DRAFT RAIL CAPACITY STRATEGY

February 2016

Sustainable Streets Division

Planning Group

SFMTA
Municipal
Transportation
Agency

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ABOUT THIS REPORT

The Rail Capacity Strategy has been created by the San Francisco Municipal Transportation Agency (SFMTA) to alleviate existing crowding conditions on the San Francisco rail system, integrate and inform local and regional planning efforts on the city's investment priorities, and prioritize long term investments for further scope, schedule and budget development. The goals of the strategy are to: (1) Improve reliability of the rail transit system, (2) improve travel time consistency across the network, (3) improve in-vehicle comfort especially during peak-periods, and (4) provide San Francisco residents with high capacity rail access within a half-mile. The SFMTA will use this living document to inform and continue working in partnership with city transportation planning partners; the regional rail network operators; regional, state, and federal agencies; and key stakeholders as part of the city's investment planning efforts.

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FOREWORD

If we could reinvent San Francisco's transportation system, what would we envision for the generations to come? Certainly we would design a system that could support reliable transportation connections, quicker trips from one end of the city to the other, and the ability to add capacity that allows for future growth. Like most of the world's great cities, we would create a great rail system that could move people quickly, efficiently and safely – preferably underground and out of the path of traffic.

San Francisco's rail system right now is a hybrid of the best engineering from the 1920s and the early 1980s. Evolving Muni into a modern system that works for our 21st century city is the goal. The Rail Capacity Strategy is the beginning of this conversation, and it lays a foundation for short, medium and long term actions that the SFMTA can take to modernize our transportation system.

The benefits are clear. Investing in rail capacity will alleviate the pressures of increasing ridership that we see on our system today while forging a path for expansion that creates better, smarter and more convenient connections across the city. More San Franciscans – at least 95% – will be within walking distance of a rail line, and there will be room for customers to hop on a train when it arrives. For everyday San Franciscans, this means less time getting to where they are going and more time with their family, friends and loved ones.

This sounds far-reaching, and in many ways, it is. But it's necessary to lay out a vision and begin a dialogue about the future in order to achieve progress.

We are thankful to those who participated in shaping the 2016 Rail Capacity Strategy, and we look forward to an ongoing and robust community dialogue about the future of rail transportation in San Francisco. Transportation is a public good best done in partnership with others. We hope many more will join us on this journey to create the best transportation system for our diverse, beautiful and vibrant city.

ED REISKIN
DIRECTOR OF TRANSPORTATION, SFMTA

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GIANTS

EXECUTIVE SUMMARY

San Francisco has recently experienced significant demands on its transportation system due to rapid employment and population growth. This rapid growth has also brought with it changes in preferences toward multi-modal and technology-enabled travel. With this growth and innovation, peak-period travelers are placing even greater demand on the city and regional rail networks. As the city continues to grow, it will be critical to ensure this backbone network is adequately managed, maintained, enhanced and expanded to meet the current and future mobility needs of its residents, workers and visitors.

The Rail Capacity Strategy has been developed to serve three key purposes:

- Alleviate existing crowding conditions on the city rail system (fleets, facilities, rights-of-way)
- Integrate and inform local and regional planning efforts on the city's investment priorities
- Prioritize long term investments for further scope, schedule and budget development.

The Strategy's customer-focused goals aim to improve the existing customer experience now and in the future in the following ways:

1. Improve reliability of the rail transit system
2. Improve travel time consistency across the network
3. Improve in-vehicle comfort especially during peak-periods
4. Provide San Francisco residents with high capacity rail access within a half-mile.

This strategy will focus on the city rail network, primarily operated by the San Francisco Municipal Transportation Agency (SFMTA), as the Agency has the responsibility to maintain, enhance and expand this system for the city. The city rail network also includes the regional rail line operating through the center of the city served by the Bay Area Rapid Transit (BART) system and a commuter rail line on the eastern side of the city operated by Caltrain. The development of this strategy included technical groups and stakeholder input from various backgrounds including transit operators, advocacy, business, disability, and technology groups. The stakeholder process informed the three types of investments:

- **System wide Investments** that provide overall network benefits
- **Location Specific Near-Term Investments** that can be delivered in a five year time frame
- **Long-Term Corridor Investments** that mostly expand the city rail network.

The Strategy acknowledges the essential role that the regional rail partners provide in terms of service to and from the city. Their capacity investments are included and integrated in this strategy. In addition, the future high-speed rail terminal and service to San Francisco is also included as part of the long-term needs.

SFMTA will use this living document to inform and continue working in partnership with city transportation planning partners; the regional rail network operators; regional, state and federal agencies; and key stakeholders as part of the city's investment planning efforts. Funding for the long-term investments will require concerted effort to develop new funding sources and/or financing partnerships. Overall, these partnerships and investments are essential to continue to support the city's economic competitiveness and meet the SFMTA's vision of excellent transportation choices.


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1. GOALS & PURPOSE

1.1 INTRODUCTION

The SFMTA, through the San Francisco Municipal Rail way (Muni), is the largest transit operator in the San Francisco Bay Area on a ridership basis carrying over 700,000 daily transit trips, or nearly 50 percent of daily transit trips in the region. Of the 700,000 daily transit trips taken on Muni, 150,000 occur on the five-line city light rail network. In addition, the Bay Area Rapid Transit District and the Caltrain commuter rail service provide almost 320,000 trips each day to, from, and within San Francisco. Within San Francisco, nearly one-half million riders are utilizing the local and regional rail transit network each day.

However, the capacity of the Muni Metro Subway is constrained by inconsistent platform lengths, vehicle person capacity, unreliable surface operations, congestion points at subway portals, and capacity constraints at terminal locations. Due to these conditions, the Muni Metro Subway portion of the system operates at approximately 60 percent of the design capacity during the peak-period.

Looking ahead over the next few decades, the city rail network is facing a number of challenges that will impact its customers including but not limited to:

- By 2040 the number of households in San Francisco is forecast to grow by nearly 30 percent and the number of jobs by 35 percent. (Figure 1.1, 1.2, and 1.3)
- Peak-hour light rail boardings are anticipated to grow by 80 percent by 2040. (Figure 1.4)
- Much of the population and employment growth is concentrated in regionally adopted Priority Development Areas (PDAs) that are served by the existing light rail system.

This growth will directly contribute to increased peak–period crowding on the SFMTA light rail system. (Figure 1.5)

Increased rail transit capacity is essential to maintain and improve mobility today, let alone in the near future, as San Francisco continues to grow. To address these issues and develop solutions, the need for an SFMTA Rail Capacity Strategy was identified in late 2013. Specifically, the Rail Capacity Strategy identifies strategic near term investments to reduce crowding in a cost-efficient manner and long term investments to achieve the Rail Capacity Strategy goals for both existing and future customers. Additional planning for infrastructure elements that support overall system capacity has been documented in the SFMTA Fleet, State of Good Repair Report, and Real Estate Vision for the 21st Century plans. The relationship of these and other citywide and regional planning efforts are shown in Figure 1.6 and, together provide a road map to increased service capacity, flexibility, and reliability through infrastructure investment.

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Percent Change in Population by 2040

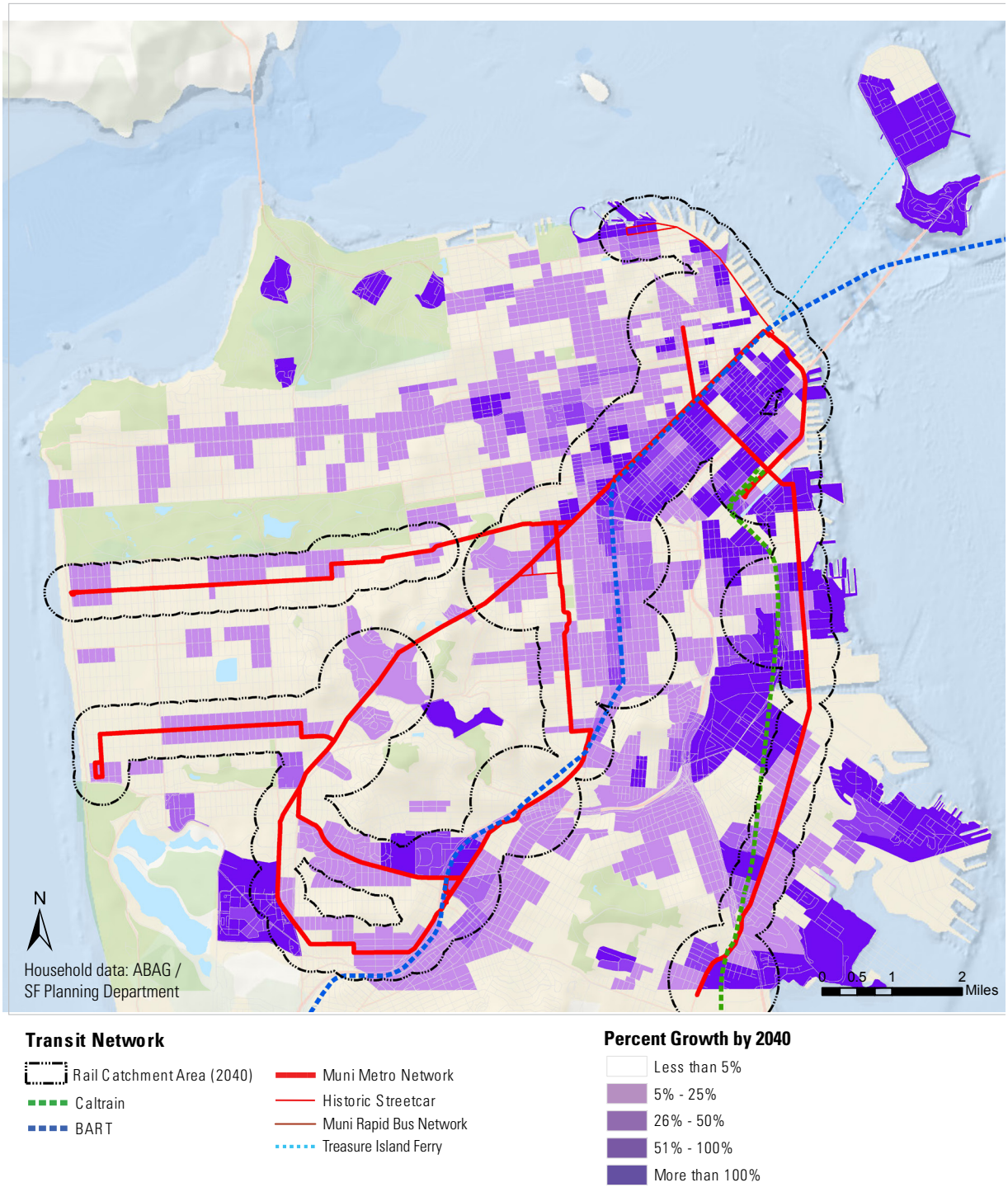

Figure 1.1 Percent Change in Population by 2040

The population of San Francisco is forecast to grow by nearly 30 percent over the next 25 years. Much of this growth is anticipated in the South of Market and eastern areas of the city, as well as along established transit corridors. While the existing system is well positioned to serve the growing population of San Francisco, improvements will be necessary to meet the mobility needs of existing and future residents and employees.

