



**SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT**

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2018

January 30, 2018

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RE: BART's Train Control Modernization Project  
2018 Local Partnership Program Competitive Grant Program

Dear Ms. Bransen:

On behalf of the San Francisco Bay Area Rapid Transit District, I am pleased to submit BART's request for \$50 million in funding from the 2018 Local Partnership Program Competitive Grant Program (LPP). Our project, BART's Train Control Modernization Project, is an important element of a larger project to increase BART's system capacity. This larger project, BART's Transbay Core Capacity Project, which consists of multiple project elements and includes many funding partners, has regional and statewide significance in reducing greenhouse gas emissions, providing access to jobs and stimulating the economy, reducing freeway and arterial congestion, providing mobility, and regional and statewide transportation connections for all residents including those in disadvantaged communities.

The requested funding for the train control modernization project, which is a new state-of-the-art, communications-based train control system, is critical for BART to achieve up to 30% in additional capacity on the existing BART system without adding a second Transbay Tube from the East Bay to downtown San Francisco. In addition, the project will greatly assist the region and the state in reducing both VMT and greenhouse gas emissions, as well as improve the system's reliability and greatly enhance the customer experience.

BART's current Transbay Corridor ridership exceeds capacity in the peak hours between the Embarcadero station in downtown San Francisco and stations in the East Bay. Within this corridor, riders in the peak hours often endure excruciatingly crowded conditions while some choose other modes because BART trains are so crowded. BART's ability to increase ridership – and the region's ability to steer growth to places served by transit – depend upon additional BART capacity in the Transbay Corridor.

For the past few years, BART has worked diligently to design and identify costs of the project components of the Transbay Core Capacity Project, as well as identify potential

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funding sources. Funds will be provided by a combination of federal, state, regional and local sources, including BART's own capital allocations and funding provided by the successful passage of a general obligation bond in November 2016. In its Plan Bay Area 2040, adopted in July 2017, the Metropolitan Transportation Commission (MTC) identified the BART Transbay Core Capacity Project as a critical regional need, and has included this project in its Core Capacity Challenge grant program. BART is also working closely with the federal government on a New Starts grant through the Capital Investment Grant program. In addition, BART has requested funding from various local county sales tax measures. The funds requested through the LPP program will close the remaining funding gap and allow BART to achieve the biggest capacity boost possible while renovating and maintaining the core BART system.

We appreciate your consideration of this application, and would be happy to answer any questions or provide additional materials if needed. As BART's General Manager, I have reviewed the materials submitted and approved the cost estimates provided in this application, including the amounts and fund sources cited.

Please do not hesitate to contact me or Duncan Watry, Project Manager – Core Capacity, at (510) 287-4840, or [dwatry@bart.gov](mailto:dwatry@bart.gov).

Sincerely,

A handwritten signature in blue ink, appearing to read "Grace Crunican". The signature is fluid and cursive, with the first name "Grace" written in a larger, more prominent script than the last name "Crunican".

Grace Crunican  
General Manager

Attachments



# BART's Transbay Core Capacity Program – Train Control Modernization Project



## CALIFORNIA STATE LOCAL PARTNERSHIP COMPETITIVE GRANT PROGRAM

California Transportation Commission

January 30, 2018

SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT



# I. Project Overview

BART’s proposed Local Partnership Program – Competitive Grant proposal is a request for \$50 million to fill a funding gap in its train control modernization project. This project is located in the San Francisco Bay Area and will serve the entire BART system including new extensions to Santa Clara County and eastern Contra Costa County.

Figure 1: BART system map



The estimated cost for BART’s Train Control Modernization Project (TCMP) is approximately \$1.151 billion. Matching funds will be provided by a variety of sources, many of which are already committed, including funds from BART’s Measure RR (a \$3.5 billion general obligation measure passed by the voters in November 2016), BART’s capital allocations (operating funds transferred to support BART’s capital program), federal formula and competitive funds, other state grant funds, and funds provided by the Santa Clara Valley Transportation Authority.

More than any other component of BART’s Transbay Core Capacity Program, the Train Control Modernization Project is the most critical because of it is essential to the continued operation, safety and reliability of the BART system.

## **Project Description**

BART's Transbay Core Capacity Program (the "Program") is a comprehensive program of projects that will relieve crowding, increase 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 TCCP will allow the number of trains operating through the Transbay Tube to increase from 23 to 30 trains per hour, and peak hour train lengths to be increased from an average of 8.9 to 10 cars, maximizing throughput capacity in the most heavily used part of the BART system. The Program has four major project components: 1) the train control modernization project (TCMP); 2) an additional 306 new rail cars; 3) additional vehicle storage at BART's Hayward Maintenance Complex; and 4) five new traction power substations. With this application, BART is requesting \$50 million to close the funding gap for the train control modernization project.

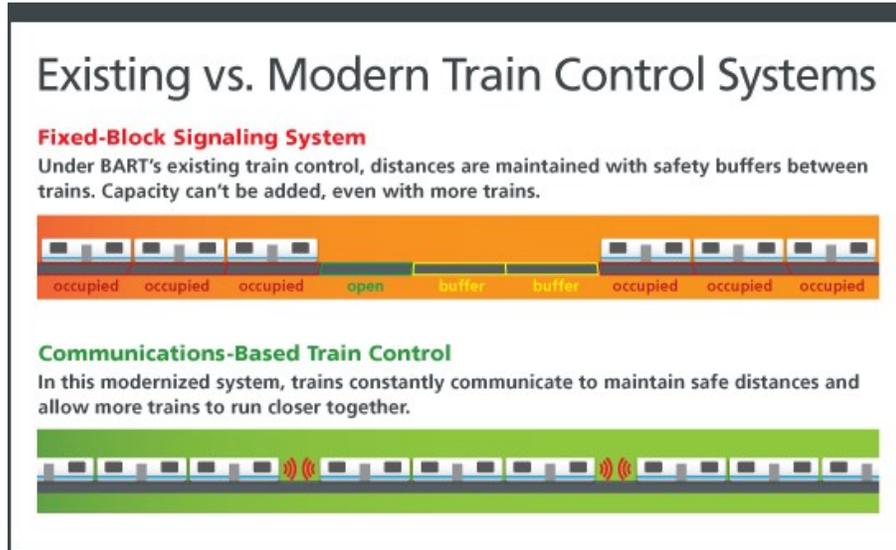
This application is for partial, but critical, funding of a new, communications-based train control system. Currently in design, the TCMP is the linchpin of BART's Transbay Core Capacity Program and is key to expanding capacity as well as enhancing system reliability and safety. In 2017, between 15-25% of all delayed trains were caused by problems with the existing train control system, which is over 40 years old. BART is proposing to completely replace its aging and obsolete equipment with a communication-based system (CBTC) which will allow trains to run closer together safely, thereby increasing system capacity. This new system, CBTC, is a fully-tested and operational system and is used all over the world including New York, London, Paris and Denmark.

The four program elements of the Transbay Core Capacity Program will allow BART to decrease headways on each of the five BART lines from 15 to 12 minutes, thus increasing overall system frequency by 25%. Expansion of the rail car fleet will allow for trains of 10 cars, adding capacity in the system. The overall increase in peak hour capacity through the Transbay Corridor will be approximately 45%. BART estimates that these systemwide improvements will result in an increased average weekday ridership of 202,972 riders beyond current levels and will decrease GHG emissions by at least 4,748,924 metric tons of carbon dioxide equivalent (MTCO<sub>2e</sub>) over a 50-year period.

## **Project Scope**

BART's Train Control Modernization Project (TCMP) will replace BART's existing 1970s-era train control system with a new communications-based train control (CBTC) system, 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 CBTC system will be based on a moving-block signaling approach throughout the existing 112-mile system plus the Berryessa extension south of Warm Springs now under construction (see Figure 2 below). The new CBTC system will be installed within or adjacent to the existing BART trackway and wayside facilities. Existing signaling equipment will be overlaid with the most current electronics, software, computer systems, and cabling. 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.

Figure 2: Existing vs. Modern Train Control Systems



## Project Background/Purpose and Need

In 2016, the Bay Area became the fifth largest metropolitan region in the US.<sup>1</sup> In 2010, the nine-county region was home to more than 7.6 million people and 3.7 million jobs. Some 300,000 jobs are located in San Francisco's central business district alone, the fourth largest central business district in the country.<sup>2</sup> The Bay Area's economy is healthy and growing, and downtown San Francisco is undergoing large construction projects that will increase office space and enable the city to add more jobs. By 2040, the region expects 9.3 million residents and 4.5 million jobs<sup>3</sup> to be located here.

