

December 2014

San Mateo County
Transit District

El Camino Real Bus Rapid Transit Phasing Study



FEHR  PEERS

ARUP

El Camino Real Bus Rapid Transit Phasing Study – Final Report

Prepared for:



December 2014

SF13-0692

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EXECUTIVE SUMMARY

The intent of this study is to develop and recommend a phased implementation Bus Rapid Transit (BRT) plan for the El Camino Real Corridor (Corridor) in San Mateo County. It aims to complement current and future land use and transportation planning efforts for the Corridor as part of the Grand Boulevard Initiative (GBI). The GBI is a collaboration of 19 cities and local and regional agencies in San Mateo and Santa Clara counties. Its goal is to develop a blueprint for increasing housing and employment densities and creating more livable, transit oriented communities along El Camino Real. As densities increase and streets become more livable based on the actions of the individual jurisdictions along the Corridor, it is an opportune time for SamTrans, as San Mateo County's transit provider, to supplement these efforts by preparing a phased BRT plan that meets the needs of current and future customers and helps realize the vision of the GBI and associated planning initiatives.

In the context of this study, the primary objective is to develop a short- and long-term BRT operating strategy:

- The **short-term operating plan** and phasing plan will focus on **Rapid** bus service.
- The **long-term operating plan** and phasing plan will focus on more capital intensive **BRT** services.

STUDY GOALS AND OBJECTIVES

The study's goals and objectives help guide the development and evaluation of the Rapid and BRT service concepts designed to enhance bus service on the Corridor. The study's goals and objectives are outlined below in **Table E-1**.

Key Definition: Rapid vs. Bus Rapid Transit

Rapid service refers to an enhanced bus service with greater reliability and faster operating speeds due to longer stop spacing and/or transit signal priority. Rapid service operates in mixed flow lanes and is subject to conflicts with vehicular traffic.

BRT service refers to a more capital-intensive form of bus service operating with significantly upgraded stations and segments of bus-only lanes that is able to operate faster and more reliably than Rapid service.



TABLE E-1: PROJECT GOALS AND OBJECTIVES

Goal	Objective
1. Increase bus ridership along the Corridor by improving service for existing customers and attracting new customers	1.1. Increase ridership 1.2. Improve passenger experience
2. Complement the Grand Boulevard Initiative's vision of realizing El Camino Real as a "grand boulevard of meaningful destinations" by building consensus on transit improvements that promote livability and commercial vitality	2.1. Improve pedestrian safety 2.2 Increase access to households, employment and retail opportunities 2.3. Support planned growth in corridor
3. Minimize system capital and operating cost increases and operational impacts by developing a conceptual bus operating plan that optimizes local, Rapid and Full BRT services along the corridor	3.1. Provide cost-effective service 3.2. Minimize ECR operating impacts
4. Minimize corridor traffic and parking impacts while maximizing the benefits of Rapid and Full BRT services	4.1.Minimize traffic impacts 4.2. Minimize physical changes to corridor infrastructure

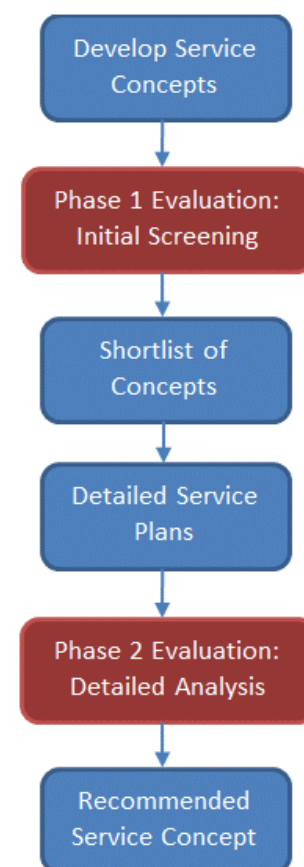
STUDY ANALYSIS TIMEFRAME

For the near-term Rapid and long-term BRT year 2020 (Phase 1) and year 2040 (Phase 2) were chosen as horizon years for modeling purposes. Each phase would occur when on-going monitoring of financial, ridership, and growth conditions warrant the service enhancements to ECR service.