SFMTA Municipal Transportation Agency

2040 Population Density

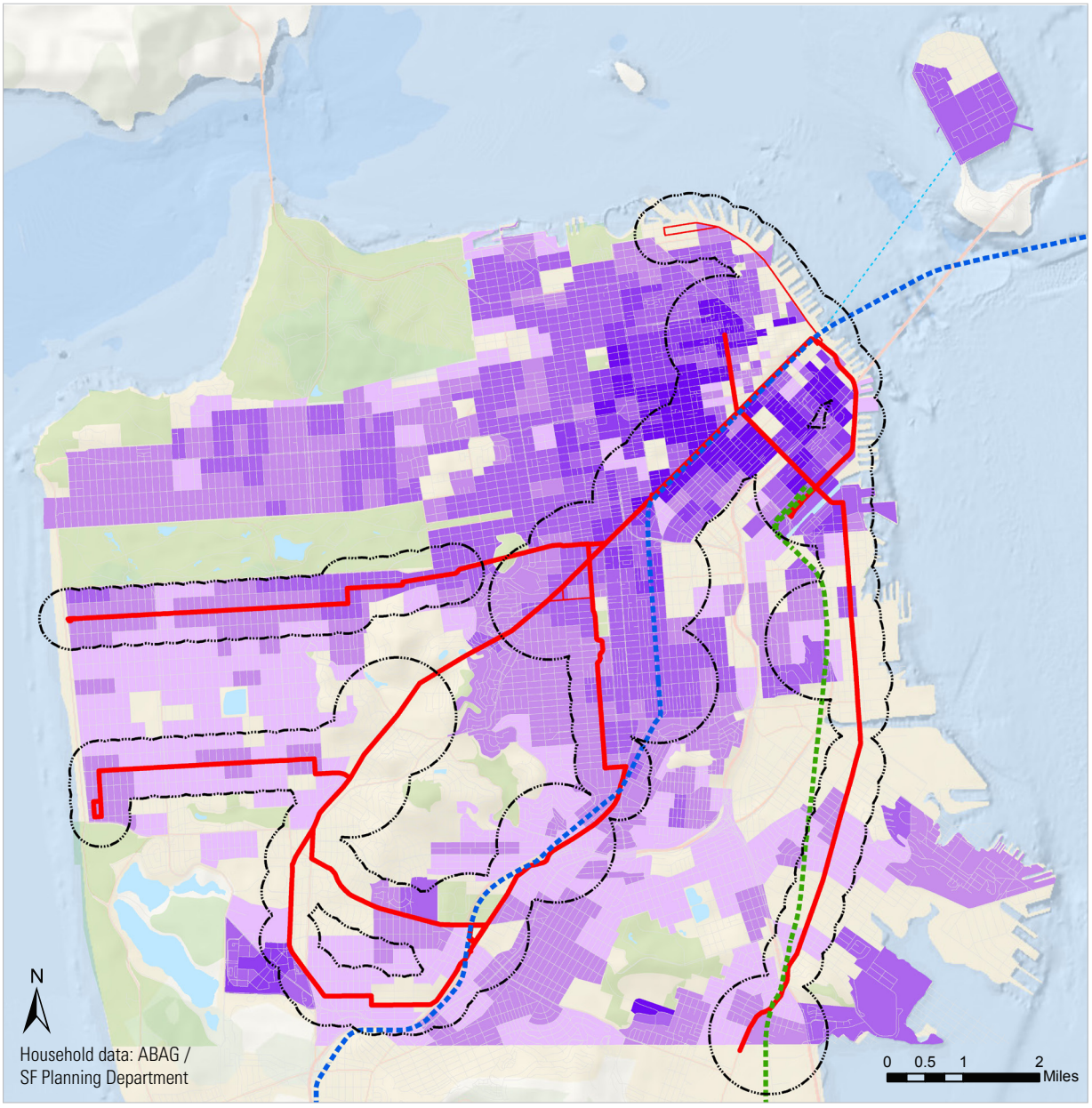

Figure 1.2 2040 Population Density

San Francisco is the second most densely populated city in the United States. Existing population centers will be maintained and intensify through 2040. Emerging population centers are forecasted to grow significantly, but existing population centers will remain the focal point of San Francisco's density.

SFMTA Municipal Transportation Agency

2040 Jobs Density

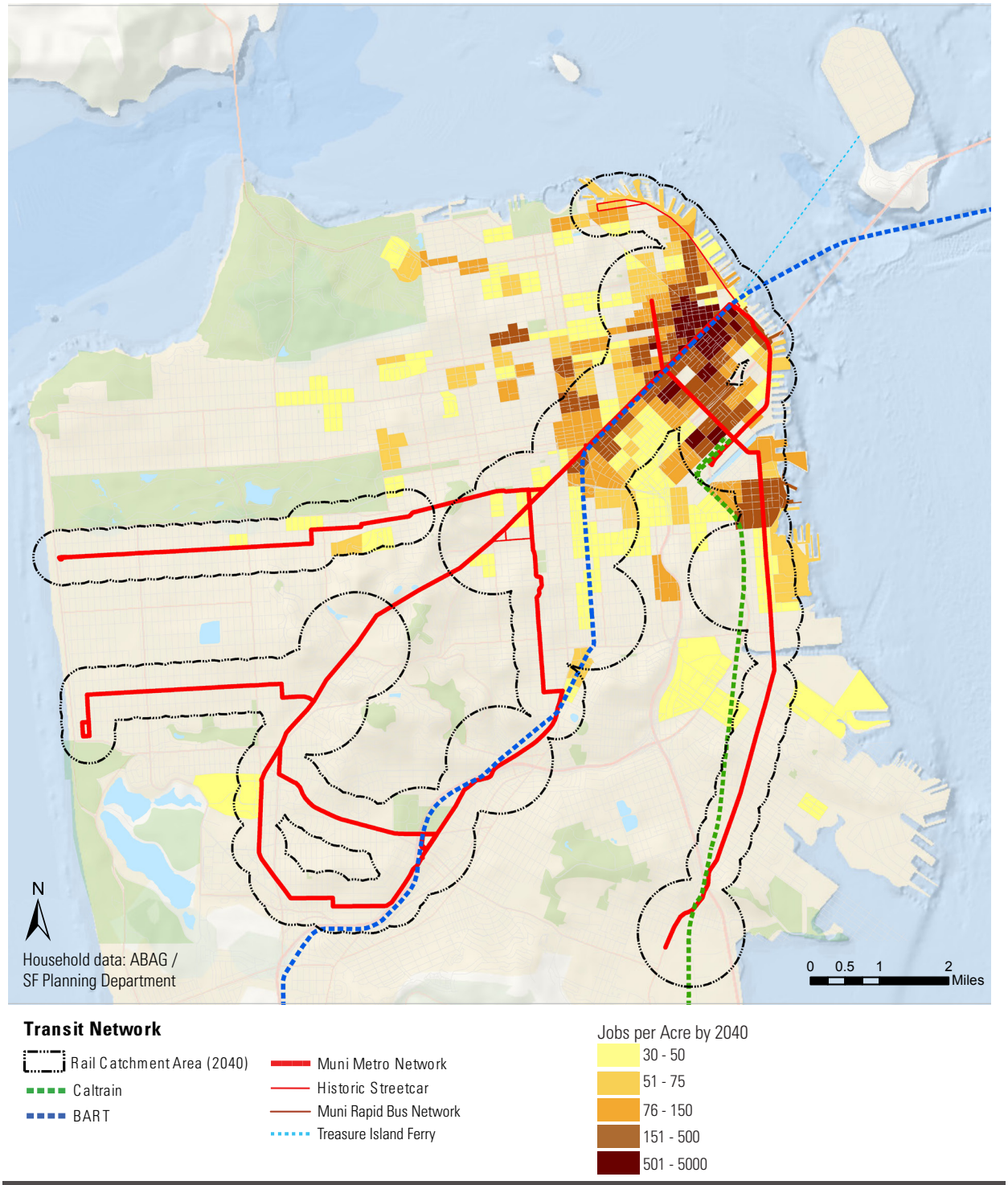

Figure 1.3 2040 Jobs Density

The Financial District is forecast to remain San Francisco's employment center through 2040. Employment density is anticipated to increase in the South of Market and Mission Bay areas, but would not eclipse that of the Financial District. The highest density employment centers of San Francisco will continue to be located within the catchment areas of both local and regional transit.

1.2 GOALS

The Rail Capacity Strategy has a customer-focused set of goals to improve the customer experience in the following ways:

1. Improve reliability of the rail transit system
2. Improve travel time consistency across the network
3. Improve in-vehicle comfort especially during peak-periods
4. Improve the percentage of San Francisco residents within a half-mile of high capacity rail.

The Rail Capacity Strategy is rooted in the need to address the issues of crowding, systemwide coverage, reliability and travel time. As the plan is refined and additional community input included, it is anticipated that geographic and social equity, the timing of implementation and the cost-benefit of individual projects will further prioritize projects considered for future investment.

1.3 PURPOSE

The Rail Capacity Strategy serves three key purposes:

- Alleviate existing crowding conditions
- Inform local and regional planning efforts
- Prioritize long term investments for the next phase of implementation.

Each purpose of the Rail Capacity Strategy is further discussed on the following pages.

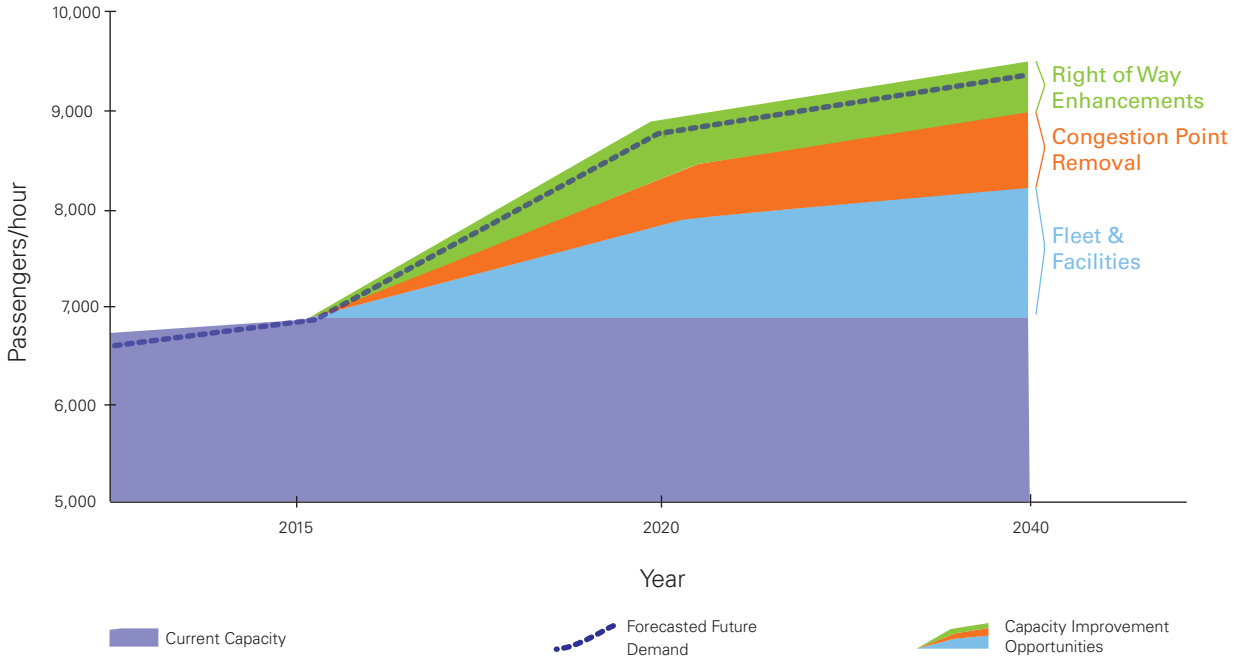

Figure 1.4 Peak-Hour Light Rail Demand and Capacity Improvement Opportunities

Peak hour light rail demand is forecast to grow by up to 80 percent by 2040. Various investments in the light rail system can be improved to increase capacity of the existing system to meet this increased demand. Capital investments in the light rail fleet and supportive storage and maintenance facilities can significantly increase overall peak hour capacity. Improvements such as removing major congestion points, providing transit signal priority, and increasing the amount of dedicated right of way can also produce peak hour capacity enhancements. Restructuring of operations and associated infrastructure to optimize service delivery efficiency can provide further increase in capacity. Combined, these improvements in these areas would provide the additional capacity to meet forecasted ridership demand.