According to recent analysis profiled in MTC's Vital Signs, the region's current economic boom has pushed freeway congestion levels to record highs for the fourth consecutive year<sup>4</sup>. Freeway delays due to congestion have increased 9 percent from 2015, averaging 3.5 minutes per commuter in 2016. Notably, regional traffic congestion is significantly worse compared to previous economic booms. Since the peak of the dot-com boom in 2000, per-commuter congested delay has skyrocketed by 64 percent, while population has grown by 13 percent and jobs have grown by 8 percent. This trend is particularly noticeable for Bay Area drivers given that nearly all of the growth in gridlock has occurred during the last four years. Commuters are likely also experiencing delays on arterials and local roads, although there is insufficient data to quantify these trends.

As the Bay Area's second largest transit network, BART currently operates and maintains 46 stations and 112 miles of revenue track, serving over 440,000 passengers every weekday in the counties of Alameda, Contra Costa, San Francisco, and San Mateo. The Transbay Corridor is the only connection between many East Bay residential areas and jobs in San Francisco. It is the region's most heavily used

<sup>1</sup> Census – San Jose-San Francisco – Oakland, CA Combined Statistical Area

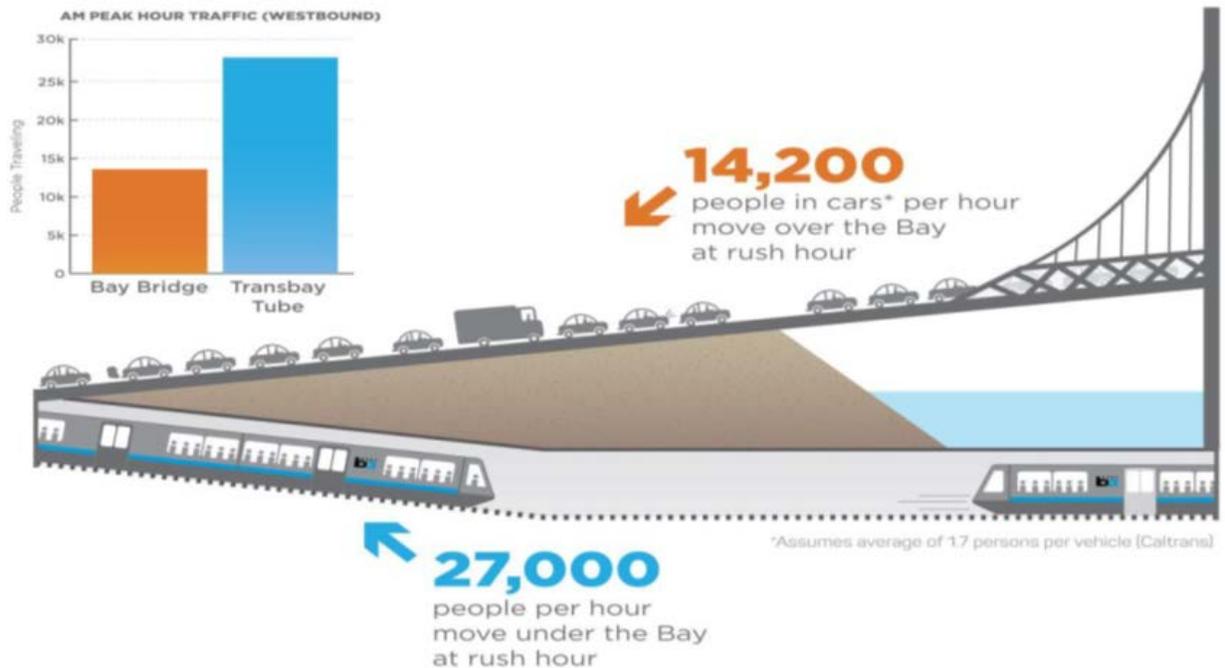
<sup>2</sup> As of 2010, American Community Survey 2006-2010

<sup>3</sup> [https://mtc.ca.gov/sites/default/files/2-The\\_Bay\\_Area\\_In\\_2040.pdf](https://mtc.ca.gov/sites/default/files/2-The_Bay_Area_In_2040.pdf)

<sup>4</sup> <http://www.vitalsigns.mtc.ca.gov/time-spent-congestion>

transportation corridor, carrying more than 40,000 trips per hour in the peak, two-thirds of which are made on BART's two tracks crossing under the Bay. Virtually all the remaining trips are in cars and buses that utilize the heavily congested San Francisco-Oakland Bay Bridge (Interstate 80).

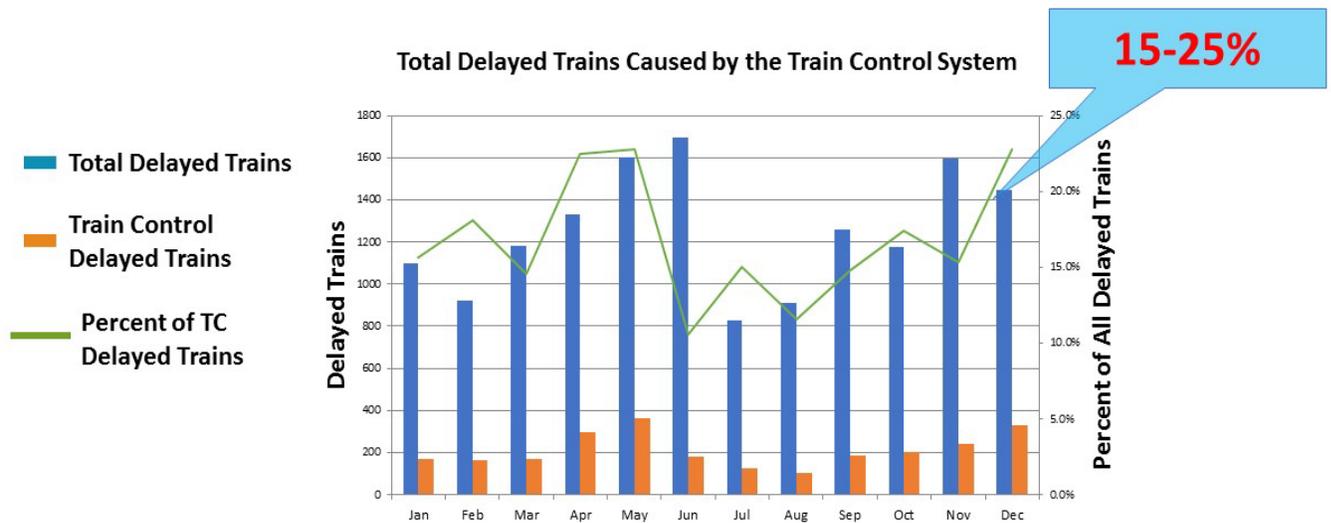
Figure 3: BART's Peak Hour Transbay Market Share



On the main trunk of the BART system, from the Oakland wye (junction in downtown Oakland where trains of all routes merge) through the Transbay Tube to Daly City, BART currently operates a maximum of 23 trains per hour in each direction. Train lengths vary, but currently average 8.9 cars per train in the peak. Between the East Bay and San Francisco, peak hour trains are crowded and ridership has been growing. As the system expands – extensions into Santa Clara County and eastern Contra Costa will open in 2018 – and as the core continues to attract development, tens of thousands of new riders are expected. BART's existing Transbay Corridor ridership exceeds capacity in the peak between the Embarcadero station in San Francisco and the Downtown Berkeley, Rockridge, and Bay Fair stations in the East Bay.

Although BART staff has continued to maintain the existing train control system in excellent working order, because of its obsolescence, new parts are unavailable. BART staff relies on EBay and other secondary markets, and often hand-manufactures the necessary parts to maintain the system in good working order. BART estimates that up to 25% of current system delays are due to aging hardware fails. Not only do these system delays adversely affect the riding public, wayside train control repairs and maintenance are very labor intensive. Figure 4 demonstrates BART's train control system delay trend.