SCREENING PROCESS

The screening process is a multi-step framework to identify a recommended service concept.

- **Initial Screening Options** – Based on an analysis of the existing corridor conditions including ridership, travel trends, and current ECR/KX service, eight Rapid service concepts for the ECR Corridor were



developed (near-term implementation potential).

- **Phase 1 Evaluation (Initial Screening)** – This evaluation represented a qualitative screening of the Rapid service concepts to identify a shortlist of candidate concepts for more detailed development (e.g., elaboration on headways, spans of service, stop locations, travel times). (A BRT concept would also be brought forward for detailed development as part of a long-term implementation strategy.) A subset of representative screening criteria was used for this evaluation, based on the larger project goals and objectives.
- **Detailed Service Plan Development** – For the initial Rapid concepts that passed the initial screening process and the BRT concept, detailed service plans were developed. Building on the service parameters outlined in the initial screening options, each concept carried forward was modeled for ridership, operating and maintenance (O&M) costs, and capital costs.
- **Phase 2 Evaluation (Detailed Analysis)** – This was a quantitative and qualitative analysis of shortlist Rapid concepts and the BRT concept that was based on data and outputs from the detailed service plan development process and the City/County Association of Governments of San Mateo (C/CAG) Bi-County Model. This alternatives analysis evaluation was based on the detailed evaluation framework.
- **Recommended Service Concept** – Based on the results of the feasibility screen, concepts that should be considered for near- and long-term ECR Corridor service enhancements are presented along with the pros and cons of each alternative.

SERVICE CONCEPTS CONSIDERED FOR THE BRT PHASING PLAN

The service concepts that passed the Phase 1 initial screening and were moved into detailed development for the Phase 2 evaluation are as follows:

- **Rapid Concepts** – This concept calls for Rapid service along the entire Corridor with the same termini as existing Route ECR (Palo Alto in the south and Daly City in the north). This service concept family includes a “Full Rapid”, which would operate all day along the entire corridor and “Peak Rapid” concept, which would operate along the entire corridor but just during peak periods. Under these concepts, Rapid service would be overlaid on top of existing ECR Local service.
- **Truncated Rapid Concepts** – This concept calls for Rapid service that is truncated within the Corridor and excludes areas of lower ridership demand. This service concept family includes a “Redwood City to Daly City Truncated Rapid” and “Redwood City to San Bruno Truncated Rapid” concept. Under these concepts, Rapid service would be overlaid on top of existing ECR Local service. Analysis of stop-level ridership data found that some segments of the corridor experienced low ridership – particularly in the very north of the corridor (for instance through Colma) and in the south of the corridor (between Redwood City and Palo Alto). These concepts



assessed the benefits of “truncating” service along the corridor to minimize operations in these lower ridership segments.

- **Hybrid Rapid Concepts** – This concept calls for Rapid service that is a hybrid of a typical Rapid service and Local service; with fewer stops than ECR Local but more stops than ECR Rapid (more stops are located in higher ridership areas, with fewer stops in lower ridership areas). This service concept family includes a “Hybrid Rapid A” and “Hybrid Rapid B” concept. Under these concepts, there would be no overlay – ECR Local would be replaced by Hybrid Rapid. The Hybrid Rapid A concept would provide local coverage in the higher demand segments (between Redwood City and San Bruno) and limited stop service (same pattern as Rapid) at either end of the Corridor. The Hybrid Rapid B concept follows a limited stop pattern throughout the Corridor, but with still more stops than Rapid due to no ECR Local overlay.
- **BRT Concept** – This concept calls for BRT service along the entire Corridor with the same termini as existing Route ECR (Palo Alto in the south and Daly City in the north). This long term alternative would use the same service structure as the “Full Rapid” concept with additional transit preferential treatments such as bus-only lanes in order to significantly improve the passenger experience and improve travel speeds and reliability. Based on a corridor assessment of where transit-only lanes would be feasible, the Full BRT concept assumes that vehicles would operate in dedicated bus lanes for 10.9 miles and in mixed flow traffic lanes for 14.76 miles.