Figure 1.5 Increased Peak-Period Crowding

ALLEVIATE EXISTING CROWDING CONDITIONS

Current passenger experience conditions call for immediate actions to relieve crowding. The SFMTA is working to alleviate crowding by the following measures:

- **Muni Forward upgrades:** The Muni Forward program has a toolkit of proven treatments such as transit signal priority, dedicated "red carpet" travel lanes, and extended boarding platforms known as "bulbs" to decrease existing travel times and improve reliability on the busiest transit corridors in San Francisco. Identifying and initiating capacity improvements will provide relief to passenger crowding year-over-year in the near term. While these improvements do not provide enough capacity to meet long-term forecasted demand, they can be implemented in a relatively rapid timeline and will provide incremental capacity increases that will be leveraged by future investments.

- **Fleet improvements:** Simply put the SFMTA does not have enough rail cars to meet the current peak-period demand for service. SFMTA has purchased an additional 24 trains that will be in service by 2019 and plans to purchase 40 more trains for service by 2021. This a nearly 45 percent increase in the size of the light rail fleet over the next five years. Additionally, the internal configuration of the existing light rail fleet can be adjusted to provide additional standing space, which increases the total number of passengers on a single vehicle. The recent pilot of seat configuration has shown to increase capacity by approximately 10 percent per rail car. The LRV 4 vehicles will include a longitudinal seating configuration to optimize person capacity.

- **Transportation Demand Management:** The city and regional rail ridership is heavily skewed toward peak-period usage, an outcome of employment and education schedules and land use concentrated in the northeast portion of the city. The SFMTA with its partners will be assessing potential opportunities (like more flexible work schedules) to spread some of the customer demand to lessen the crowding conditions experienced by commuters. The SFMTA is also upgrading parallel bicycle facilities to help shift some users over to bicycling to increase capacity for potential new riders. This has already been experienced along the N Judah line with upgrades along Oak, Fell and the Wiggle to Market Street.

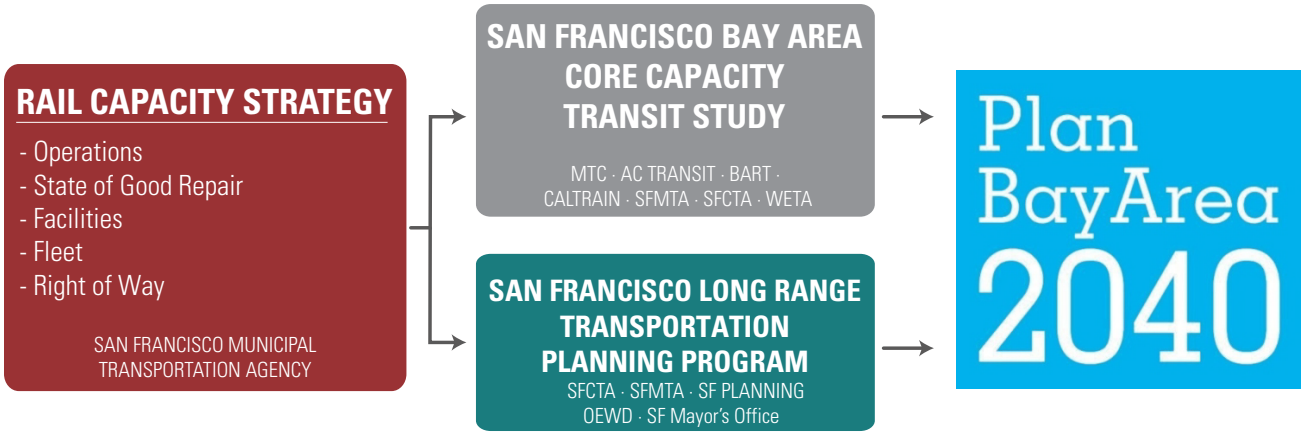

Figure 1.6 Relationship of Planning Efforts for City Rail Network

The Rail Capacity Strategy builds upon these immediate efforts with specific upgrades including relief of bottlenecks, congestion points, and capacity constraints within the SFMTA rail system that were explicitly not included within Muni Forward.

INFORM LOCAL AND REGIONAL PLANNING EFFORTS

In addition to identifying existing system barriers to increased capacity and service efficiency, the Rail Capacity Strategy serves as one of the key information sources for major planning efforts both locally and regionally. The relationship of rail planning efforts is shown in Figure 1.4.

Local Planning Efforts: The San Francisco Long Range Transportation Planning Program (SF LRTPP) is a collaborative long-term planning effort among the San Francisco County Transportation Authority, San Francisco Planning Department, and the SFMTA in coordination with the Office of Economic and Workforce Development and the Mayor's Office. The SF LRTPP includes development of a San Francisco Vision for transportation. This vision will inform an update to the Transportation Element of the San Francisco General Plan as well as development of the San Francisco Transportation Plan (SFTP) 2050. The SFTP 2050 is the County of San Francisco's blueprint for transportation system development and investment over the coming decades.

Regional Planning Efforts: The Metropolitan Transportation Commission (MTC) initiated the San Francisco Bay Area Core Capacity Transit Study (CCTS) in the spring of 2015. The purpose of this analysis is to identify infrastructure investments and policies that provide for the necessary increase in transit capacity to meet demand in the Transbay and Muni Metro travel corridors for short (~2020), medium (~2030), and long-term (~2040) planning horizons. The CCTS project team consists of AC Transit, BART, Caltrain, SFCTA, SFMTA, WETA and the outcomes will inform development of the Regional Transportation Plan (RTP) component of the region's sustainable communities strategy "Plan Bay Area". Plan Bay Area is a long-range integrated transportation and land-use/housing strategy through 2040 for the San Francisco Bay Area. The prioritized investments identified in the Rail Capacity Strategy will be considered and evaluated against other regional transportation investments in Plan Bay Area.

As previously discussed, the Rail Capacity Strategy is the initial step and provides inputs into these related studies. It is anticipated that these subsequent efforts will further inform the SFMTA's rail infrastructure investment priorities.

PRIORITIZE LONG TERM INVESTMENTS FOR THE NEXT PHASE OF IMPLEMENTATION

Multiple long range infrastructure planning efforts are underway or on the horizon. The Rail Capacity Strategy identifies and prioritizes concepts with the greatest system benefit and develops order of magnitude cost estimates. This information will be used to inform regional discussions of investment priorities through the CCTS and in establishing a vision for transportation in San Francisco through the SF LRTPP. In each case, additional analysis and documentation of project benefits will aid in identifying projects that can most efficiently address rail capacity needs for San Francisco. This prioritization of long term investments serves as an initial step in establishing a pipeline of effective rail capacity improvement projects.

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2. METHODOLOGY

The Rail Capacity Strategy utilized a three step process that identified issues, brainstormed concepts, and screened and prioritized concepts for further study. The methodology uses the Assess, Develop, Screen process as outlined in Figure 2.1.

Rail projects that have received a Record of Decision as part of environmental review are not included in the Rail Capacity Strategy. These projects, namely the Extension of F-Line Service to the Fort Mason Center, have undergone a level of planning, analysis, and design so that costs and benefits are sufficiently understood to pursue detailed design and construction funding and comparison to conceptual projects in the Rail Capacity Strategy is not appropriate.

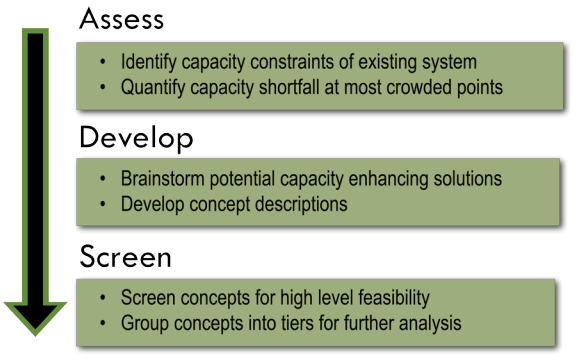

Figure 2.1 Methodological Process

2.1 ASSESS

A Rail Capacity Technical Panel was initiated comprising senior technical experts from all critical areas of SFMTA's light rail system as well as representatives from SFMTA teams that interact with the light rail system to identify current system needs. The primary task of the panel was to conduct a detailed line-by-line review of operational congestion points, areas of friction, and barriers, such as subway portal locations and points where lines merge. Data, plans, or research reviewed by the Rail Capacity Technical Panel included:

- Existing and Future Land Use
- Existing and Forecast Ridership
- Best Practices Research
- Travel Time & Reliability Data
- Adopted plans and policies
- System operations
- Track configurations
- Signal systems

Additional interviews with relevant staff who were not members of the Rail Capacity Technical Panel, including bicycle, pedestrian, and traffic operations, were also conducted. The thematic issues identified by the Rail Capacity Technical Panel drove development of both near- and long-term investment concepts.