Figure 4: BART Train Control System Delay Trend

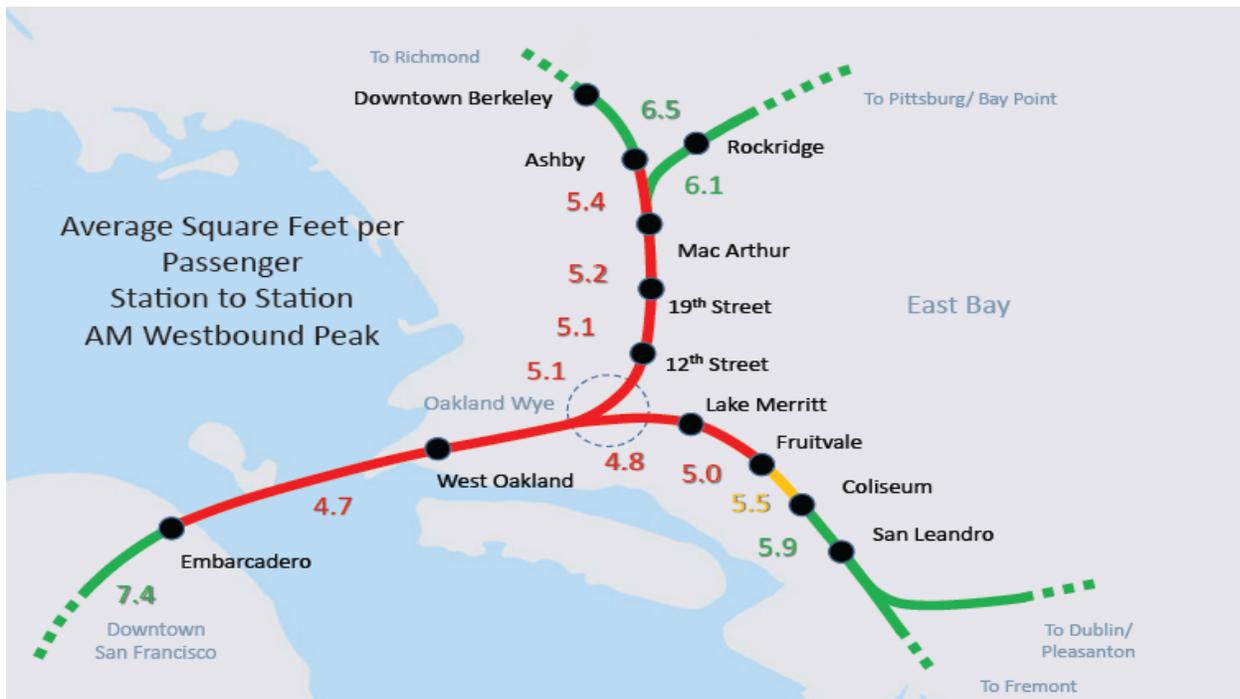


Within this corridor, riders in the peak hour currently have an average of 5.2 square feet of space each, which is an uncomfortable level for passengers. The Transit Capacity and Quality of Service Manual published through the Transit Cooperative Research Program (TCRP) establishes 5.4 square feet of space per passenger as a comfortable loading level on U.S. rail transit systems.<sup>5</sup> The Federal Transit Administration (FTA) has adopted this as the threshold level of crowding for funding Core Capacity projects with Capital Investment Grant funds.

The most crowded part of the BART corridor is the five-mile-long Transbay Tube between the Embarcadero and West Oakland stations, where the average rider has just 4.7 square feet of space, far less than the FTA threshold. Current BART riders endure uncomfortably crowded conditions, while some commuters choose other modes to avoid the crush-load conditions on some BART trains. Figure 5 illustrates the average square feet per passenger in the morning peak period.

<sup>5</sup> TCRP Report 165

Figure 5: Square Feet per Passenger in Transbay Corridor



Color Legend:

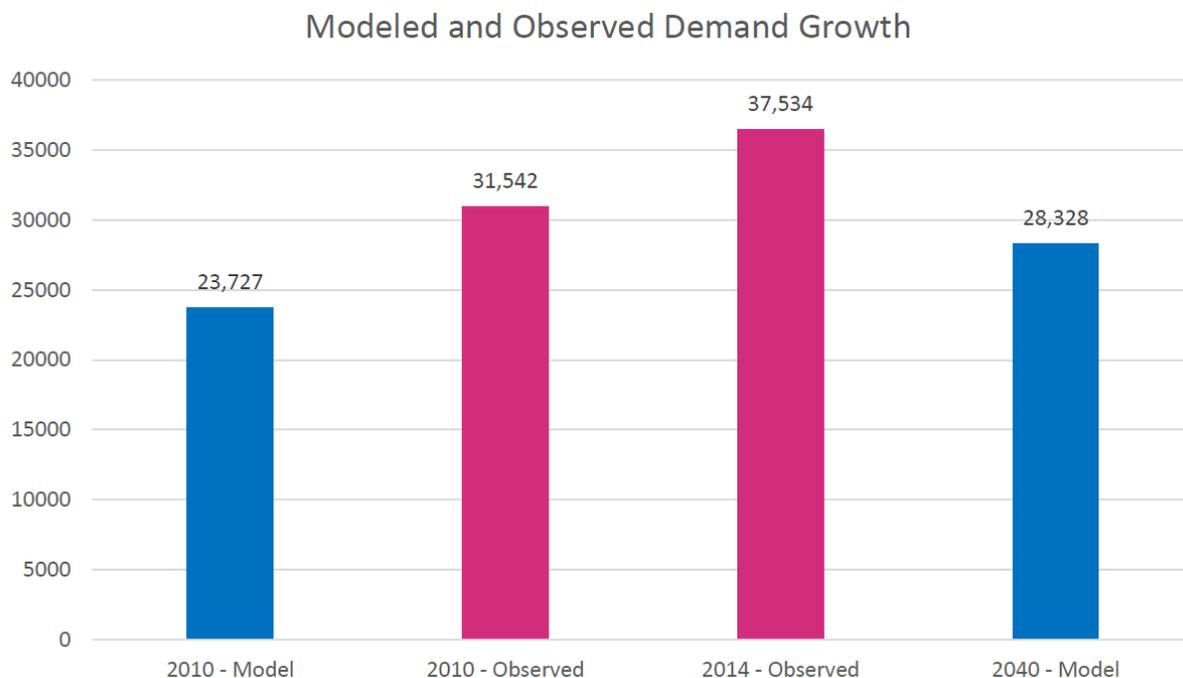
- Currently at or over capacity
- Will be at capacity within 5 years
- Less than full capacity

The Transbay Core Capacity Program will relieve current levels of crowding during the peak while creating the opportunity for ridership growth. Based on current ridership, the space per passenger in the corridor will be increased from the current average of 5.2 square feet to a more comfortable 7.6 square feet.

The issue of transit overcrowding through the Transbay Corridor extends beyond the BART system. To better understand the Core Capacity needs of the Transbay Corridor, the Metropolitan Transportation Commission (MTC) undertook the Bay Area Core Capacity Transit Study (CCTS) as a collaborative effort to identify and prioritize investments that will improve travel on public transit to and from the San Francisco Core.<sup>6</sup> Part of the study focused on forecasting 2040 demand in the corridor, and concluded that the 23,700 modeled trips in the AM peak hour will increase to 28,300 trips in 2040. Moreover, observed demand for all modes already has increased by 18% (4.3% per year) between 2010 and 2014. More than 99% of the total growth forecast between 2010 and 2040 has been realized in the first four years of the forecast period, as shown on Figure 6.

<sup>6</sup> <https://mtc.ca.gov/our-work/plans-projects/other-plans/core-capacity-transit-study>

Figure 6: Modeled and Observed Demand Growth, AM Peak Hour



MTC’s Bay Area Core Capacity Transit Study evaluated short, medium and long-term investments that could steadily upgrade the overall transportation system and keep pace with anticipated population growth for the next quarter century. Both the BART car expansion and the BART train control system modernization were included in the study’s list of prerequisite projects. In addition, both projects are included in MTC’s Core Capacity Challenge grant program.

### **Concurrence with MTC’s Regional Transportation Plan and Sustainable Communities Strategy**

In July 2017, MTC adopted an update to its Regional Transportation Plan, called Plan Bay Area 2040<sup>7</sup>. Drawing on the priorities of the previous regional plan, Plan Bay Area 2040’s investment priorities for the next 24 years are to operate and maintain the existing transportation system, modernize transit and roadways, and expand the system in strategic locations to accommodate growing job centers and Priority Development Areas. In the Bay Area, Plan Bay Area 2040 serves as the region’s Sustainable Communities Strategy (SCS), as required by Senate Bill 375, and integrates transportation, land use and housing to meet greenhouse gas reduction targets set by the California Air Resources Board (CARB).

### **Plan Bay Area’s Key Transportation Strategies, Investments and Projects**

Plan Bay Area 2040 develops a blueprint for short-term and long-term transportation investments to support the plan’s focused growth strategy. Investment priorities for the next 24 years reflect a primary commitment to “Fix It First.” As shown in Figure 7, approximately 90 percent of Plan Bay Area 2040’s investments focus on operating, maintaining and modernizing the existing transportation system. Plan

<sup>7</sup> Plan Bay Area 2040: <http://2040.planbayarea.org/what-is-plan-bay-area-2040/>

Bay Area 2040 also directs almost two-thirds of future funding to investments in public transit, mostly to ensure that transit operators can sustain existing service levels through 2040.