The detailed Rapid/BRT alternatives development process included defining stations, routing, headways, service spans, and resource impacts (in terms of revenue hours, miles, and vehicles) for these “families” of concepts. Concept definitions for the Phase 2 evaluation are shown in **Table E-2**.



TABLE E-2: RAPID/BRT ALTERNATIVES CARRIED FORWARD FOR DETAILED EVALUATION

#	Horizon Year for Modeling	Service Concept	Rapid/BRT Stops	Description of Service Tier(s)	Rationale
1	2020	Baseline	-	<ul style="list-style-type: none"> ECR (providing 15-minute headways, stopping at existing 102 northbound (NB) and 104 southbound (SB) stops) 	<ul style="list-style-type: none"> ECR operates existing schedule and serves current stop pattern
2	2020	Full Rapid	37	<ul style="list-style-type: none"> Rapid (providing 15-minute headways, stopping at 37 stops in each direction from Daly City to Palo Alto) ECR (providing 15-minute headways, stopping at existing 102 NB and 104 SB stops) 	<ul style="list-style-type: none"> Rapid service is introduced, providing faster service, making less frequent stops ECR operates existing schedule and serves the current stop pattern
3	2020	Truncated Rapid (Daly City-Redwood City)	32	<ul style="list-style-type: none"> Rapid (providing 15-minute headways, stopping at 32 stops in each direction between Daly City and Redwood City) ECR (providing 15-minute headways, stopping at existing 102 NB and 104 SB stops) 	<ul style="list-style-type: none"> Rapid service is introduced, providing faster service, making less frequent stops; no service is provided south of Redwood City (representing a low demand segment) ECR operates existing schedule and serves the current stop pattern
4	2020	Truncated Rapid (San Bruno-Redwood City)	23	<ul style="list-style-type: none"> Rapid (providing 15-minute headways, stopping at 23 stops in each direction between San Bruno and Redwood City) ECR (providing 15-minute headways, stopping at existing 102 NB and 104 SB stops) 	<ul style="list-style-type: none"> Rapid service is introduced, providing faster service, making less frequent stops; no service is provided north of San Bruno and south of Redwood City (representing lower demand segments) ECR operates existing schedule and serves the current stop pattern



TABLE E-2: RAPID/BRT ALTERNATIVES CARRIED FORWARD FOR DETAILED EVALUATION

#	Horizon Year for Modeling	Service Concept	Rapid/BRT Stops	Description of Service Tier(s)	Rationale
5	2020	Hybrid A - 12 min	76	<ul style="list-style-type: none"> Hybrid Rapid (providing 12-minute service and stopping at 76 stops between Daly City and Palo Alto) 	<ul style="list-style-type: none"> Hybrid service will provide faster service than ECR, but provide more local access than the Rapid in higher demand segments (thus 76 stops versus 37) ECR service is discontinued
6	2020	Hybrid B - 12 min	50	<ul style="list-style-type: none"> Hybrid Rapid (providing 12-minute service and stopping at 50 stops between Daly City and Palo Alto) 	<ul style="list-style-type: none"> Hybrid service will provide faster service than ECR, but provide more local access than the Rapid in higher demand segments Similar to Hybrid A, except fewer stops are served (50 stops versus 76) (eliminates mid-Corridor low ridership stops) to increase travel speeds ECR service is discontinued
7	2020	Peak Rapid	37	<ul style="list-style-type: none"> Rapid (providing peak 15-minute headways, stopping at 37 stops in each direction from Daly City to Palo Alto) ECR (providing 15-minute headways, stopping at existing 102 NB and 104 SB stops) 	<ul style="list-style-type: none"> Rapid service is introduced in the peak only (lower operating cost than Concept #2), providing faster service, making less frequent stops ECR operates existing schedule and serves the current stop pattern
8	2020	Hybrid A - 10 min	76	<ul style="list-style-type: none"> Hybrid Rapid (providing 10-minute service and stopping at 76 stops between Daly City and Palo Alto) 	<ul style="list-style-type: none"> Hybrid service will provide faster service than ECR, but provide more local access than the Rapid in higher demand segments Similar to Hybrid A (Concept #5), except operates at 10-minute headways to assess ridership sensitivity to service frequency ECR service is discontinued