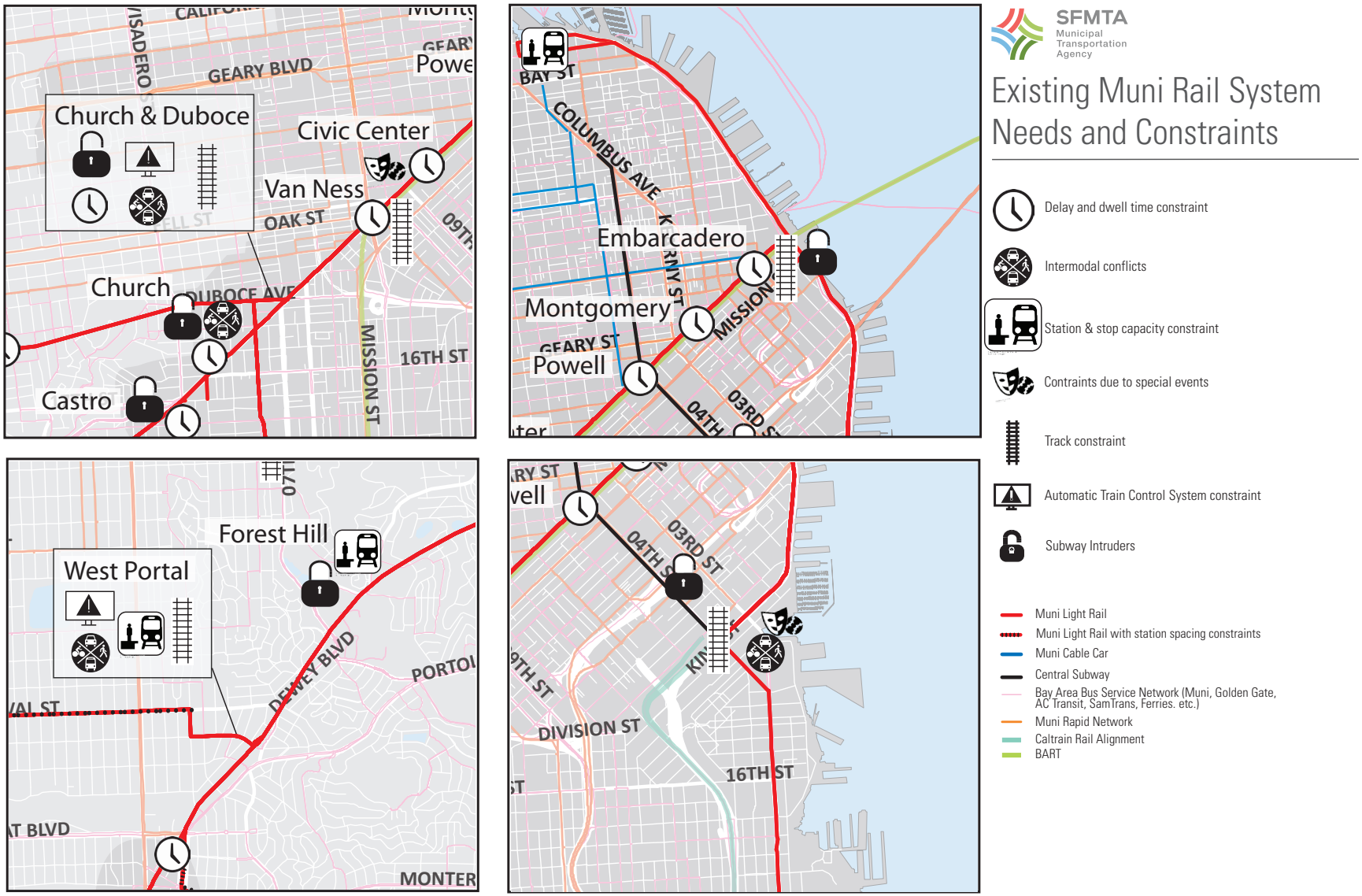

Figure 2.2 Existing System Capacity Needs & Constraints

The Rail Capacity Technical Panel identified four key areas of the muni rail system with acute and context specific constraints (clockwise from top left); Church & Duboce intersection and Duboce portal, Muni Metro Embarcadero Turnback and Folsom Portal, 4th & King intersection, and West Portal. Consistent among the four key areas is the merging/diverging of multiple lines. Areas where trains transition from Muni Metro Subway operations to surface at-grade operations were also identified as areas of system constraint.

A major cause of system friction and congestion identified by the Rail Capacity Technical Panel was the lack of dedicated right-of-way. The inherent conflicts between people driving, biking, walking, and riding transit of a surface system are compounded by a lack of dedicated transit lanes and traffic control measures that prioritize people riding transit. These issues are further exaggerated at points where rail lines merge, unique paths of travel exist, and adherence to the vehicle code is inconsistent. In addition to the general lack of dedicated right-of-way, the Rail Capacity Technical Panel identified key points of friction, which are highlighted in Figure 2.2.

Existing ridership trends and land use also informed identification of current system needs. The combined existing residential and employment densities were assessed against current rail system coverage. This analysis illustrated that there are major transportation corridors in San Francisco that exceed North American best practices for rail supportive land use densities, but are only served by local and rapid bus service. As shown in Figure 2.3 (next page), these corridors include:

- Inner/Outer Geary to Financial District
- Marina to Financial District/SOMA
- Van Ness/Fillmore to Mid-Market

Some of these corridors' current ridership levels on local and rapid bus service exceed that of existing rail lines and total system ridership of other Bay Area operators. The anticipated changes in density by 2040 are shown in Figure 2.4 (next page).

The design capacity of the existing system was also evaluated. The Muni Metro subway was opened in 1980 and serves five lines that carry over 150,000 passengers per day, or just over 20 percent of the entire SFMTA transit system. The potential capacity of the Muni Metro subway and Muni Metro Extension (MMX) is significantly greater than what is delivered during peak hours, primarily as a result of environmental factors and infrastructure outside the Muni Metro Subway and MMX. Based on the conditions from West Portal to Embarcadero and along the Muni Metro Extension, the available and currently scheduled capacity in terms of trains, cars, and passengers are provided in Table 2.1.

Table 2.1 Total Hourly Train Capacity (Muni Metro)

TOTAL HOURLY TRAIN MUNI METRO CAPACITY			
Total Hourly 3-car Train Capacity	20	Total Hourly 2-car Train Capacity	19
Total Hourly Person Capacity on 3-Car Trains	7,140	Total Hourly Person Capacity on 2-Car Trains	4,522
Total Car Capacity		98	
Total Hourly Person Capacity		11,662	
Scheduled Cars		58	
Scheduled Hourly Person Capacity		6,902	
Utilization of Muni Metro Capacity		59 percent	

The Muni Metro Subway and Muni Metro Extension have an estimated replacement value of $3.7 Billion. Operating conditions west of West Portal Station and the Church and Duboce portal limit the provided capacity to just under 60 percent of the design Muni Metro subway capacity based on current infrastructure. This is due to platform lengths, vehicle person capacity, unreliable surface operations, congestion points at subway portals, and capacity at terminal locations. Identifying strategic investments to utilize this untapped capacity is paramount for SFMTA to reduce passenger crowding in a cost-efficient manner.

When examining Muni Metro operations beyond just the peak period, available capacity exists in shoulder and off-peak periods. The crowded condition is a result of numerous individuals choosing to travel to work or home in a short period of time. Figure 2.5 represents the acute crowding conditions driven by commute patterns during peak periods, and available capacity just outside the peak periods. Using non-infrastructure methods (fare pricing, commute incentives, etc.), this under utilized capacity could provide substantial relief or allow continued growth without further exasperating currently crowded conditions.

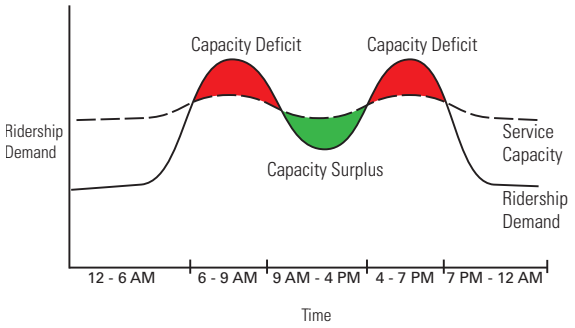

Figure 2.5 Daily Capacity Deficit and Surplus

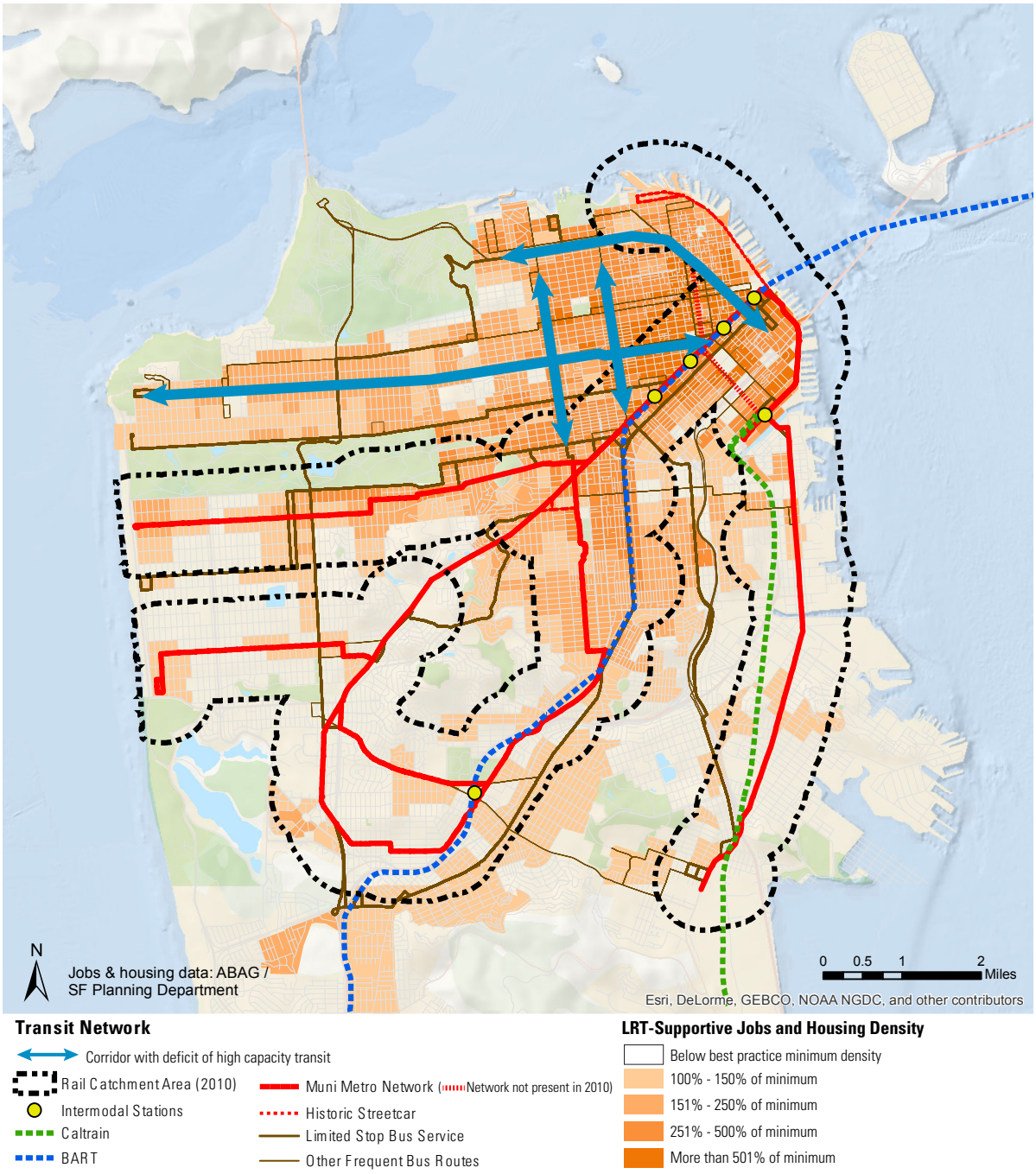

Figure 2.3 Corridors with Deficit of High-Capacity Transit

The current residential and employment density in many areas of San Francisco are at a level that, according North American best practices, supports high capacity transit. While this capacity may be provided in the form of high quality Bus Rapid Transit, the vehicle capacity and scalability of light rail are more appropriate at the lower levels of rail supportive density. At the higher levels of rail supportive density, heavy rail may be needed to address ridership demands. The existing rail system provides coverage to a large portion of the rail supportive densities in San Francisco. However, there are many rail supportive corridors where rail service does not exist and corridors or areas in the Southwest portion of San Francisco where densities do not indicate a rail supportive environment according to best practices. Corridors that currently lack rail service but have land use that would support rail service are indicated in the figure above.

