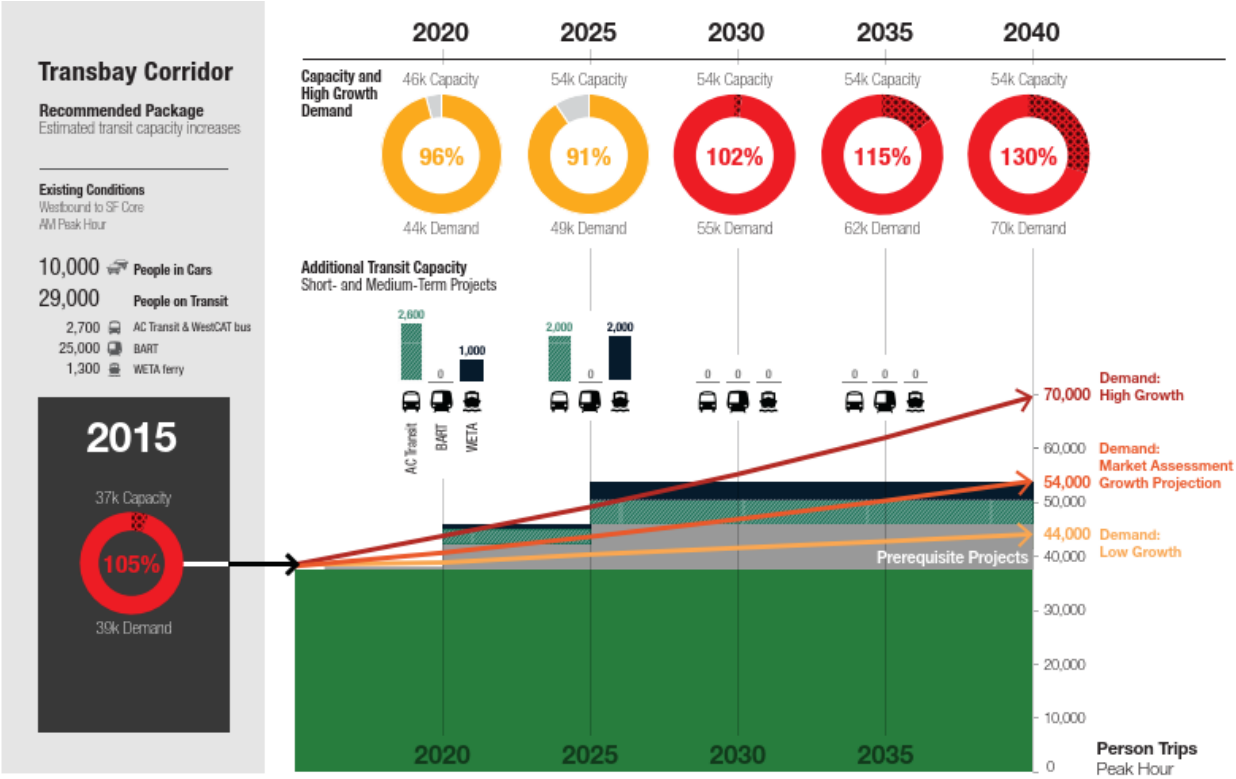
Packages 2-4 all propose increasing ferry service during the peak hour from Oakland, Alameda, and Vallejo, while adding new ferry terminals in Alameda and new routes from Berkeley and Mission Bay. Increasing ferry service and adding new ferry routes was a relatively simple way for the BACCTS to increase capacity along the Transbay Corridor without the need for significant investment, such as that required for a new Transbay crossing.

4.2 Demand Impacts

The impacts of both the BACCTS and Crossings study are centered on meeting demand in the Transbay Corridor by increasing capacity, either through short-and medium-term investment strategies, such as those found in the BACCTS, or long-term strategies, such as those outlined in the Horizon Crossings Perspective Paper.