TABLE E-2: RAPID/BRT ALTERNATIVES CARRIED FORWARD FOR DETAILED EVALUATION

#	Horizon Year for Modeling	Service Concept	Rapid/BRT Stops	Description of Service Tier(s)	Rationale
9	2020	Hybrid B - 7.5 min)	50	<ul style="list-style-type: none"> Hybrid Rapid (providing 7.5-minute service and stopping at 50 stops between Daly City and Palo Alto) 	<ul style="list-style-type: none"> Hybrid service will provide faster service than ECR, but provide more local access than the Rapid in higher demand segments Similar to Hybrid B (Concept #6), except operates at 7.5-minute headways to assess ridership sensitivity to service frequency ECR service is discontinued
10	2040	BRT	37	<ul style="list-style-type: none"> BRT (providing 15-minute headways, stopping at 37 enhanced stations in each direction from Daly City to Palo Alto) ECR (providing 15-minute headways, stopping at existing 102 NB and 104 SB stops) 	<ul style="list-style-type: none"> BRT service is introduced, providing faster service via dedicated transit lanes on some corridor segments and serving enhanced BRT stations ECR operates existing schedule and serves the current stop pattern

ALTERNATIVES ANALYSIS AND FINDINGS

- **Concept 2 – 2020 Full Rapid was the Top Performer in the Alternatives Evaluation for the Intermediate Term**
- **Concept 1 – 2020 Base Case and Concept 5 – 2020 Hybrid A (76 Stops – 12 Min) Are the Next Best Performers**
- **Combined Rapid and ECR Concepts Perform Better than Hybrid Concepts**
 - Overall, concepts with combined Rapid and ECR service seem to perform better than Hybrid concepts. The reason is likely that access is a key element in the concept evaluation – thus loss of access by eliminating stops (as is done for all Hybrid concepts) has a significant negative impact on the rating of service concepts and the perceived level of service.
- **If Improvements Are Implemented, Concepts 2 and 5 Can Both Be Strong Options, But Each Brings Different Benefits**



- There are key differences between each service concept, however, with different implications for the future scope/extent of BRT service and infrastructure. Concept 2 provides better access and level of service for all riders, but has two tiers of service which increases O&M and capital costs. Concept 5 provides a single service to eliminate confusion and reduce O&M and capital costs, but reduces access to transit along the corridor.

RECOMMENDED NEAR-TERM STRATEGY OPTIONS

Full Rapid - While Concept 2 performs the best and offers the most robust enhancement to customer service and access with the full-corridor overlay Rapid service, it is more expensive overall in terms of both O&M costs (as the number of Revenue Vehicle Hours (RVH) is significantly higher than the 2020 Base Case) and capital costs (due to the high number of additional peak vehicles required). Overlay Rapid service in Concept 2 is a natural precursor to BRT with dedicated bus lanes and more robust bus stations. There are some shortcomings of Concept 2, in particular, higher costs may preclude enhancements if adequate budget is not available.

Hybrid A (76 Stops – 12 Min) - Concept 5 on the other hand, may score lower in customer service and access, but has much lower O&M and capital cost (as it requires minimal increases in RVH and thus O&M costs, and does not require a significant number of new peak vehicles to be acquired). It may be easier to garner political support for Concept 5, with its cheaper price, and it can likely be implemented faster. Taking a long-term perspective, however, Concept 5 represents a minor change to existing ECR service – essentially creating a “limited stop” ECR. Concept 5 does allow for a transition to a future BRT system, which would have both local and BRT service running in parallel. Concept 5 would essentially become the local service in the long-term with a future BRT overlay. The steps of creating a Rapid-style service in the short-term and then rebranding as local service in the long-term would be confusing to customers and send conflicting messages to the public and policymakers.