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2040 Light Rail Transit Supportive Land Use

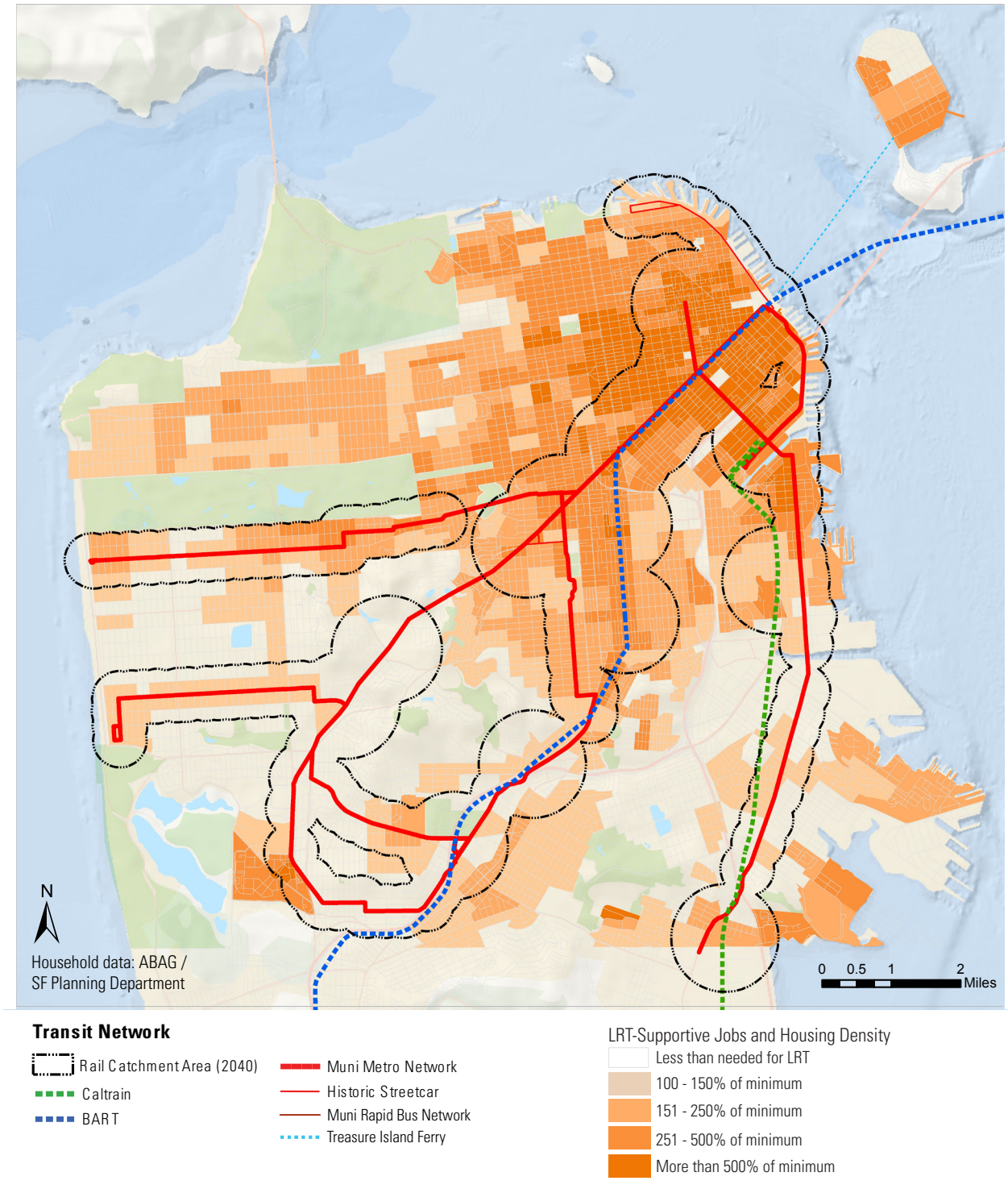

Figure 2.4 2040 Light Rail Transit Supportive Land Use

Land use along the L-Taraval and T-Third rail lines is anticipated to intensify to levels that are shown to be supportive of light rail transit in North America. However, many portions of San Francisco with even greater intensity would remain outside rail transit catchment areas.

SFMTA Municipal Transportation Agency

2014 AM Peak 30 Minute Travel Time to Embarcadero

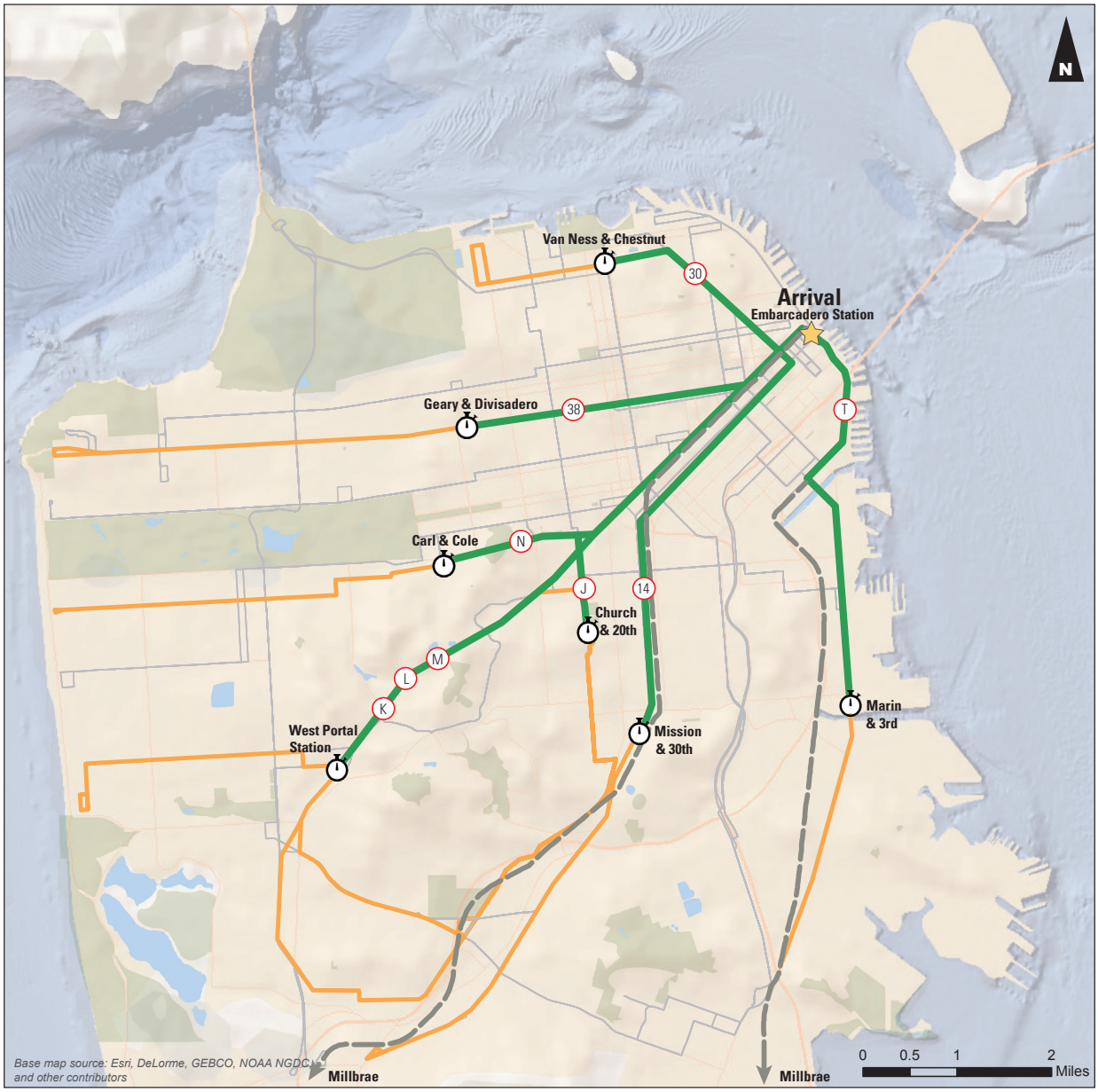

Figure 2.6 2014 AM Peak Travel Time to Embarcadero Station

The distance passengers can reliably travel is a major component of the decision to take transit, or choose another mode. When considering the AM peak period commute, passengers could travel to Embarcadero Station within 30 minutes on 85 percent of their trips from the origins depicted above. Passengers originating to the south and west of these locations would need to plan additional travel time to ensure they would reach the Embarcadero Station on time. When considering regional passengers on BART and Caltrain, trip origins as far south as Millbrae could reliably reach Embarcadero Station and 4th & King, respectively.

Travel time from key points in the existing system was also analyzed. While travel time is not a direct input into delivered capacity, it does influence the resources needed to supply capacity and affects the customer experience and attractiveness of transit. Figure 2.6 provides AM peak period inbound travel times to Embarcadero Station from various points in the Muni system. What is notable is the difference in travel times experienced by residents in the outer areas depending on the rail line. For example, customers who live in West portal experience significantly shorter travel times to Embarcadero than their neighbors in the south east due to grade separation and controlled right of way conditions. In addition, the map shows non-rail times at key locations where variability is even higher. As a point of reference the Bay Area Rapid Transit (BART) line runs from the Balboa Park station to the Embarcadero station in 15 minutes. For a city of seven-by-seven miles it should be conceivable that a rail network should be able to connect consistently across the outer areas of the city to the Embarcadero station in 30 minutes or less. The Rail Capacity Strategy looked at measures to ensure consistency among lines to meet a goal of the 85th percentile of trips from various points of the city reaching the Embarcadero in 30 minutes or less.

To identify future system needs, a combination of ridership forecasts for existing or planned transit service and anticipated changes in land use type and intensity were analyzed. The 2014 SFMTA Transit Fleet Management Plan (Fleet Plan) provides forecasted ridership demand for existing transit routes. For rail lines, the Fleet Plan indicates where additional capacity will be needed. For bus lines, forecasted ridership levels and changes in land use may indicate where transit ridership levels would be more appropriately served with a high capacity transit service, such as light rail. The frequency or spacing of at-grade crossings was also considered where high frequency service would require grade separation for efficient operations.