If the BACCTS recommended short- and medium-term package improvements (modified Package 3) are taken, Transbay Corridor capacity will be able to meet demand up until 2030, as shown in Figure 4-5.

Figure 4-5: Transbay Corridor Capacity and Demand in 2050 with Recommended Package



Source: Bay Area Core Capacity Transit Study

Even with the new capacity gained from the short- and medium-term improvements shown in Figure 4-5, a gap between travel demand and capacity will remain if the corridor demand grows faster than the market assessment forecast. Additionally, by 2030, these short- and medium-term investments will be unable to meet increasing demand in the region, further emphasizing the need for a new Transbay crossing, such as those outlined in the Crossings paper.

The demand impacts of the Crossing concepts are displayed in Figure 3-2 and Figure 4-1. These figures show that certain Crossing concepts will be able to meet demand in the future by increasing capacity and reducing congestion in the Transbay Corridor.

4.2.1 Induced Demand Analysis

MTC's Activity-Based Travel Model One is used in both the BACCTS and Crossings paper to analyze induced demand, with Travel Model 1.5 (a major update to Travel Model One) being used for the entire Horizon initiative. Induced demand, or induced traffic, is demand that exists but is suppressed by the inability of the existing system to handle it. Once additional capacity is added to a network, that potential demand materializes as actual used.

For the Crossings paper, induced demand is reflected in Travel Model 1.5 in both short- and long-term effects. Short-term decision based-based induced demand is generally captured from changes in transportation supply, in that residents may choose to change their travel destinations, amount of travel, mode of travel, travel route, or time of travel based on accessibility changes from the project. For example, adding travel lanes to a highway corridor adds road capacity ("supply"). The increase in supply does not simply have the effect of alleviating congestion for existing road users in that corridor, but transit users and/or road users of other corridors may alter their mode or route to take advantage of the new capacity. The increase of road capacity improves accessibility making that travel choice a more attractive option compared to a "no build" condition. Increasing supply of a mode generally results in increase usage of that mode, more vehicular travel or more transit riders.

Long-term decision based-based induced demand is generally captured from changes in household/job locations. Households may "choose" or change their auto ownership decisions and work locations based on accessibility changes from increases in supply. Therefore, some long-term decision-based induced demand is captured, in that more residents may prefer to change their job locations if that improves their travel outcomes. This is reflected in the two auto-only crossing concepts which both result in higher VMT for the region. Note that the transit-only concepts modeled in the Crossings paper do not result in higher VMT for the corridor. Other long-term effects are related to changes in household/job locations resulting from the project (e.g. new rail station may spur more housing construction in station areas). These effects are captured through feedback loops between the land use model and travel model.

4.3 Performance Metrics

Measuring the performance for a set of recommended projects is essential in determining whether these projects will benefit the transportation system. Both the BACCTS and Crossings paper focus on increasing capacity of the transit system in order to meet current and future demand in the Transbay Corridor. The following performance metrics have been chosen to highlight how the recommended projects and strategies in these two plans will increase capacity along the corridor.

4.3.1 Service Availability and Delivery

Measuring service availability and delivery means measuring the ease of transit access based on where (service coverage and/or stop accessibility) and how often (frequency and reliability) service is provided, while also considering passenger loads on different travel modes.

One of the primary methods in which the BACCTS addresses capacity deficiencies is by increasing the frequency of service provided by a variety of transit operators in the region. Each package is built on prerequisite projects that are focused on increasing the

fleet size of buses and ferries in the corridor, as well as BART projects like those in the TCMP that are intended to reduce headways.

The BACCTS recommends, that in order to adequately offer expanded service under the recommended packages, AC Transit would need to increase fleet size by 110 buses, WETA would need to expand their fleet by 11 vessels, and BART would need to add 306 railcars to its fleet. The expansion of the WETA and AC Transit fleets, in addition to new routes and transit-priority infrastructure, will reduce congestion along the Bay Bridge, leading to reductions in travel times for travelers in the corridor.