Figure 7: Plan Bay Area 2040's top ranked projects

Rank	Project	Investment* (\$ Billions)
1	California High-Speed Rail (Bay Area Segment)	\$8.5
2	Regional Express Lanes	6.0
3	BART to Silicon Valley (Phase 2)	5.5
4	BART Transbay Core Capacity Project + BART Metro Program	4.6
5	Caltrain Extension to Transbay Transit Center**	4.1
6	Caltrain Electrification (Phase 1)	2.4
7	Clipper	1.7
8	San Francisco Muni Fleet Expansion	1.3
9	Bay Area Forward	1.0
10	Treasure Island Mobility Management Program	1.0

\* Investment values are costs within the plan period and include operating expenses; shown in year-of-expenditure dollars.

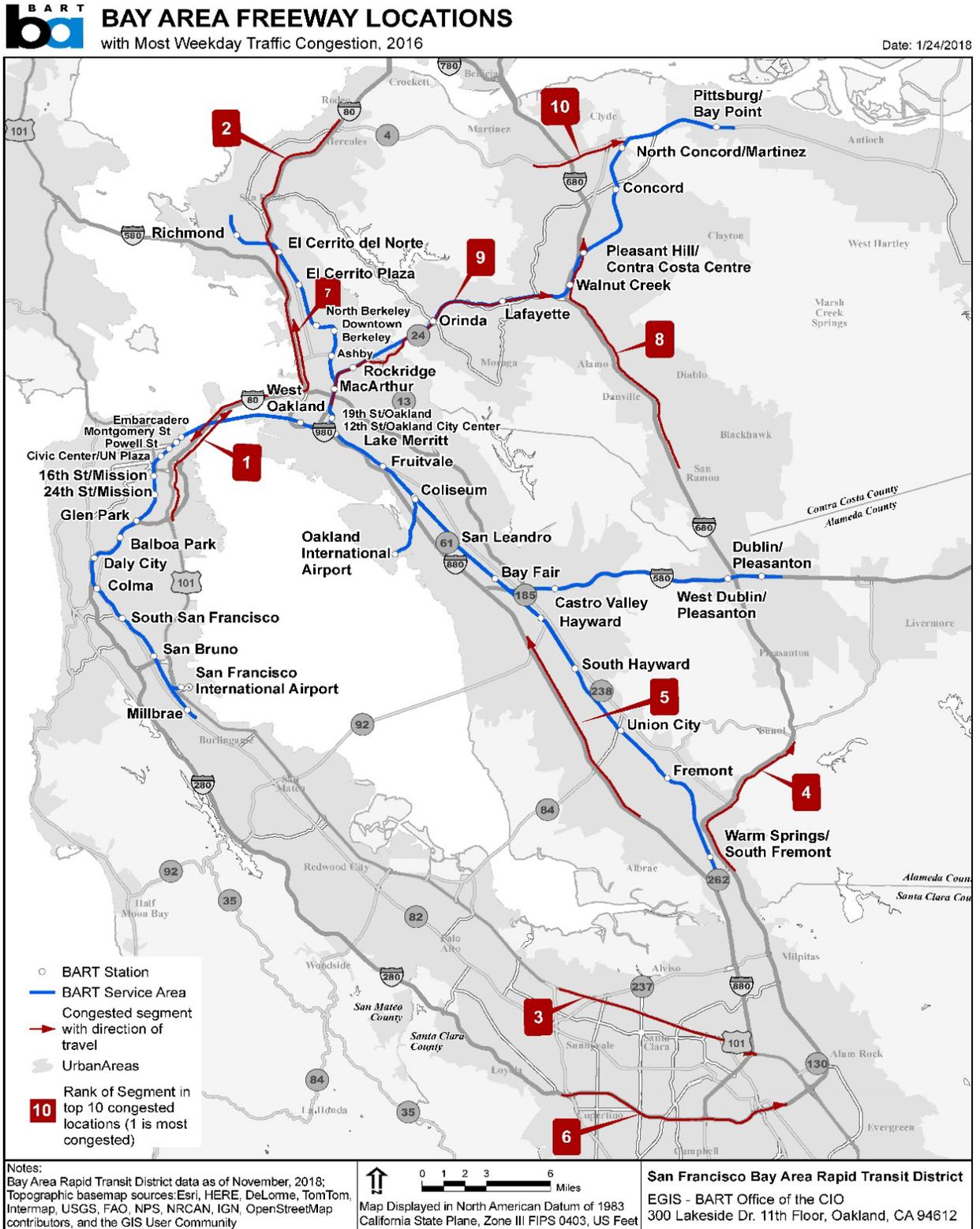
\*\* Does not include \$109 million already expended on the project.

Plan Bay Area 2040 establishes a vision for the Bay Area that closely aligns with the broad goals of the State of California. The plan's goals to promote economic vitality, ensure social equity and protect the environment link to the policy framework established in California Transportation Plan 2040 by the California Department of Transportation. Central to both plans are carbon dioxide (CO<sub>2</sub>) emissions reduction targets designed to tackle climate change in the years to come. Similarly, both plans prioritize fixing an aging transportation system, focusing future growth and directing increased funding toward non-auto modes of travel. Both multi-year planning efforts reflect a relatively consistent vision for moving forward for the region's 8 million people and the state's 39 million people. The key to implementation will be working together across local, regional, state, and federal levels to achieve these shared goals.

### Traffic Relief on Region's Freeways and Increased Travel Options

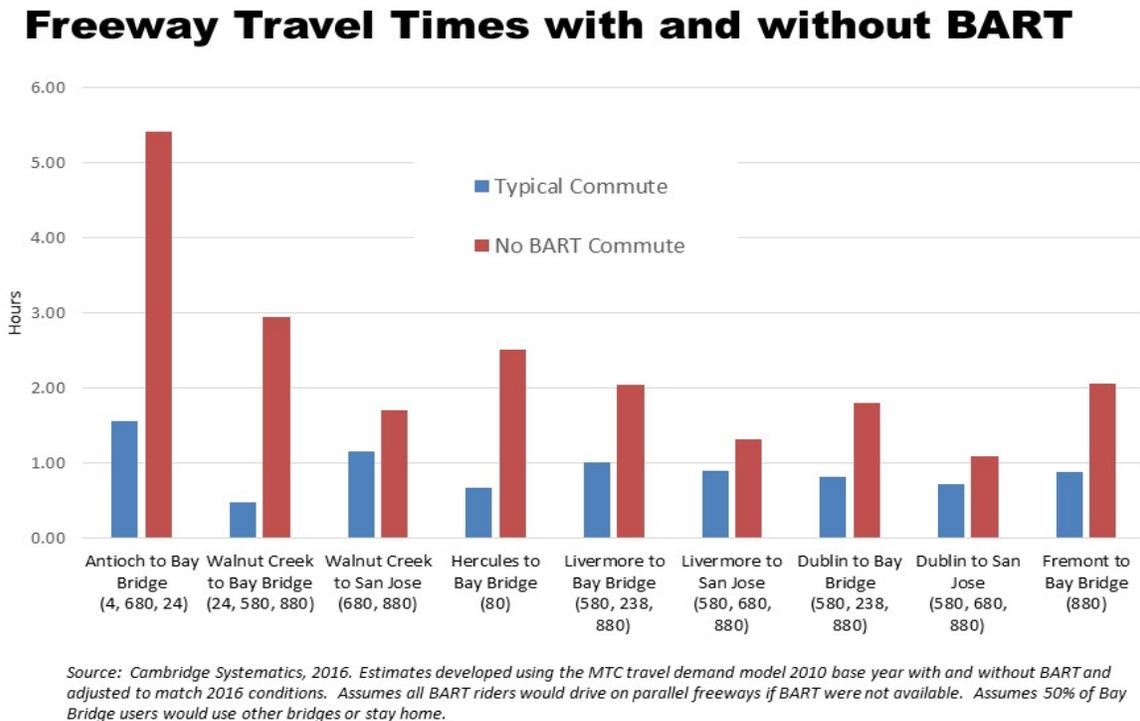
The BART Transbay Core Capacity Project could have a significant impact on the region's freeways, particularly those with the most congestion – including the Transbay Corridor, the 101 corridor and Interstate 80. As shown on the Figure 8 map, BART lines parallel Interstate 80 from Hercules to San Francisco, as well as Highways 24 and 680 in central Contra Costa County, and Highway 880 in Alameda County. BART also serves northern San Mateo County, and connects with the Caltrain service at the BART Millbrae station.