Rail Line	Existing	2020	2040
J-Church			
KT-Ingleside/Third K-Ingleside (2019)			
L-Taraval			
M-Ocean View			
N-Judah			
T-Third/ Central Subway	Service begins 2019		

Comfortable | Approaching Uncomfortable | Uncomfortable | Extremely Uncomfortable

Figure 2.7 Passenger Experience on Muni Light Rail System

Generally, transit ridership projections follow the broader employment and population trend. However, the growth in the Muni light rail system is anticipated to outpace the rate of employment and population growth. This can be attributed to a significant portion of the employment and residential growth being located in close proximity to the Muni light rail system, as well as the opening of the Central Subway in 2019. This has the potential to result in passenger crowding conditions on the Muni light system significantly more extreme than today. Figure 2.7 indicates the passenger experience along each light rail line by 2040 without improvements in person carrying capacity.

2.2 DEVELOP

Two stakeholder workshops, with approximately 25 representatives from transit operators, advocacy, business, development, disability, and technology groups, were held to both identify potential investments concepts and understand, at a high level, which concepts were priorities for the stakeholder groups. The initial stakeholder session included identifying existing system bottlenecks and constraints, developing possible solutions to existing system constraints, and identifying potential system expansion corridors. All concepts identified by the stakeholder group were considered in the screening process. Priorities identified by the stakeholder group at the second workshop were also considered when SFMTA prioritized long-term investment concepts.

An online opportunity to develop investment concepts and submit them to the Rail Capacity Strategy project team was also provided. Results of the online stakeholder feedback are presented in Figure 2.8. The online submissions were also considered by technical staff when prioritizing investment concepts. The stakeholder input met Goal 4 of ensuring high capacity rail transit within half a mile of all San Francisco residents.

In addition to major infrastructure investments, additional capacity can be delivered by increasing the length of trains operating along each line. As discussed in the current system needs assessment, the Muni Metro Subway operates at less than the design capacity. Incremental investments in the fleet, platform and terminal capacity enhancements, storage facilities, and travel time and reliability improvements, such as those proposed under Muni Forward, have the potential to greater utilize the existing system. Supporting infrastructure investments, such as overhead power, would likely also be needed with each of these enhancements.

2.3 SCREEN

Following the development of potential solutions to existing constraints and long-term needs, the Rail Capacity Technical Panel (RCTP) conducted feasibility and redundancy screening of all concepts. Concepts with major operational barriers or constructability issues were removed from further consideration. Concepts that served similar corridors or included slight variations with one another were grouped together. The remaining concepts were then prioritized by the RCTP based on the following: amount of additional capacity provided by an improvement, independent utility, complement to other future system enhancements, land use connection, operating costs, removal of existing constraints, and implementation timeline. This prioritization process included qualitative and quantitative data as well as professional judgment. The outcomes of this prioritization process are described in the following chapter.

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Online Stakeholder Feedback

Figure 2.8 Online Stakeholder Concepts

An online opportunity for the public to submit corridor or network concepts as created. Individuals could draw new rail lines, leave sticky notes, and explain their rail network of the future. Over 100 unique submissions were received, some including fully developed networks. These submissions were layered upon one another so that darker purple represents a concept that appeared in a greater number of submissions, and lighter colors indicating a concept that was seen less frequently in the online submissions.

3. RESULTS

Following the three step process reflected in the Methodology chapter, results were grouped into three categories:

- System-wide Investments: Investments that are not tied to a particular location
- Location Specific Near-Term Investments: Capacity improvements that can be delivered in a five-year time frame and will be recommended for consideration in the next two five-year capital improvement plan cycles
- Long-Term Corridor Investments: Capacity improvements that mostly expand the city rail network. Funding for these investments has not been identified and would take 15-30 years or longer to deliver, based on historic funding cycles. If new funding sources and/or financing partnerships were to be realized, these projects could be delivered much sooner.

3.1 SYSTEM-WIDE INVESTMENTS

The Rail Capacity Strategy identified investments that should be considered as part of all future SFMTA State of Good Repair investments in the rail system. These investments would each contribute to improved system flexibility, service reliability, person capacity, ability to recover from service disruptions, and passenger experience. Any improvements to the existing system will also need to examine the basic elements that support operations, such as overhead power lines and track condition. See Table 3.1 for more information.

3.2 LOCATION SPECIFIC NEAR- TERM INVESTMENTS

After identifying the various thematic issues within the existing system, the Rail Capacity Technical Panel identified the most acute locations and conditions within the thematic areas that presented barriers to existing operations. Each of these investments help relieve crowding on the existing system in a cost-efficient manner and provide utility for the system of today, as well potential systems of the future. See Table 3.2 for more information.

3.3 LONG-TERM CORRIDOR INVESTMENTS

SFMTA staff and stakeholders used ridership forecasts, anticipated population and employment growth, known system investments, and identified system constraints to develop investment concepts. Concepts with similar functionality and benefit for the existing system were grouped together. Concepts for system expansion along similar corridors were also grouped. This process recognizes that dedicated funding for further phase development of major investments is necessary to attain a greater understanding of the costs and benefits of specific corridor investments. The concepts were grouped into three categories:

- Enhancement of the existing system
- Removal of system congestion points
- Expansion of the system

Table 3.1 System-wide Investments

SYSTEM-WIDE INVESTMENT	PROGRAM DESCRIPTION	BENEFITS
 Vetag switches/crossovers	Electrify and automate switches and crossovers as part of any rail replacement or reconstruction efforts. All new crossovers and switches will be electrified and automated.	Removal of any delay associated with crossing a switch or crossover, such as visual inspection. Reduced delay when utilizing a switch due to cab activation of switch or crossover.
 Switches/crossovers	Install switches and crossovers at strategic locations to provide for greater operational flexibility and system resiliency.	Increased flexibility for repositioning trains in service to balance demand and realign service. Increased resiliency for unplanned events that remove trackway from service (collisions, disabled train, etc.)
 Terminal/Tail track	Expand/lengthen terminals and tail tracks to allow for storage of 3 or 4 car trains sets and disabled trains.	Increased terminal and layover capacity necessary for increased car count trains. Storage areas for disabled trains speeds system recovery when train is pulled from service.
 Transit "Red Carpet"/ Raised Trackway	Install red paint to delineate transit-only roadway. When replacing tracks elevate track bed to physically delineate transit-only lanes from general purpose roadway	Reduce conflicts with vehicles, reduce travel time variability and increase average travel speed.
 Station/Platform Enhancement	Extend stations and platforms to accommodate 3 or 4 car trains. Consider creating high floor platforms when working near the Muni Metro subway.	Incremental increases in station capacity allow for special event service and eventually higher capacity trains during regular service.
 Transit Signal Priority	Include any necessary signal transit priority equipment when upgrading signal controllers or replacing track.	Transit Signal Priority reduces travel time variability and increases reliability and average travel speed.

Table 3.2 Location Specific Near-Term Investments

NAME / PROJECT DESCRIPTION	BENEFITS	TIMELINE	COST
West Portal Conflict Reduction: • Restrict conflicting turn movements • Replace magnetized rail segments	• Improved Reliability • Improved Travel Time	<3 Years	$1.5m (Pilot only)
Muni Metro Extension Turnback Track: • Construct pocket track east of Harrison Street	• Improve Passenger Comfort • Improve Reliability • Improve Travel Time	4–5 Years	$8.5m
Muni Metro Extension Surface Train Control System: • Upgrade existing Transit Signal Priority along Embarcadero from Ferry Portal to 4th and King and south along 3rd Street to 16th Street	• Improved Passenger Comfort • Improved Reliability • Improved Travel Time	3–5 Years	$10.5m
Church & Duboce Portal Conflict Reduction: • Analyze vehicle or turn prohibition and improved pedestrian and bicycle circulation	• Improved Reliability • Improved Travel Time	2–5 Years	$0.5m (Planning only)

Within each of these categories, concepts were prioritized based on a high level understanding of project contribution toward achieving the four goals of the Rail Capacity Strategy. Concepts that provided synergistic benefits to both the existing system and expansion corridors tended to be prioritized higher. Concepts were then grouped into three tiers as follows:

Tier 1: Concepts should continue or initiate project development. These concepts address key system constraints and/or existing and future demand.

Tier 2: Concepts should initiate project development as planning for Tier 1 projects is completed, or additional funding become available. These concepts address future constraints and demand.

Tier 3: Concepts provide additional coverage and access and should be initiated as part of a new funding and/or financing partnership package.

The prioritized long-term investments totaling almost $17 billion and over 30 years of implementation provide a pipeline of potential investments that should be further studied. In particular, many of these concepts have the potential to reduce overall operating costs by delivering capacity more efficiently (longer trains, reduced travel time, etc.). Development of operating plans should be included in subsequent study of these concepts so a greater understanding of the costs and benefits can be understood. Table 3.3 shows long-term investments by tier, while Table 3.4 shows individual project costs and timelines. This pipeline of strategic investments will need planning level resources as the next step to:

- Further detail the costs and benefits of each investment
- Identify potential new funding sources and/or finance partnerships, and
- Identify the most streamlined and efficient project delivery methods for these capacity improvements.

Figure 3.1 indicates the potential passenger experience in 2040 based on the the long-term City rail network investments, as shown in Figure 3.2. With these investments no line would operate at an uncomfortable passenger crowding level during peak periods. Over 97 percent of San Francisco residents would be within a half mile of high capacity transit. Furthermore, travel time and reliability would be improved allowing significantly greater mobility with 30 minutes of travel time, as shown in Figure 3.3.

Achievement of the four goals defined by the Rail Capacity Strategy represents a key first step in conceptualizing a future rail network. As this network is refined and additional community input included, it is anticipated that geographic and social equity, the timing of implementation and the cost-benefit of individual projects will further prioritize projects considered for future investment

Table 3.3 Long-Term City Rail Network Investments

	ENHANCEMENT OF EXISTING SYSTEM	REMOVAL OF SYSTEM CONGESTION POINTS	EXPANSION OF THE SYSTEM
Tier 1	M-Line/19th Ave. Core Capacity (tunnel)	Geneva LRT (surface)	LRT on Geary (tunnel & surface)
			Central Subway Extension (tunnel)
Tier 2	N-Judah Subway and Three-Car Train Capacity (tunnel)	Four-car Train Capacity at West Portal & Forest Hill Stations	East/West LRT from Market & Church to Mission Bay/4th & King (surface)
Tier 3		Non-revenue L and N track	Evans Avenue T-Line Spur (surface)
			2nd & Sansome Streetcar (surface)
			19th Ave LRT (surface)
			Marina to Upper Market LRT (tunnel & surface)
State/Regional Investments	CalTrain Electrification	BART Rail Cars	California High Speed Rail
			Transbay Transit Center Phase 2: Downtown Rail Extension "DTX"

Table 3.4 Long-Term City Rail Network Investments Mileage and Estimated Cost

PROJECT NAME	MILEAGE	COST (MILLIONS)#		IMPLEMENTATION*
		Low	High	
M-Line Muni Subway Expansion	2.0	$2,500	$3,000	2025+
Geneva LRT	3	$260	$610	
Geary LRT	6.3	$1,410	$3,030	
Central Subway Extension to Fisherman's Wharf	1	$840	$1,410	
Tier 1 Total	12.3	$5,010	$8,050	
N-Judah 3-car Operations and Underground from 9th Ave	2.3	$1,460	$3,130	2040+
4-car train Capacity at West Portal & Forest Hill	0	$80	$150	
East West LRT from Market & Church to Mission Bay/4th & King	2	$240	$520	
Tier 2 Total	4.3	$1,780	$3,800	
Non-revenue N and L Track	1.3	$100	$210	2050+
Evans Ave T-Line Spur	1.7	$140	$290	
19th Ave LRT	4.7	$370	$790	
Marina to Upper Market LRT	2.1	$1,350	$2,900	
2nd & Sansome Streetcar	3	$240	$510	
Tier 3 Total	13.8	$2,200	$4,700	
TOTAL	30.4	$8,990	$16,550	

Costs based on project feasibility studies or FTA construction cost database plus 30 percent increase for regional cost adjustment and reflect at-grade vs. grade-separated alignment assumptions.