The TCMP, in conjunction with five new traction power substations and an increased fleet, will allow the number of trains operating through the Transbay Tube to increase from 23 to 30 per hour, and peak hour train lengths to be increased from an average of 8.9 cars to 10, maximizing person throughput capacity in the corridor. In addition, the TCMP is expected to improve system reliability. BART estimates that up to 40 percent of current system delays are due to train control issues. Better reliability results in enhanced confidence in the system which leads to increased ridership. Research has shown that travelers are more sensitive to travel time reliability than they are to travel time itself.

The Crossings paper, in each of the crossing concepts that involve BART, has a large effect on service coverage. In Concepts #3, #4, #6, and #7, at least 15 new transit stations will be added, distributed between the East Bay and San Francisco. Additionally, these concepts will provide 8-minute headways in peak and 15-minute headways off peak thorough the corridor.

4.3.2 Multimodal Metrics

Both studies note the growing demand for transit within the Transbay Corridor as congestion on the Bay Bridge further increases auto travel times. However, passenger loads on the transit system, specifically the BART system, are very high. In order to address this, the BACCTS considered and recommended adjusting transit fares across different modes (train, bus, ferry) to better balance passenger loads. Additionally, the study recommended increasing ferry frequencies to 15- and 30-minute headways to increase the competitiveness of the mode in relation to bus and train transit.

The BACCTS selected travel demand model findings for the recommended package are displayed in Table 4-1 below. According to these findings, the intended effects of the recommended package will be realized in terms of change in commute mode. Carpooling, bus, and ferry use will all increase as transit priority lanes are added to the Bay Bridge and tolls and transit fares are modified to encourage this behavior. Further, the strain on the BART system will be reduced slightly as travelers choose to use other transit modes.

Table 4-1: Package 3 Increase in Travel Demand by Mode

	2030 Baseline Peak-Hour Trips	2030 Peak-Hour Trips with Infrastructure, Transit and Tolls	% Change
Non-HOV	10,855	10,178	-6%
HOVs	10,567	11,286	7%
BART	31,679	30,632	-3%
Bus	3,845	7,678	100%
Ferry	1,871	4,175	123%
Total	58,817	63,949	9%

Source: Bay Area Core Capacity Transit Study

As described earlier in this plan, the Crossings paper evaluated the benefit cost ratios of each of its proposed crossing concepts to help determine which crossing to recommend. The Crossings study calculated per capita benefits by monetizing social benefit categories like transit crowding, freeway reliability, access to mobility, auto ownership, health, safety and the environment. Projects with expected benefit/cost ratios of 1.0 or greater are considered especially strong while those with ratios below 0.5 rank at the low end of the benefit/cost scale. Results shown in Figure 4-2 below display the results of this analysis for each of the Horizon futures.

Table 4-2: Crossing Concepts Benefit Cost Ratios over 2025-2080

Mode	Crossing	Rising Tides, Falling Fortunes	Clean and Green	Back to the Future
	Concept #1	●○○○	●○○○	●○○○
	Concept #2	●○○○	●○○○	●●●○
	Concept #3	●●○○	●●●○	●●●○
	Concept #4	●●○○	●●●○	●●●○
	Concept #5	●●○○	●●●○	●●●●
	Concept #6	●●○○	●●●○	●●●○
	Concept #7	●●○○	●●●○	●●●○

Color Range: < 0.5 | 0.5–0.9 | 1.0–1.9 | > 1.9

Notes:
- Benefit-Cost ratios over the time period: 2025-2080
- Discount rate: 3%. Time to Implement: 10 years
- Costs include a residual value of investment at 2080

Source: Crossings: Transformative Investments for an Uncertain Future

5 Connection to Other Planning Activities

As multimodal and collaborative studies, the BACCTS and Horizon Crossings Perspective Paper contain many similarities in approach and principles of many other federal, state, and local planning activities. As described in Section 3.1, the guiding principles of both studies cover a wide array of areas including increasing capacity, multimodal corridor demand, transit utilization, environmental resiliency, and economic prosperity. These principles are not unique to the BACCTS and Crossings study; rather they are consistent with the goals and principles of many other federal, state, and local planning activities. The following subsections summarize several different plans and programs which align with the goals and principles of the BACCTS and Crossings paper.