Figure 8: BART and Bay Area Freeway Congestion



If we assume that each congested lane of freeway accommodates approximately 2,000 cars per hour, and that each car carries an average of 1.15 people (in a single-occupant vehicle lane), we can estimate that a congested freeway lane during one hour of the peak period commute carries 2,300 people. In comparison, a fully loaded ten-car BART train, using the national passenger load standard of 113 passengers/rail vehicle, we estimate that BART can carry 23,052 passengers per hour during the peak period commute. BART is therefore 10 times more efficient than a freeway lane of traffic. The graphic below illustrates the impact of BART on the Bay Area freeway system.

Figure 9: Commute Comparisons



## II. PROJECT DELIVERY PLAN

### Project Schedule

BART has developed a schedule to coordinate delivery of the four Program elements and achieve 28 trains per hour (TPH) through the Transbay Tube by 2026 and 30 TPH beginning in 2028. The Program has been sequenced to deliver all four component projects concurrently to minimize the overall Program duration and bring the benefits to fruition as quickly as possible. As shown on Figure 10, the CBTC contains the longest schedule duration in the Program; accordingly, the Program critical path extends through the CBTC implementation schedule.



The Federal Transit Administration (FTA) approved the Transbay Core Capacity Program into the Capital Investment Grant (CIG) pipeline in August 2015, and anticipates approval for entry into Engineering in January 2018. Program design is currently at the 30 percent level. BART has initiated a design-build procurement for the communications-based train control system and is developing specifications to procure the 306 new vehicles. With approval into Engineering, BART will continue to advance HMC Phase 2 and the traction power substations beyond the 30 percent design stage.

The Program will take place entirely within publicly owned transportation right-of-way, the vast majority of which is already owned by BART.

## Procurement Status

Table 1 summarizes the current procurement status.

*Table 1: Procurement Status*

Program Element	Procurement Status
<b>Vehicles</b>	RFP scheduled for release in September 2018.
<b>HMC Phase 2</b>	Construction contract documents are under development. Awards are expected in August 2018 for track, March 2019 for storage yard construction, and April 2019 for flyover construction.
<b>Communications Based Train Control</b>	Request for design-build qualifications released August 15, 2017. BART anticipates issuing NTP to the selected bidder in February 2019.
<b>Traction Power</b>	The fabrication and installation of traction power substations will be procured following completion of the design phase, now underway. BART anticipates entering into a contract in 2019.

## BART Project Management Capability

Since the 1950s when planners, elected officials and engineers designed and built the original BART system, BART has amassed a proven track record of successfully delivering large-scale, complex projects, including system extensions, new stations to existing lines, a billion-dollar earthquake safety retrofit project, major system upgrades, and other state-of-good repair projects.

As a recent example, in March of 2017, BART service was extended south 5.4 miles from the Fremont Station to a new station in the Warm Springs district of Fremont in southern Alameda County (the “Warm Springs Extension”). The Warm Springs Extension alignment is mostly at-grade; however, it runs beneath Fremont Central Park in a mile-long cut and cover subway. The project funding plan for the \$890 million extension included substantial contributions from a variety of local and State sources and surplus revenues from the BART SFO Extension; the project had no federal funding. The project was implemented via two major contracts: the \$137 million Fremont Central Park Subway contract which was begun in August 2009 and completed on schedule and within budget in April 2013; and the \$299 million design-build Line, Track, Station and Systems (“LTSS”) contract which was begun in October 2011 and was completed approximately \$100 million under budget.

BART has also successfully added new rail services using non-BART technology, further demonstrating the agency's engineering and project management expertise. Both the Oakland Airport Connector (opened in 2014) which provides rail service from the Oakland Coliseum BART station to the Oakland

International Airport, and a new rail service extension called the eBART/East Contra Costa Rail Extension (set to open May 2018) which extends ten miles from the Pittsburg/Bay Point BART line to the City of Antioch, operate using non-BART technology (cable-propelled people mover, and diesel multiple unit, respectively).

## Project Cost Estimate

The total estimated project cost for the train control modernization project is approximately \$1.151 billion. Of that amount, \$554.4 million is committed, and includes BART fare revenues, federal formula funds and Measure RR GO bond funds. Uncommitted funds in the amount of \$596.1 million include federal New Starts Capital Investment Grant Funds, funds from the Santa Clara Valley Transportation Authority (VTA) funds, and other Senate Bill 1 grant funds. Please see the Project Programming Request (PPR) for the train control modernization project, and the financial plan for the entire Transbay Core Capacity Project; both can be found in Appendix A.

As stated previously the overall Transbay Core Capacity Program includes four elements – a new communication-based train control system, 306 additional rail vehicles, an additional rail vehicle storage and maintenance facility, and five additional traction power substations. BART is seeking LPP funding for only one of these elements, the communication-based train control system (CBTC). The Program is currently at the 30% design stage, and cost estimates reflect this level of design, including appropriate level of contingency.

**The CBTC system represents a usable segment of the Program, separate from the other Transbay Core Capacity Project components, and can be fully completed with funding through State of California SB1 and Cap-and-Trade grant programs in 2018.** As can be seen in the chart in Appendix A, all funding elements have been secured (except for Santa Clara VTA and FTA Capital Investment Grant (CIG) funds and GANs) other than the State of California funding sources. These state sources include:

- SB1 Local Partnership Program (Current Request) - \$50 million
- TIRCP Request (submitted January 12, 2018) - \$454 million  
(Usable segment request - \$318.6 million)
- SB1 Congested Corridor Program (February 2018) - \$100 million

The Santa Clara VTA portion of funding (\$101.6 million) is not available for use by the Transbay Corridor portion of the Transbay Core Capacity Program, and only will be applied to the Santa Clara VTA extension of the BART system. Hence, the CBTC system can be implemented fully in the existing system (where ridership, GHG emissions, and other benefits are realized) without Santa Clara VTA funds. Additionally, the FTA CIG amount of \$25.9 million that is allocated to the CBTC system can be fully shifted to be funded by BART Capital Allocation or Measure RR funds if CIG funding is not approved by the FTA. **With the usable segment request of \$318.6 million in TIRCP funds and \$150 million in additional state program funding, the entire CBTC system is funded completely and can move forward without delay.**

If BART is unable to secure the anticipated but currently uncommitted funds for the TCMP project, BART will use any reasonable means available to secure additional funds. The Train Control Modernization Project is BART's highest priority project – without the modernization, BART will not only be able to meet the region's mobility goals or its ridership and capacity goals, but system service breakdowns and delays are likely to increase, causing disruption and higher operating and maintenance costs. In this

event, BART will prevail upon its regional and county partners to assist in closing any funding gaps. BART could also temporarily divert funding from other Measure RR projects and/or use additional fare revenues, to cover a small funding gap, but that would leave other important projects unfunded.

### Leveraged Funds

The proposed \$50 million investment in LPP funds in the communication-based train control project represents approximately 4.3% of the total cost of \$1.151 billion. Every dollar of LPP funds spent on the CBTC project leverages approximately \$22 million in other federal, state, regional and local funds.

### Delivery Risks

As part of the CBTC design process currently underway, BART has conducted a thorough analysis of the risks in fully delivering the CBTC project and has outlined specific mitigation strategies to minimize the risk. The potential risks include: unforeseen site conditions, inadequate survey data, Oakland shop availability, unforeseen HAZMAT, proposer protests and BART staffing levels. By identifying these issues early in the design process, BART is prepared to implement the identified strategies including the performance of additional site and conditions surveys, organizational team management to ensure appropriate staffing and organizational readiness, and other tasks. A more complete summary of the potential delivery risks can be provided upon request.

### Financial Capacity

As demonstrated above, BART has the project management skills, professional expertise and financial means to deliver this project, assuming funding is secured. Any cost overruns would be born solely by BART, paid for with BART fare revenues or additional funding through its Measure RR program.

## III. Project Benefits

### Cost Effectiveness

An economic benefit-cost analysis (BCA) of the Program was conducted using a model developed by the consulting firm WSP that incorporates the parameters outlined in Caltrans’ Life-Cycle Benefit-Cost Analysis Model 6.2 (Cal-B/C v.6.2). Because the different components of the Program work together to generate the capacity improvements, the BCA evaluates the costs and benefits of the entire Program, not just the TCMP. The analysis shows that the Program will generate an estimated \$5.6 billion in present-value benefits (2016\$) over its expected useful life of 50 years, exceeding the expected Program costs (capital and O&M) of \$3.0 billion (discounted 2016\$). With a benefit-cost ratio (BCR) of 1.86, the Program is expected to generate economic benefits that outweigh its costs. Table 2 outlines the results of the BCA over the full life of the Program and in its first 20 years of operation. The BCA model is available upon request.