* Implementation timeline assumes 5 years per expansion project with enhancement and congestion point removal projects constructed concurrently. Alternative delivery methods, such as Public Private Partnerships, could provide additional funding and accelerated project delivery.

Each of these investments build upon the existing rail system and rely on supportive infrastructure elements, such as traction power systems and the Automated Train Control System. These supportive infrastructure elements will also require reinvestment in the coming years as part of the SFMTA Transit Fixed Guideway Capital Investment Program. It is estimated that almost $2.7 Billion will be needed for these elements over the next 20 years. This need is documented in the SFMTA 20-year Capital Plan.

Accompanying this transformation in the light rail system would be a comparable transformation in the bus network. Many of the benefits realized by customers within walking distance of a rail line would also materialize for bus customers. Bus routes may be restructured to circulate customers to rail lines that provide a more reliable and frequent service so customers can reach their destinations sooner. This analysis would be part of a detailed operating plan accompanying any major rail investment.

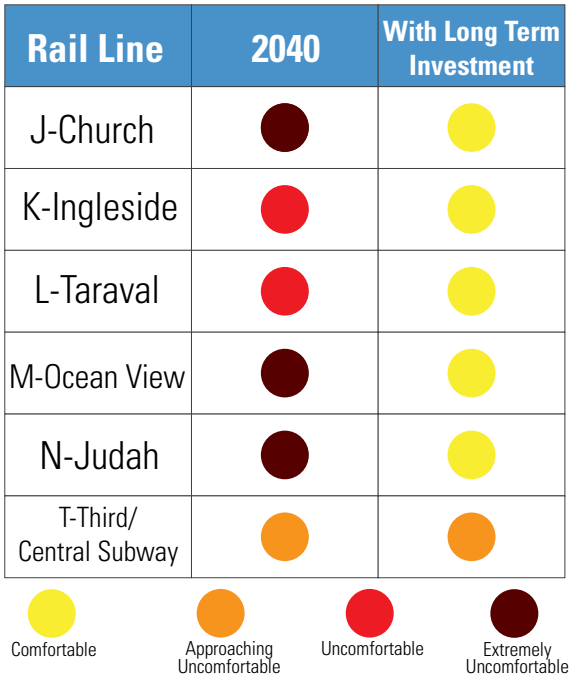


Figure 3.1 Passenger Experience with Long-Term Investments

SFMTA Municipal Transportation Agency

Long Term Corridor Investments

Tier 1

Tier 2

Tier 3

1/2 Mile Buffer

Current and Planned Transit System

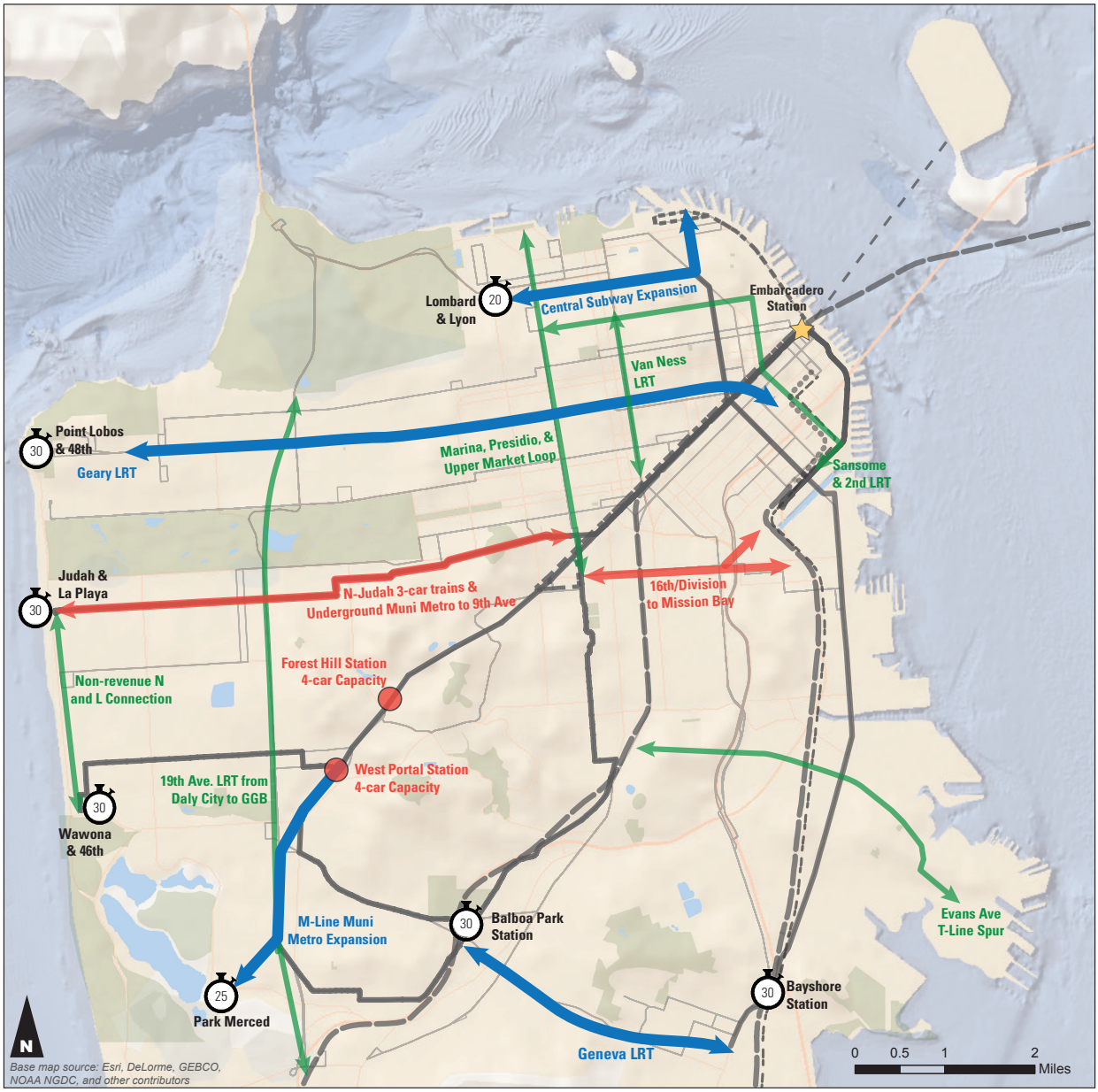
- Muni Rapid Bus Network
- Historic Streetcar
- Muni Metro Network
- Planned High Speed Rail
- Treasure Island Ferry
- Regional Rail (BART/Caltrain)
- Planned Regional Rail

Figure 3.2 Long-Term Corridor Investments

When implemented, the long term corridor investments identified in the Rail Capacity Strategy would provide high capacity rail service within a half mile of over 95% of the population of San Francisco. Vehicle capacity and travel time reliability improvements would result in a comfortable passenger experience during peak periods.

SFMTA Municipal Transportation Agency

Long Term Corridor Investments - Travel Times



Tier 1
Tier 2
Tier 3

30 Travel Time From Origin to Embarcadero

Current and Planned Transit System

- Muni Rapid Bus Network
- Historic Streetcar
- Muni Metro Network
- Planned High Speed Rail
- Treasure Island Ferry
- Regional Rail (BART/Caltrain)
- Planned Regional Rail

Figure 3.3 Long-Term Corridor Investments and Travel Times

The long term corridor investments would improve the travel time and reliability of the rail system. The number of destinations that could be accessed with 30 minutes of travel time would be greatly increased compared to the current system. Improvements in travel time and reliability would also provide passengers with reduced crowding and enhanced in-vehicle comfort.

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EXCEPT MUNI
EXCEPT MUNI
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1510A
MUNI
MOTORISTS MUST STOP FOR PEDESTRIANS

4. IMPLEMENTATION

To realize the benefits from these investments, an action plan was developed to not only address existing crowding, but initiate the up-front planning necessary to meet the long term mobility needs of San Francisco.

4.1 OUTCOMES

Implementation of the Rail Capacity Strategy would result in the following customer-focused outcomes:

- **Improved reliability of the rail transit system:** Implementation of the Tier 1 and 2 would eliminate the majority of service disruptions, delays and system vulnerabilities allowing for more reliable service experience.
- **Improved travel time consistency across the network:** Implementation of Tier 1 and 2 projects results in travel time of 30 minutes or less from the outer zones of the system to Embarcadero Station.
- **Improved in-vehicle comfort especially during peak-periods:** The new LRV fleet of up to 260 vehicles would allow for operation of 2, 3 and 4 car operation in peak-periods. Coupled with the new longitudinal layout, the in-vehicle experience will be significantly improved over today's conditions.
- **Improved high capacity rail access within half-mile of San Francisco residents:** Implementation of all three tiers would provide high capacity and reliable rail transit service within one-half mile of over 95 percent of San Francisco residents and employees.

4.2 FUNDING

The Rail Capacity Strategy has an estimated cost range of approximately $9.0-$16.6 billion, including significant contingency based on rough order of magnitude cost estimate technique. Further project development will be needed more detailed cost estimates.

The tiers and their funding sources are as follows:

Tier 1: The SFMTA is currently developing the 2017-2022 Capital Improvement Program. Estimated revenue for transit enhancement projects is approximately $691 million, including federal, state, regional and local fund sources. However, the identified funding need for transit enhancement projects such as Muni Forward, Bus Rapid Transit projects, spot improvements and location specific near term rail capacity improvements is upwards of $835 million. Of the Tier 1 projects, environmental planning and conceptual design for the M-Line/19th Avenue Core Capacity project and pre-environmental planning for the T-Third Phase III project are included in the $835 million of needs. Upwards of $5 billion in additional federal, state, and local funds, from either existing or new sources, need to be identified to deliver the projects in Tier 1.

Tier 2: Similarly, the estimated $2 to $4 billion necessary for delivery of projects in Tier 2 has not been identified.

Tier 3: Tier 3 projects are estimated at between $2.2 and $4.7 billion. This strategic prioritization of projects will need further study to determine and develop costs estimates and project scope schedule and budgets.