5.1 Federal

The **Congestion Mitigation and Air Quality Improvement** (CMAQ) Program provides federal funds to States for transportation projects designed to reduce traffic congestion and improve air quality, particularly in areas of the country that do not attain national air quality standards. Both the BACCTS and Crossings studies placed a focus on reducing traffic congestion and considering environmental effects of the proposed strategies. The BACCTS, in each package of short- and medium-term investments, considered toll increases in order to reduce congestion on the Bay Bridge. The Horizon Crossings Healthy guiding principle placed a focus on decreasing emissions in order to ensure that the region's natural resources, open space, clean water and clean are conserved.

The **ITS Strategic Plan 2020–2025**, developed by the USDOT ITS Joint Program Office (JPO), includes in-depth discussion of the ITS JPO's strategic goals, related research areas, and four technology transfer programs, which together work to accelerate deployment:

- Emerging and Enabling Technologies
- Data Access and Exchanges
- Cybersecurity for ITS
- Automation
- Complete Trip – ITS4US
- Accelerating ITS Deployment through:
    - ITS Evaluation
    - ITS Professional Capacity Building
    - ITS Architecture and Standards
    - ITS Communications

The BACCTS prerequisite projects include one major ITS deployment in the form of the communications-based train control project, a major component of the TCMP. This project, and its inclusion in the BACCTS, aligns with the ITS strategies outlines in the ITS JPO strategic plan.

5.2 State

The **California Transportation Plan 2040** (CTP) is the state's long-range transportation plan that establishes an aspirational vision that articulates strategic goals, policies, and recommendations to improve multimodal mobility and accessibility while reducing greenhouse gas emissions. The purpose of the plan is to present innovative, sustainable, and integrated multimodal mobility solutions.

The **Interregional Transportation Strategic Plan** (ITSP) is the long-range planning document that helps prioritize transportation projects across the state and supports Caltrans' role in improving the interregional movement of people, vehicles, and goods. The ITSP guides Interregional Transportation Improvement Program (ITIP) funds towards intercity rail corridors and a subset of routes identified in California's legislatively designated Interregional Road System (IRRS). BART connects Capitol Corridor intercity rail service at Richmond and Oakland Coliseum as well as Amtrak Thruway service at the Salesforce Transit Center.

Smart Mobility 2010: A Call to Action for the New Decade, also known as The Smart Mobility Framework (SMF), is a planning guide that furthers integration of smart growth concepts into transportation planning in California. Smart Mobility moves people and freight while enhancing California's economic, environmental and human resources by emphasizing:

- Convenient and safe multimodal travel
- Speed suitability
- Accessibility
- Management of the circulation network
- Efficient use of land

Smart Mobility responds to the transportation needs of the State's people and businesses, addresses climate change, advances social equity and environmental Justice, supports economic and community development, and reduces per capita vehicle miles traveled.

The **Scoping Plan for Achieving California's 2030 Greenhouse Gas Target** (California Climate Change Scoping Plan) identifies how California can reach their 2030 climate target to reduce greenhouse gas (GHG) emissions by 40 percent from 1990 levels, and substantially advance toward our 2050 climate goal to reduce GHG emissions by 80 percent below 1990 levels.