RECOMMENDED PHASING PLAN OPTIONS

Because Full BRT service would require significant and complementary investments in transit supportive land uses to justify the capital improvements, this study considered a series of near-term, lower cost Rapid concepts as the initial phase in enhancing transit service in the Corridor. The recommended phasing plan includes near-term and long-term approaches. The recommended near-term concepts are based on the findings of the detailed evaluation and the long-term BRT concept is based off the service design of the Rapid concept with additional capital improvements.



Two potential service strategy options for enhancing bus service on the Corridor are recommended for further study. Both strategies are feasible options for enhancing transit service on the Corridor and complement the Grand Boulevard Initiative (GBI) vision.

- **Option 1 – Near-Term Full Rapid and Long-Term BRT** consists of a phased approach that gradually upgrades trunk line transit along the Corridor from the current local service provided by the ECR Local, to a Rapid overlay on top of the ECR Local, to a BRT overlay (an upgraded Full Rapid) on top of the ECR Local.

This option has many benefits - increasing ridership, enhancing access, providing a faster, more reliable, more frequent, brand-distinguished overlay service, operational flexibility (the ability to modify Rapid service while maintaining consistent ECR Local service), and setting up the corridor for an efficient transition to BRT service. It also has its drawbacks, most notably, high operating and capital costs resulting in lower productivity compared to Option 2. BRT would require supporting land use (appropriate land use mix and higher densities) along the corridor that is far more intensive than today in order to justify the high capital costs (exclusive transit lanes) identified for this option.

- **Option 2 – Near Term Hybrid A (76 stops – 12-minutes) and Long Term BRT** consists of a phased approach that upgrades the ECR Local service along the Corridor to Hybrid Rapid in the near-term and introduces a BRT overlay on top of the Hybrid in the long term (Hybrid Rapid becomes the local service).

In the near-term this approach would require a minimal operating and capital cost increase while increasing speed, reliability, and ridership along the corridor. Due to the lower capital outlay and operating costs compared to Option 1, Option 2 would be easier to implement. Because it would eliminate lower productivity stops, overall access would decrease compared to existing ECR Local service. At a 12-minute service frequency, customers would see one additional bus per hour (a total of five) over existing service, which is far lower than the 8 buses per hour (4 Rapid, 4 local) that would be provided under Option 1. Option 2 would require a more difficult operational transition to long-term BRT service, as the BRT service would be introduced on top of the Hybrid service as opposed to a transition of Rapid service in Option 1.



1.0 INTRODUCTION

The intent of this study is to develop and recommend a phased implementation Bus Rapid Transit (BRT) plan for the El Camino Real Corridor (Corridor) in San Mateo County. It aims to complement current and future land use and transportation planning efforts for the Corridor as part of the Grand Boulevard Initiative (GBI). The GBI is a collaboration of 19 cities and local and regional agencies in San Mateo and Santa Clara counties and its goal is to develop a blueprint for increasing housing and employment densities and creating more livable, transit oriented communities along El Camino Real. As densities increase and streets become more livable based on the actions of the individual jurisdictions along the Corridor, this is an opportune time for SamTrans, as San Mateo County's transit provider, to supplement these efforts by preparing a phased BRT plan that meets the needs of current and future customers and helps realize the vision of the GBI and associated planning initiatives. Ultimately, by improving service along the corridor, BRT helps spur revitalization and promotes economic development by creating a more livable corridor that is an accessible and convenient all-day and all-night destination for all types of users.

1.1 BACKGROUND OF THE STUDY

In San Mateo County, the Corridor is projected to see an increase of over 24,800 households and over 90,800 jobs between 2005 and 2035 using 2007 projections from the Association of Bay Area Governments (ABAG). The GBI's 2010 Multimodal Corridor Plan found that higher land use densities support higher transit ridership. Currently, transit infrastructure is already concentrated along the Corridor, where five of the six San Mateo County Bay Area Rapid Transit (BART) stations are located in close proximity to El Camino Real and 15 Caltrain stations are located within a half mile.