Table 2: BCA Summary Results

Benefit / Cost	Total Value over Program Life (2016\$, discounted at 4%)	Value over first 20 years (2016\$, discounted at 4%)
Vehicle Operating Cost Savings	\$3,922	\$2,336
Crash Reduction Cost Savings	\$944	\$558
Emission Cost Savings	\$75	\$43
Travel Time Savings	\$681	\$431

<b>Total Benefits</b>	<b>\$5,622</b>	<b>\$3,368</b>
<b>Capital Costs</b>	<b>\$2,268</b>	<b>\$2,268</b>
<b>Operation and Maintenance Costs</b>	<b>\$747</b>	<b>\$479</b>
<b>Total Costs</b>	<b>\$3,015</b>	<b>\$2,747</b>
<b>Benefit/Cost Ratio (BCR)</b>	<b>1.86</b>	<b>1.23</b>
<b>Net Present Value (NPV)</b>	<b>\$2,607</b>	<b>\$621</b>

Results are shown in \$ millions

The increase in ridership and the corresponding decrease in VMT described in subsequent sections will result in fewer greenhouse gas emissions, fewer automobile crashes, and lower vehicle operating costs, which have been estimated and monetized using the parameters laid out in Cal-B/C v. 6.2. The travel time savings calculation assumes that the change in headway from 15 minutes to 12 minutes will result in the average current rider waiting 90 seconds fewer per trip (half of the decrease in headway). This figure does not account for additional time savings from reduced delays and reduced passenger queuing. Travel time changes for new riders were not included in the analysis.

### Air Quality Benefits

Consistent with the California Air Resources Board's (ARB) *Greenhouse Gas Quantification Methodology for the California State Transportation Agency Transit and Intercity Rail Capital Program Greenhouse Gas Reduction Fund FY 2016-17* (TIRCP GHG Guidance), CO<sub>2</sub>e emissions reductions for the first operational year (Yr1 - 2027) and the final operational year (YrF - 2076) of portions of the Core Capacity Program were estimated based on Core Capacity Program operating data. GHG emissions reductions rely on the increased ridership estimates that can be submitted upon request. The TIRCP GHG emission estimates (column 'TIRCP Results' in Table 3) were based on the CBTC system as well as the 306 new vehicles that are also part of the overall Core Capacity Program.

The table below summarizes the lifetime CO<sub>2</sub>e reductions, which were quantified assuming a 50-year Program life. The Core Capacity Program life of 50 years is based on the expected service life of all elements of the BART Core Capacity Program, with the main element being the CBTC system. The ARB GHG model included benefits from both the CBTC project, as well as 306 new vehicles. These results are shown in the 'TIRCP Results' column. The original TIRCP request was for \$454 million, while the current LPP request is for \$50 million. In order to estimate the benefits described below for the LPP request, a multiplier of .11 (\$50 million/\$454 million) was applied to the 'TIRCP Results', equaling the estimated 'LPP Results.'

If requested, BART will complete a separate analysis estimating the GHG emissions reductions from the CBTC system alone.

Table 3: GHG Model Results

Pollutant	TIRCP Results	LPP Results
<b>Total GHG Reductions</b>	<b>4,748,924 MTCO<sub>2</sub>e</b>	<b>523,009 MTCO<sub>2</sub>e</b>
<b>Total GHG Emission Reductions/Total Funds (TIRCP,LPP) Requested (MTCO<sub>2</sub>e/\$)</b>	<b>.010460 MTCO<sub>2</sub>e /\$</b>	<b>0.010460 MTCO<sub>2</sub>e /\$</b>
<b>Passenger VMT Reductions (miles)</b>	525,263,200 VMT	57,848,370 VMT
<b>Reactive Organic Gases (ROG)</b>	162,199 ROG	17,863 ROG
<b>Oxides of Nitrogen (NO<sub>x</sub>)</b>	891,662 NO <sub>x</sub>	98,201 NO <sub>x</sub>

Fine Particulate Matter (PM <sub>2.5</sub> )	27,476 PM <sub>2.5</sub>	3,026 PM <sub>2.5</sub>
Diesel Particulate Matter (DPM)	55,666 DPM	6,131 DPM

Based on the total GHG reductions over the lifetime of the Core Capacity Program for the LPP Results (523,009 MTCO<sub>2</sub>e), the following equivalencies are shown for the LPP request<sup>8</sup>:

- Nearly 60 million gallons of gasoline consumed
- Over 570 million pounds of coal burned
- Over 56 thousand homes' energy use for 1 year
- Nearly 1 million barrels of oil consumed

Additionally, GHG reductions from the Core Capacity Program is equivalent to carbon sequestered by:

- Over 13 million seedlings grown for 10 years
- Over 600 thousand acres of US forests in one year

BART is happy to provide the original TIRCP GHG emissions model is available, as well as detailed methodology regarding the GHG model and ridership input estimates, if requested.

## Ridership Benefits

The Transbay Core Capacity Program, and specifically the CBTC system, is expected to increase ridership by increasing service frequency throughout the system. The methodology used (calculated for BART's TIRCP grant proposal, and which can be provided upon request) was based on the increased frequency described above for the Program once complete. To predict the ridership benefits of the Core Capacity Program, the June 2016 level of 435,973 riders per day was established as the constrained baseline. The capacity of the system through the Transbay Tube will stay constrained until the completion of the Core Capacity Program in FY 2027. This ridership increase was a main input to the GHG emissions modeling described in the previous section.

*Table 4: Capacity Constrained Ridership Increase from Transbay Core Capacity Program*

Program Milestone	Date	Capacity Constrained Ridership
Base Ridership – At Capacity	2016	435,973
Core Capacity Program Complete	2027	
Projected Ridership – At Capacity	2037	638,945

Completion of the Transbay Core Capacity Program will allow BART to increase the peak hour capacity through the Transbay Tube by 45% during the peak period. Assuming current ridership trends continue, the capacity-constrained ridership after the completion of the Transbay Core Capacity Program will be about 45% higher than the current capacity-constrained ridership. This leads to an average weekday systemwide capacity-constrained ridership of 638,945 with the Transbay Core Capacity Program. This is an increase of 202,972 average weekday riders due to increased capacity alone. Under the most likely

<sup>8</sup> These equivalencies were calculated based on the EPA Greenhouse gas equivalencies calculator: <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>

ridership increase scenario, which is based on increased frequency, this 638,945 capacity limit is expected to be reached in 2037.

Additionally, this increase in average weekday riders could, at a minimum, increase fare revenues by over \$400,000 per weekday.

This ridership analysis did not include other factors that could affect increases in ridership, including decreased crowding, new vehicles, and overall access to transportation.

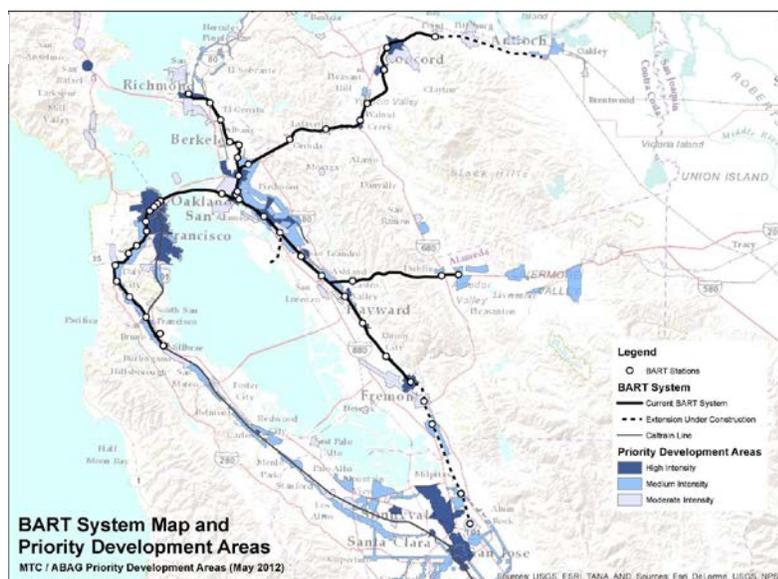
## Reduced VMT through Growth in Ridership

As stated previously, the increased capacity from the Transbay Core Capacity Program has the potential to increase BART peak period ridership by approximately 45%. Based on this ridership increase, an average trip length of 13.5 miles, and an adjustment factor for transit dependency of 291.5<sup>9</sup>, the ARB TIRCP Calculator estimates that implementation of the Program will reduce regional VMT by an average of 525 million miles per year. Over the 50-year life of the project, this equates to approximately 26 billion vehicle miles reduced as result of the Program.