The **California State Rail Plan** (CSRP) is a strategic plan with operating and capital investment strategies that will lead to a coordinated, statewide travel system. The Rail Plan is an important element in the comprehensive planning and analysis of statewide transportation investment strategies detailed in the CTP. In concert with CTP 2040 and other plans, the Rail Plan will help clear the air, invigorate cities, and provide the mobility that Californians will need in the future. This Rail Plan is more ambitious than

previous rail plans. In compliance with federal and state laws, it proposes a unified statewide rail network that better integrates passenger and freight service, connects passenger rail to other transportation modes, and supports smart mobility. The CSRP also contains specific mention of the TCMP as a part of its plan to meet demand in the Bay Area.

The California **Congestion Management Program** (CMP) is a state-wide transportation funding proposal that requires local governments to implement mitigation measures to offset the impacts from new development on the regional transportation system. The goal is to link land use, transportation, and air quality decisions at the regional and local level.

5.3 Regional

Plan Bay Area 2050 is a long-range plan charting the course for the future of the nine-county San Francisco Bay Area and serves as a continuation to Plan Bay Area 2040. Plan Bay Area 2050 will focus on four key issues—the economy, the environment, housing and transportation—and will identify a path to make the Bay Area more equitable for all residents and more resilient in the face of unexpected challenges. Building on the work of the Horizon initiative, this new regional plan will outline strategies for growth and investment through the year 2050, while simultaneously striving to meet and exceed federal and state requirements. The TCMP is a key component of this regional plan. Plan Bay Area 2050 also plans growth around PDAs, in accordance with California's Sustainable Communities Strategy.

Plan Bay Area 2040 was adopted in July 2017 and is the predecessor plan to Plan Bay Area 2050, which is now under development. PBA 2040 discusses how the Bay Area will grow over the next two decades and identifies transportation and land use strategies to enable a more sustainable, equitable and economically vibrant future. The plan includes discussion of transit modernization and efficiency as well as associated discussions around equity and disadvantaged communities that will benefit from the project.

The **Bay Area Regional Rail Plan,** developed by the MTC in partnership with the California Heed Rail Authority, BART and Caltrain outlines near-, intermediate- and long-term strategies to:

- Incorporate more passenger trains into existing rail systems
- Expand the regional rail service network
- Improve connections between high-speed rail and other transit services
- Coordinate rail investment around transit-oriented neighborhoods – or TODs – and business districts

The Regional Rail Plan proposed the idea of creating a higher frequency, higher capacity BART system to support the urban core of the Bay Area. This is a concept that will be effectuated by the TCMP.

The **Alameda Countywide Transit Plan**, developed by the Alameda County Transportation Commission in close coordination with local jurisdictions and transit providers identifies near- and long-term transit capital and operating priorities aimed to creating a transit system that is dependable, easy-to-use, safe, affordable, and competitive with travel by other modes while aligning with land use and economic development goals across the county. The plan addresses American's with Disabilities Act paratransit, potential for public and private shuttles in the transit network, and solicited input from private industry groups, community groups and the public. The plan links BART, AC Transit, and WETA service to other regional providers like the Altamont Corridor Express (ACE) and Capital Corridor intercity train services.

The **San Francisco Transportation Plan** is the citywide, long-range investment and policy blueprint for San Francisco's transportation system. The plan analyzes every transportation mode, every transit operator, and all streets and freeways every four years. The San Francisco Transportation Plan process coincides with the development of Plan Bay Area 2050 and incorporates input from all transportation providers within San Francisco including BART. The plan also highlights the delays related to an outdated train control system on the BART line as well as other plans to increase capacity and reliability throughout the city, which includes portions of the Transbay Corridor.

6 Outcomes

6.1 BACCTS Outcomes

To assess how well each package addressed the capacity and performance issues facing the Transbay Corridor, the BACCTS identified priority evaluation criteria based on the study's guiding principles (Section 3.1). The criteria aim to answer key questions, including how well demand is served, how the appeal of transit improves, and how efficient and reliable the system is. The criteria are as follows:

- **Capacity**: How many more people can be carried by transit?
- **Utilization**: How much of the capacity offered is expected to be used?
- **Reliability**: To what degree is variability in travel time reduced, in order to make the transit trip more attractive and competitive for users?
- **Resiliency**: Does the package improve the transit network's ability to recover from or adjust to routine delays or extraordinary events?
- **Efficiency**: How much will it cost?