The GBI is focused on creating a complete streets vision for the Corridor which provides for the routine accommodation of all users of the roadway, including motorists, pedestrians, bicyclists, individuals with disabilities, seniors, and users of public transportation.¹ Enhanced transit service that includes bus-only lanes, queue jumps as well as faster, more reliable, and more frequent service is complementary to these principles.

Studies indicate that BRT service is feasible along the Corridor. A 2005 California Partners for Advance Transportation Technology study (*Top Five Candidate Corridors for Bus Rapid Transit in San Francisco Bay Area*) identified El Camino Real as a top candidate for enhanced bus service. The *El Camino Real Bus Corridor Origin and Destination Survey* (SamTrans, 2006) recommended the implementation of a Rapid-

¹ California's 2007 Complete Streets Act (AB 1358)



style service to prime the pump for anticipated BRT service. The GBI Corridor Plan also found that with sufficient land use densities, BRT would be feasible on the Corridor.

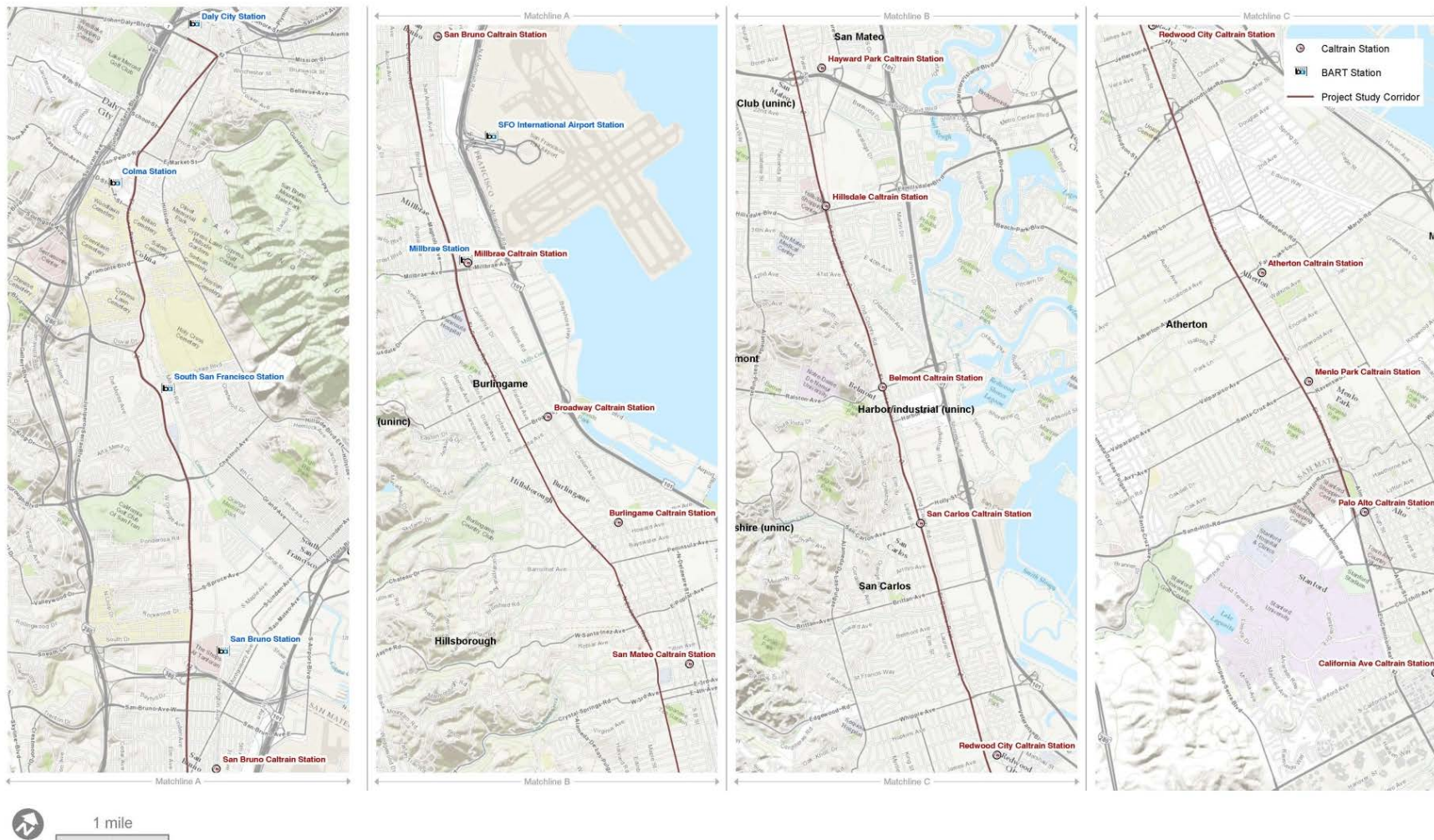
In Santa Clara County, the Santa Clara Valley Transportation Authority (VTA) implemented a Rapid Bus service (Rapid 522) on its portion of the Corridor in 2005. The success of its Rapid service and BRT planning efforts as part of its *Bus Rapid Transit Strategic Plan* (VTA, 2009) support the belief that BRT can be successful on the Corridor. VTA is currently in the environmental and design phase for BRT service and is expected to be operational as early as 2018.