These preliminary order of magnitude cost estimates suggest that the city and the region will need to identify new funding sources in addition to development agreements for projects that have a direct nexus to development. New funding sources include but are not limited to:

- Local and/or Regional Transportation Sales Taxes
- Local and/or Regional Congestion Impact Fees, and
- Property and other municipal taxes
- Public Private Partnership financing packages

Creative approaches to infrastructure funding will need to be explored. Several agencies in the nation have been developing public private partnerships for rail capacity. These projects are bundled and tied to a new or existing revenue source. This means projects can be built in parallel and delivered sooner. Each of these packages will need to be evaluated and determined to be most effective. The Rail Strategy will inform these efforts for the rail infrastructure portion of these packages.

Overall, initiating the actions identified in the Rail Capacity Strategy would directly lead to both improved conditions for rail passengers in the near term through and increased long term capacity to accommodate projected growth and maintain economic competitiveness. The near term investments focus on cost-efficient improvements and the long term investments strategically expand or enhance corridors in a manner that provide systemwide benefits. Figure 4.1 provides the implementation roadmap for the Rail Capacity Strategy long term corridor investments.

Long-Term Corridor Investments Implementation Roadmap

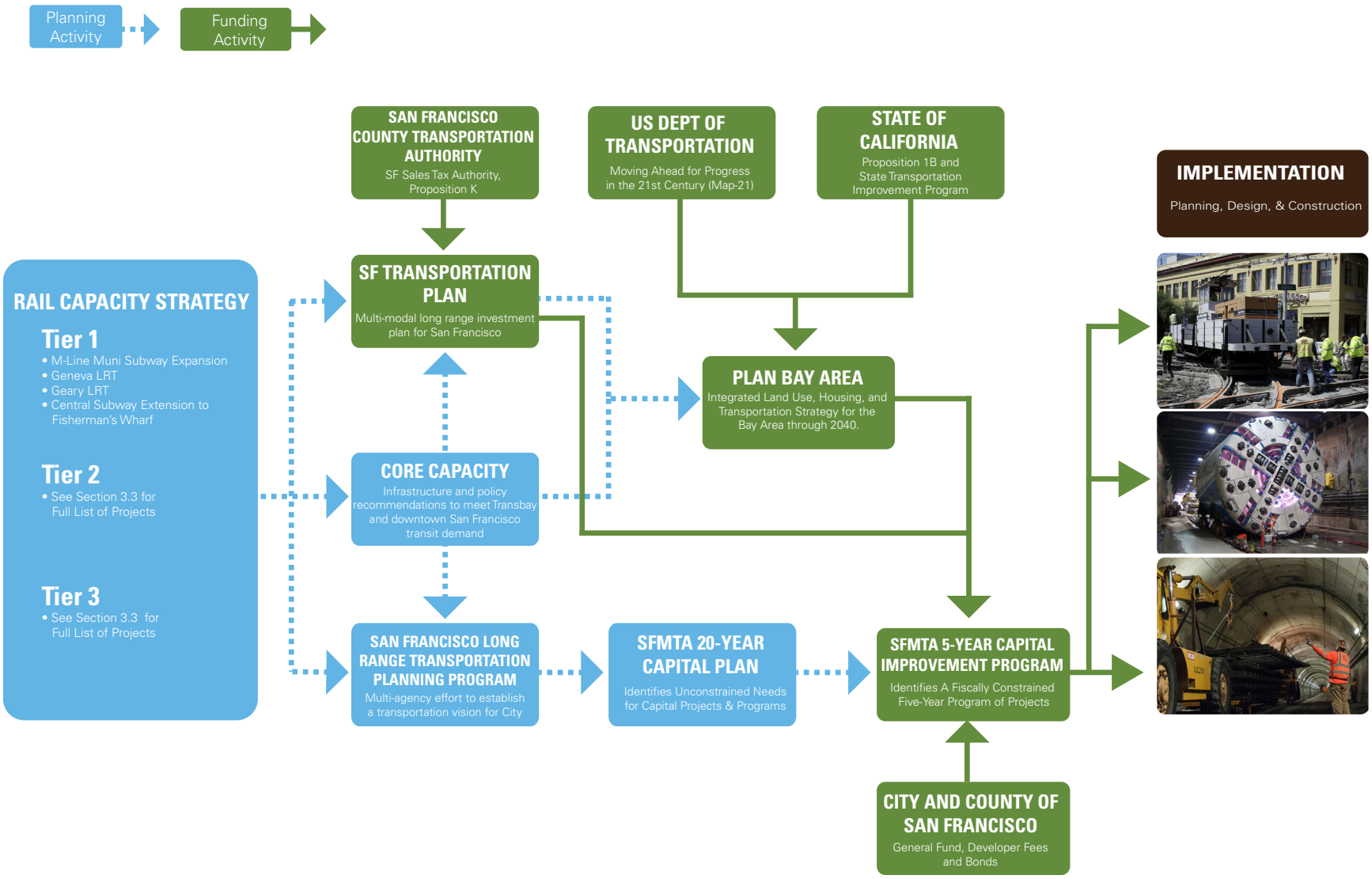

Figure 4.1 Long-Term Corridor Investments Implementation Roadmap

4.3 NEXT STEPS

In the fall of 2015 the SFMTA initiated the development of the next 5 year Capital Improvement Program (CIP). The CIP identifies the capital investments the SFMTA plans to initiate and deliver in the coming 5 years. The location specific near-term investments will be considered for funding against other SFMTA capital needs in the development of the CIP. Figure 4.2 outlines the projects proposed for inclusion in the SFMTA 2017-2022 CIP, available funding, and steps to develop a final 2017-2022 CIP.

The system-wide investments are most efficiently delivered when paired with already planned State of Good Repair or expansion projects. The need for these investments will be evaluated on a project-by-project basis, but funding would be available through the existing Transit Fixed Guideway and Transit Optimization and Expansion Capital Programs within the SFMTA 2017-2022 CIP, as shown in Figure 4.3.

The project costs for investments in tiers 1 and 2 are significant. Funding for the initial planning and concept development phases of these projects has not yet been identified. Potential funding levels are indicated in Figure 4.4. Environmental planning and conceptual design for the M-Line/19th Avenue Core Capacity project and pre-environmental planning for the T-Third Phase III project have been included for consideration in the SFMTA 2017-2022 CIP.

Additional planning for projects in tiers 1, 2 and 3 have been identified and currently underway as part of the MTC Core Capacity Transit Study and the San Francisco Long Range Transportation Planning Program (SF LRTPP). In particular, operating plans, fleet requirements, storage and maintenance facility needs, and refined operating and capital cost estimates will be developed under the SF LRTPP. The results of both efforts will also be presented as information or action items at the appropriate and relevant governing bodies. As these planning efforts provide further details on project benefits and costs, individual projects can be prioritized for discreet planning and concept development. Progress updates and milestone reporting for related planning and project development would also occur consistent with existing project management practices.

RAIL CAPACITY STRATEGY

- West Portal Conflict Reduction
- Muni Metro Extension Turnback Track
- Muni Metro Extension Transit Signal Enhancements/Embarcadero Tramways
- Church and Duboce Portal Conflict Reduction

$20M

MUNI FORWARD

- 22 Filmore: 16th St Transit Priority Project
- 14 Mission: Downtown Mission Transit Priority Project
- L Taraval: Transit and Streetscape Enhancements
- See Muni Forward Implementation Plan for additional projects

$225M

MAJOR CORRIDORS

- Van Ness Bus Rapid Transit
- Geary Bus Rapid Transit (Phase 1)
- Better Market Street
- M-Line Muni Metro Expansion (Env)
- Geneva Harney Bus Rapid Transit (Env.)

$475M

SPOT IMPROVEMENTS

- Transit Spot Improvements & Red Lanes
- Overhead Catenary System

$115M

Total Need: $835M

Estimated Revenue: $691M

Funding Gap: $144M

FY 2022-2026

FY 2017-2021

Figure 4.2 Near-Term Projects: Next Steps

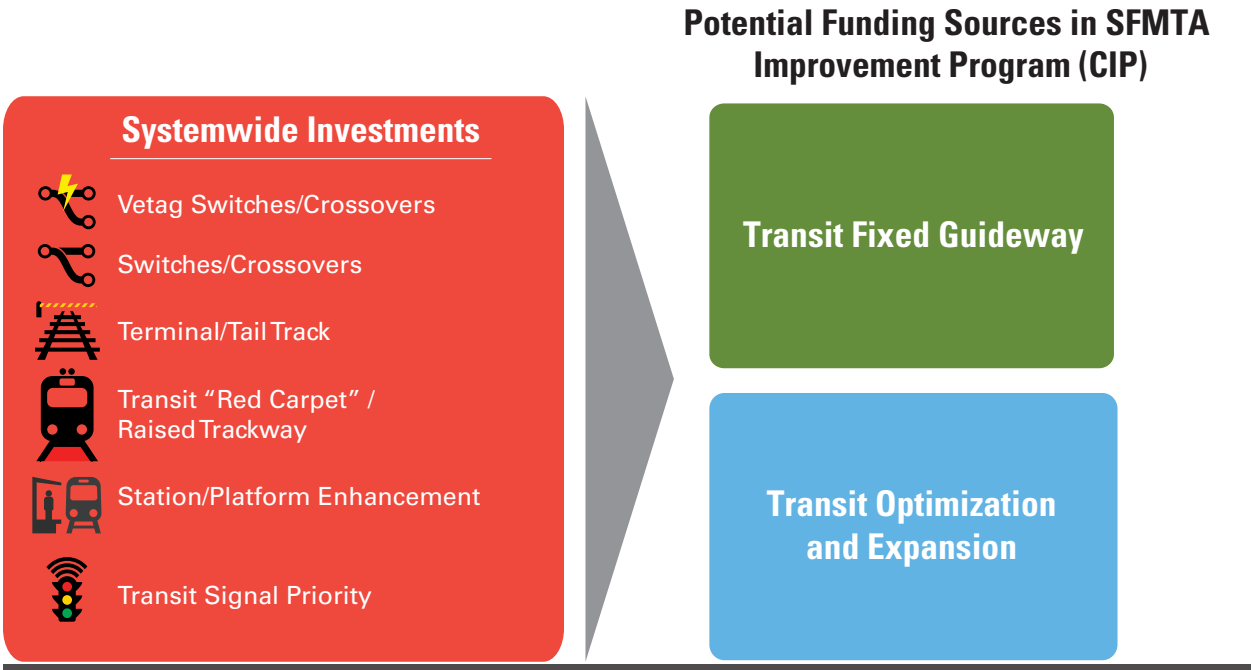

Figure 4.3 Systemwide Improvements Funding

Figure 4.4 Long-Term Project Potential Funding

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Bay Area Rapid Transit (BART)

San Francisco County Transportation Authority (SFCTA)

Market Street Railway

San Francisco Police Department

San Francisco Chamber of Commerce

San Francisco Housing Action Coalition

Livable City

San Francisco Planning Department

San Francisco Mayor's Office

San Francisco Capital Planning

San Francisco Mayor's Office on Disability

San Francisco Office of Community Investment and Infrastructure

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We work together to plan, build, operate, regulate and maintain the transportation network, with our partners, to connect communities.

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