Based on the results of the analysis, the BACCTS recommended advancing a modified version of Package 3 (Infrastructure, Transit, and Tolls), which includes the pre-requisite projects outlined in Section 4.1. This package adds additional bus and ferry transit service with increased bus and ferry fleets, new bus-priority infrastructure to ensure buses can travel quickly through the bridge toll plaza, surface street improvements to improve travel times leading up to the bridge in Oakland and Emeryville, and a small increase of Bay Bridge auto tolls. The elements of the recommended package are detailed in Table 3-4. Improvements include Transbay Corridor prerequisite projects that are not yet fully funded, in addition to the short- and medium-term project recommendations. Estimated annual operating costs are shown in Table 3-5. Figure 4-5 illustrates the impact of the recommended package on corridor capacity and demand over time. The primary benefits of the recommended package are as follows:

- **Benefits for buses:** Implement new surface-street transit-priority lanes to the bridge and refurbish an old Key System tunnel to provide direct bus access to the toll plaza. Increase AC Transit Transbay bus service during the peak hour for more service reliability. Reduce vehicle queues at the toll plaza to help provide more reliable transit service, allowing buses to quickly access HOV lanes with minimal delay.
- **Benefits for ferries:** Increase ferry service during the peak hour from Oakland, Alameda, and Vallejo. Add new ferry terminals in Alameda and new routes from Berkeley and to Mission Bay.
- **Incentivizing carpools and transit:** Incentivize people to make their commute by transit or carpool, or during another time of the day.

Key components of the recommended package include:

- BART Train Control Modernization Program
- BART Traction Power System
- WETA maintenance facilities and terminal expansion
- BART Hayward Maintenance Complex Phases 1 and 2
- AC Transit new bus ramp to Salesforce Transit Center and new bus facility
- AC Transit, BART, and WETA fleet expansion
- New bus tunnel to Bay Bridge toll plaza
- New surface-street transit priority
- lanes connecting to I-80, I-580
- More Transbay bus service
- More ferry services
- New ferry routes
- New bus park-and-ride lots
- New ferry terminals
- New ferry feeder service
- Small, medium, or large automobile toll increase

Other key findings in the BACCTS include:

- **Each package performed differently in the toll plaza queuing analysis** with respect to the level of toll increase needed to provide buses free-flow access to the HOV access points at the plaza. Table 3 documents which level of toll increase is needed for each package.
    - Adding new transit-priority infrastructure would reduce the need for a high toll increase as new infrastructure allows buses to bypass some queues. However, new infrastructure alone is not sufficient to create transit free-flow conditions.
    - Without new transit-priority infrastructure, high toll increases are needed to incentivize changes in travel behavior to create transit free-flow conditions.
- **Transit fare adjustments are an effective tool** to manage demand but are not essential for meeting study objectives.
- **Neither a contraflow or bus-only / bus + HOV lane will fulfill the study's objectives when implemented alone,** but either could be considered as additional service reliability is needed after necessary tolling, service, and infrastructure improvements have been delivered.
- **A contraflow lane would improve transit reliability and is operationally viable** but would require additional infrastructure, conversion of a travel lane on the bridge's lower deck, and an education process to alert drivers to oncoming bus traffic.
- **A bus-only / bus + HOV lane would improve transit reliability but poses vehicle-weaving challenges** and would create longer auto queues behind the toll plaza due to the dedicated lane on the bridge.

The BACCTS is a highly detailed study that analyzes many ways transit operators can increase capacity within the Transbay Corridor. However, before any of these steps can be taken, certain prerequisite and common projects must be funded and implemented in order for these operators to adequately increase capacity to meet ever-growing demand in the corridor. The Train Control Modernization Program projects are included in the prerequisite projects list in the BACCTS packages; projects that are a part of the Bay Area's transportation plan but lack the necessary funding necessary to implement. Funding is needed to advance the recommended package toward implementation; the TCMP has been partially programmed in both regional and state funding plans.