Figure 12: PDAs at BART Stations

## Housing Development

A key aspect of Plan Bay Area is to concentrate new housing and jobs in designated Priority Development Areas (PDAs) that are served by BART and other transit operators. Plan Bay Area 2040 is both a transportation plan and a housing plan, and makes the case that the Bay Area currently has a housing crisis, with a need for a tremendous amount of additional affordable and other housing to support a growing population. Additionally, Plan Bay Area's Sustainable Communities Strategy calls for a 33 percent increase in the share of housing units located in PDAs that are well served by transit. Of the 44 existing BART stations (not including the two airports), 43 are currently designated as PDAs.



While BART is not directly responsible for building housing, sustaining high quality transit service is essential in supporting the plan for concentrating housing in places served by transit. BART proactively supports Transit Oriented Development (TOD) on its property and around its stations. Twenty-two TOD projects are currently underway on BART-owned property near stations, representing over \$3 billion in private investment. These projects will add 6,917 new housing units within walking distance of BART stations. In general, BART's TOD Policy encourages and supports high quality TOD, including new housing within walking distance of BART stations.

<sup>9</sup> The 291.5 is based on average ratio of systemwide annual trips to systemwide average weekday trips included in the BART ridership forecast (2018-2040).

In 2016, the BART Board of Directors adopted an affordable housing policy and performance targets setting a goal of 35 percent affordable housing on its station sites which could result in an additional 7,000 affordable units over the next ten years. In addition, the BART Board also adopted TOD land use strategies, which ensure that TOD opportunities are explicitly accounted for in the acquisition of new properties, the location of new station sites, and the design and construction of station facilities. It is estimated that the TOD Policy will offset GHG emissions by 24% versus conventional development. This means that if BART produces 20,000 units on its property versus elsewhere in Alameda and Contra Costa counties, households will drive approximately 24% less. By supporting the development of TOD, BART is contributing to the region's Sustainable Communities Strategy goal of reducing per capita GHG emissions in 2035 by 16 percent.

### **Improved System Safety and Reliability**

BART's existing train control system, originally built over 40 years ago, is reaching the end of its useful life. The new CBTC system is a proven technology, ensuring that BART can operate more trains closer together, while maintaining the highest level of safety in train operation. Many systems worldwide have now converted to CBTC, such as the London Underground, the Paris Metro, portions of the New York City subway, and others, and BART will be following this path using fully tested and certified technology.

Currently in the evening peak, the platforms at the BART Embarcadero and Montgomery stations tend to become extremely crowded, particularly when there is a service disruption. Extreme crowding on the platform can lead to unsafe conditions when people are too close to the platform edge. More frequent and longer trains will relieve crowding on BART platforms.

In addition, the new train control system will greatly improve BART system reliability; confidence in the system leads to increased ridership. Research has shown that travelers are more sensitive to travel time reliability than they are to travel time itself.

### **Rail and Transit Integration**

BART is the backbone of the region's transit network. Every BART station provides local bus connections, with some BART stations providing major intermodal transit connections to a substantial number of other transit services such as Caltrain, MUNI light rail and bus, AC Transit, SamTrans, Golden Gate Transit, ACE commuter rail, WETA ferries, and bus services to and from Solano and Napa counties.

Capitol Corridor, which provides rail service from the Sacramento Valley to San Jose, connects with BART at both the Richmond and Coliseum stations, and in 2017, over 160,000 riders transferred between systems at these two stations. The Richmond BART station also provides connections to Amtrak's San Joaquin and California Zephyr services. In addition, BART provides direct service to both the San Francisco and the Oakland International Airports. Over 125 private and publicly funded shuttle services – from medical, university, senior center, employment and high tech services – provide rides to and from BART stations throughout the system, and many BART riders increasingly rely on the emerging Transportation Network Companies (TNCs) such as Uber and Lyft for "last mile" trips.

### **California High-Speed Rail Connections**

Increasing BART capacity is particularly important for accommodating those travelers who will use the California High-Speed Rail System, which is currently under construction in the Central Valley and will connect San Jose to north of Bakersfield in 2025, according to the California High-Speed Rail 2016

Business Plan.<sup>10</sup> The success of the high-speed rail system is highly dependent on connections to those transit systems that provide regional and local access. BART interfaces will occur at the downtown San Francisco Transbay Terminal, the San Jose Diridon Station, and the Millbrae BART station. Once built, the California High-Speed Rail system is estimated to bring 24,100 daily entries and exits to the SF Transbay Terminal and 2,500 to the Millbrae station. These new trips would yield approximately 3,300 daily transfers to BART.

## Regional Economy

BART supports the Bay Area’s growing economy. Hundreds of thousands of commute trips are made on BART every weekday, saving commuters time and money, and connecting businesses with a larger pool of workers. Commuters traveling into San Francisco save on average 30 minutes each direction compared to driving. Commuters traveling to downtown Oakland save 7 minutes on average compared to driving and those traveling to Pleasant Hill save 30 minutes on average.<sup>11</sup> These travel time benefits help support the region’s major economic centers by connecting businesses with the workers they need. About a quarter of all workers in downtown San Francisco and Oakland use BART for their daily commute. BART makes 12 percent more workers available within an hour commute of Downtown San Francisco and 28 percent more within an hour commute of the West Dublin/Pleasanton station.<sup>12</sup> Without investments in BART capacity to serve these important travel markets, the Bay Area’s economic competitiveness would suffer. Many new jobs would go to regions that enjoy shorter travel times and less crowding.

Because of the value BART provides, the land around BART stations sells and leases at a substantial premium, increasing property tax revenue to local government. At the same time, the money that the region invests in building and maintaining BART is reinvested in the Bay Area economy, further contributing to growth. Over the next 25 years, BART is expected to take on an even larger role in the Bay Area’s economy by helping to accommodate the region’s growth.



Figure 13: California High Speed Rail – Proposed Connections in San Francisco, Millbrae and San Jose

<sup>10</sup> [http://hsr.ca.gov/docs/about/business\\_plans/2016\\_BusinessPlan.pdf](http://hsr.ca.gov/docs/about/business_plans/2016_BusinessPlan.pdf)

<sup>11</sup> 2014 BART Customer Satisfaction Study. [https://www.bart.gov/sites/default/files/docs/CustSat2014Report\\_Final.pdf](https://www.bart.gov/sites/default/files/docs/CustSat2014Report_Final.pdf).

<sup>12</sup> Economic Impacts of BART Operations, ALH Urban & Regional Economics, September 2015.

## Active Transportation

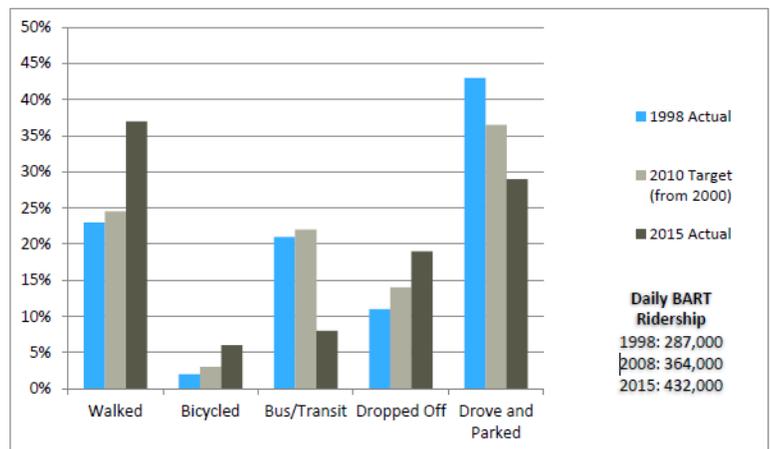
BART proactively supports projects and programs that encourage and support riders accessing the BART system by walking and bicycling. BART regularly uses existing revenues and grant funds to improve pedestrian walkways, lighting and signage, and to provide secure bicycle parking at or near its stations. In 2015, over 40 percent of BART riders accessed stations by bicycling and walking (see Figure 14 below). By increasing ridership, the Program will likely result in a proportional increase in bicycling/walking trips to BART stations.

To encourage alternative access modes, BART recently revised its Station Access Policy, which prioritizes investments to improve active transportation mode share and safety. With a clear focus on improved access, BART anticipates that the percentage of riders who use active transportation to reach BART will be even greater in the future.

## Improved Public Health

The Transbay Core Capacity Program will improve public health by increasing ridership and improving regional air quality. By making BART service more comfortable, reliable, and convenient, the Program will support ridership growth that displaces automobile travel. Reducing the number of miles driven by vehicles in the Bay Area improves air quality by reducing criteria pollutant emissions, which will improve respiratory health and other impacts throughout the region. Reductions in criteria pollutants is particularly important for communities located along high-traffic roadways. As 30% of BART stations are located within a disadvantaged community, and many more stations serve DACs (are within a half mile), the public health benefits of the Program are largely concentrated in these areas.