6.2 Horizon Crossings Outcomes

The Horizon Crossings Perspective Paper contributes to the Bay Area's continuing regional dialogue about the pros and cons of constructing an additional crossing of San Francisco Bay. Five key questions were posed at the beginning of the study:

1. Do the crossings adequately accommodate Transbay travel demand?
2. Are the crossings resilient enough to deliver benefits under uncertain future conditions?
3. Do the crossings align with Horizon's guiding principles?
4. Do the crossings improve accessibility for low-income populations?
5. Do the crossings' benefits outweigh their costs?

Table 6-1 summarizes how the seven Crossings concepts would address these key questions and identifies whether these concepts would result in an increase or decrease in overall vehicle-miles traveled, and an increase or decrease in transit ridership. The study recommends the following:

- **Do not advance the two auto-only crossing concepts (#1 New San Mateo-Hayward Bridge and #2 Mid-Bay Bridge)** for further analysis during the Horizon/Plan Bay Area 3050 process or in other future Transbay crossing efforts
- **Advance the three transit-only crossing concepts (#3 BART Market Street Redundancy, #4 BART New Markets and #5 Greater Regional Rail)** as Priority 1 concepts for further analysis in Horizon and contemplated for inclusion in Plan Bay Area 2050. These concepts should be advanced for further analysis in future Transbay crossing efforts.
- **Advance Concept #6 (Paired BART + Auto)** as a Priority 2 concept and considered for further advancement only after additional analysis of equity impacts
- **Advance Concept #7 (Paired BAART + Rail)** as a Priority 2 concept and advanced for further discussions with partner agencies focusing on whether the concept's high cost is a barrier to its inclusion in further studies and whether its components should be evaluated separately.

Table 6-1: Crossings Finding Summary

MODE	CROSSING #	KEY QUESTIONS					REGIONAL VEHICLE MILES TRAVELED	REGIONAL TRANSIT RIDERSHIP
		Q1	Q2	Q3	Q4	Q5		
	Concept 1	○	✔	○	○	○	INCREASE	DECREASE
	Concept 2	○	✔	○	○	○	INCREASE	DECREASE
	Concept 3	✔	✔	✔	✔	✔	DECREASE	INCREASE
	Concept 4	✔	✔	✔	✔	✔	DECREASE	INCREASE
	Concept 5	✔	✔	✔	✔	✔	DECREASE	INCREASE
	Concept 6	✔	✔	✔	✔	✔	DECREASE	INCREASE
	Concept 7	✔	✔	✔	✔	✔	DECREASE	INCREASE

Source: Crossings: Transformative Investments for an Uncertain Future

Transit-only concepts performed very well in the Crossings analysis, highlighting the importance of BART and conventional rail to transit demand in the region. The Crossings paper is a long-term planning document and is meant as a continuation of the short- and medium-term analysis conducted in the BACCTS. This indicates that the need for, and the success of a new crossing is predicated on successful implementation of the BACCTS short-term improvements, which include the TCMP. Without timely implementation of the TCMP, the ability of Transbay Corridor transit to meet growing demand now and in the future will be affected.

7 Conclusion

This Hybrid Summary Comprehensive Multimodal Corridor Plan summarizes the regional need to reduce congestion and improve system reliability in the Transbay Corridor. An essential part of accomplishing this goal is the implementation of the Train Control Modernization Program, considered an essential program by both the Bay Area Core Capacity Transit Study and Horizon Crossings Perspective Paper, as well as other transportation plans including the California State Rail Plan and Plan Bay Area 2050. These studies have shown the ability for the TCMP, implemented in conjunction with other transit prioritization projects, to significantly increase capacity and reduce congestion throughout the Transbay Corridor.