Figure 14: BART Station Access Mode Share



## IV. Community Impact

The many disadvantaged communities (DACs), low income communities, and other minority or at-risk communities located along the BART system will benefit from the increased frequency, greater capacity and reduced crowding gained from the Transbay Core Capacity Program.

According to the California Air Resource Board's Funding Guidelines<sup>13</sup>, the Transbay Core Capacity Program is classified as a Transit project, as it will achieve GHG reductions by reducing passenger vehicle miles travelled (VMT) through operational improvements, including increased service frequency and safety. Additionally, the Program qualifies for ARB funds because of the following criteria:

- The Program serves multiple disadvantaged communities along or within a half mile of the BART system. See Figure 15 for a map showing DACs along the BART alignment.

<sup>13</sup> [https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/2017\\_draft\\_funding\\_guidelines.pdf](https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/2017_draft_funding_guidelines.pdf)

- BART has and will continue to host community meetings, as part of the planning process to engage residents and community groups for input on community and household needs, and will continue to provide documentation showing how the input will be considered and addressed.
- The Program provides improved transit service for stations and stops within multiple AB 1550 communities on the BART system.

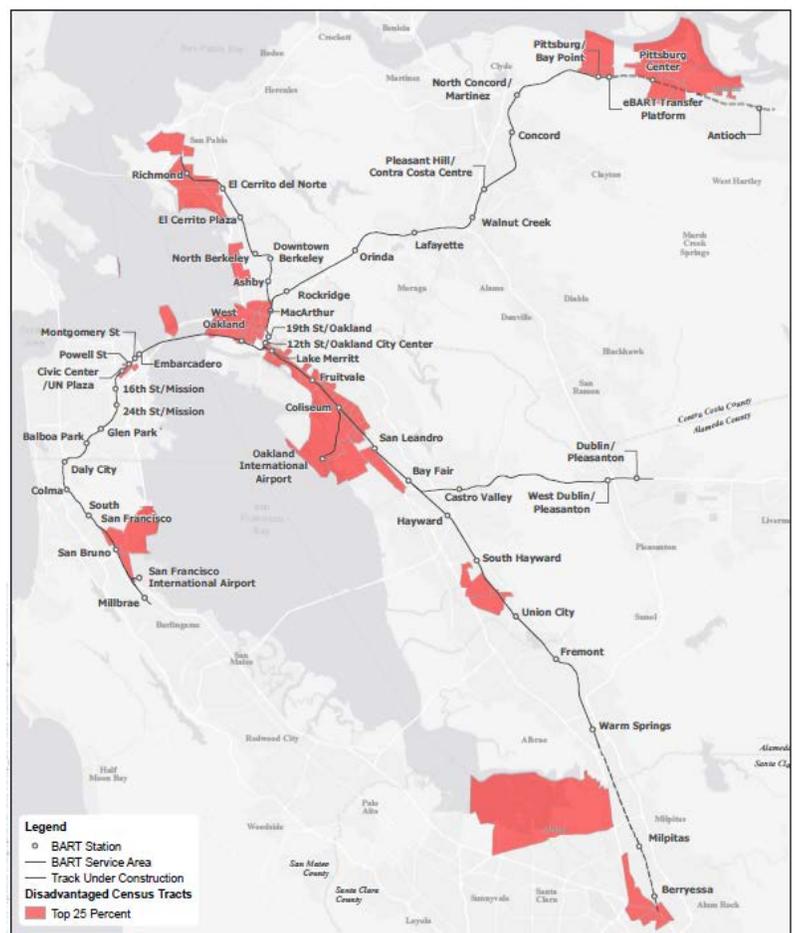
BART utilizes MTC’s definition of “communities of concern” in defining Disadvantaged Communities (DAC). MTC’s definition is intended to represent a diverse cross-section of populations and communities that could be considered disadvantaged or vulnerable in terms of both current conditions and potential impacts of future growth. For Plan Bay Area 2040, the definition of communities of concern included all census tracts that have a concentration of BOTH minority AND low-income households at specified thresholds of significance, or that have a concentration of three or more of six additional factors if they also have a concentration of low-income households. Among the additional factors are people with disability, seniors 75 years and over, and cost-burdened renters.

The Transbay Core Capacity Program corridor includes 9 BART stations located directly within disadvantaged communities. Additionally, for the most overburdened section of the Core Capacity corridor from West Oakland to Embarcadero Station, the West Oakland Station is also located in a disadvantaged community. In total, at least 15 of the over 50 existing and planned BART stations are located in disadvantaged communities, which is equal to 30% of all stations.

Figure 15: Disadvantaged Communities located within half mile of BART System

### Program Benefits to Disadvantaged or Low-Income Communities

BART riders come from across the income spectrum and from the full diversity of the region’s racial and ethnic groups in rough proportion to their representation in the population of the BART district. Likewise, riders are as racially and ethnically diverse as the Bay Area’s population. Moreover, BART offers an essential travel option for people with disabilities, for youth and seniors, for those living in households without access to a car, and for whom daily driving would be an unaffordable expense. As the spine of the regional transit system, BART helps to make the Bay Area more affordable for lower-income households and is accessible to all.



All riders will benefit from increased service, fewer system delays and less crowded trains. Members of disadvantaged communities often depend on transit services more than other populations for access to work, medical appointments, school and social activities, and therefore stand to benefit greatly by the increased service. Potential impacts of the construction of the project will be minimized by a robust outreach program notifying residents of construction activity, the implementation of “bus bridges” when stations are temporarily out of service, and other measures that will assist our riders with their BART journey.

## **Community Engagement**

BART has a long and successful history of interacting and working with social justice, environmental, community-based, faith-based, disability rights and other groups in the BART service area. BART has solicited input and sought ideas on a wide variety of both programs and projects – from the design of new rail cars, to station area improvements or development, to changes in fares and their potential impact. BART has successfully implemented a number of community-based grants such as Caltrans’ Environmental Justice grants, MTC’s Community-based Transportation Planning grants, as well as the successful Better BART outreach campaign in 2016.

In 2011, BART developed a Public Participation Plan (PPP), the culmination of months of extensive outreach throughout the BART service area. The PPP (available upon request) guides the organization’s ongoing public participation endeavors and ensures that BART utilizes effective means of providing information to, and receiving public input on transportation decisions from low income, minority and limited English proficient (LEP) populations.

As recommended in the PPP, BART has implemented a variety of outreach techniques for projects related to the Transbay Core Capacity Program. In 2014, BART launched its “Fleet of the Future” outreach campaign to obtain public feedback on the design of BART’s new vehicles. A series of ten events were held at BART stations and in local communities throughout the San Francisco Bay Area. Approximately 17,500 people attended the events and a total of 7,666 surveys were collected. BART staff consulted regularly with members of the disability community including its the BART Accessibility Task Force (BATF), on the design and functionality of the new BART trains. The BATF provided hands-on feedback on all aspects of the car design.

Outreach related to the 2014 BART Vision Plan engaged over 2,000 people in exploring the tradeoffs involved in considering how BART can meet its future needs, including the increased service levels now proposed to be implemented by the Transbay Core Capacity Program. The public helped BART staff narrow down future projects and investments by prioritizing those most important and which fit best into BART’s goal of serving the Bay Area for years to come. A total of ten in-station events were held and a total of 2,551 surveys were collected.

In November 2017, BART staff presented the Transbay Core Capacity Project to BART’s Title VI/Environmental Justice Advisory and Limited English Proficiency Advisory committees, both of which endorsed the project. These committees meet regularly to assist BART on all issues of policy with a focus on meeting the needs of minority and disadvantaged communities and riders.

## **V. Conclusion**

BART's Train Control Modernization Project, as part of the larger Transbay Core Capacity Project, is a cost-effective project that provides important congestion relief, air quality, economic, and quality of life benefits for the San Francisco Bay Area, its residents and businesses, as well as for the State of California. The proposed project is a key component of the region's Sustainable Communities Strategy for both reducing greenhouse gas emissions as well as providing intra- and inter-regional access, and mobility for millions of residents to jobs, social activities, medical care, school and university, shopping and other destinations. The BART system has served the Bay Area for over 40 years, and this project is critically needed to allow BART to continue its mission of providing the Bay Area with quality rail service for many years to come.

## **VI. Appendices and Other Information**

With this application, we are providing two appendices: Appendix A includes the Project Programming Request (PPR) and a spreadsheet showing all fund sources for the larger Transbay Core Capacity Project. Appendix B includes letters of support for the larger project, for which BART applied to the Transit and Intercity Rail Capital Program (TIRCP) on January 12, 2018, as that application also included a request for funding for the train control modernization project.