1.2 THE EL CAMINO REAL CORRIDOR

The El Camino Real Corridor connects San Francisco to San Jose along the Peninsula. El Camino Real (Royal Road in Spanish) is also the historical 600-mile route that connected the former Alta California's 21 missions from San Diego to Sonoma. For this study the "Corridor" is defined as the portion of El Camino Real that traverses San Mateo County and the small section in Santa Clara County from the San Mateo County border to the Palo Alto Transit Center. **Figure 1-1** shows the extent of the study corridor.



Figure 1-1: Corridor Map



1.3 PURPOSE OF THE STUDY

The centerpiece of planning efforts along El Camino Real is the GBI which seeks to expand the range of housing choices, spur economic development, and improve the corridor streetscape for all user types. Improved transit access and mobility along the Corridor will be a vital component in realizing this goal. This study is the first coordinated planning effort by SamTrans to complement the GBI vision by analyzing and recommending a phased BRT plan for the San Mateo County portion of the Corridor. This plan identifies through concept alternatives and the evaluation of these alternatives how SamTrans can help accommodate and support increasing densities on the Corridor and promote connectivity with transit supportive land uses and regional transit services. The purpose of this study is to develop a phased BRT plan for the Corridor that can attract sufficient ridership and provide cost-effective operations while complementing the GBI vision. Specifically, the study seeks to identify and develop:

- Essential system components;
- Ridership demand analysis;
- Operating and capital cost estimates;
- Benefits and implications of operating BRT service;
- Preferred phasing plan
- Implementation plan; and
- Funding strategy.



1.4 STUDY GOALS

The phased BRT plan sets forth a strategy to achieve the following goals:

Goal 1 – Increase bus ridership along the El Camino Real Corridor by improving service for existing customers and attracting new customers.

Goal 2 – Complement the GBI’s vision of realizing the Corridor as a “grand boulevard of meaningful destinations” by building consensus on transit improvements that promote livability and commercial vitality.

Goal 3 – Minimize system capital and operating cost increases and operational impacts by developing a conceptual bus operating plan that optimizes local, Rapid, and Full BRT services along the corridor.²

Goal 4 – Minimize corridor traffic and parking impacts while maximizing the benefits of Rapid and Full BRT services.

In the context of this study, the primary objective is to develop a short- and long-term BRT operating strategy:

- The **short-term operating plan** and phasing plan will focus on **Rapid** bus service.
- The **long-term operating plan** and phasing plan will focus on more capital intensive **BRT** services.

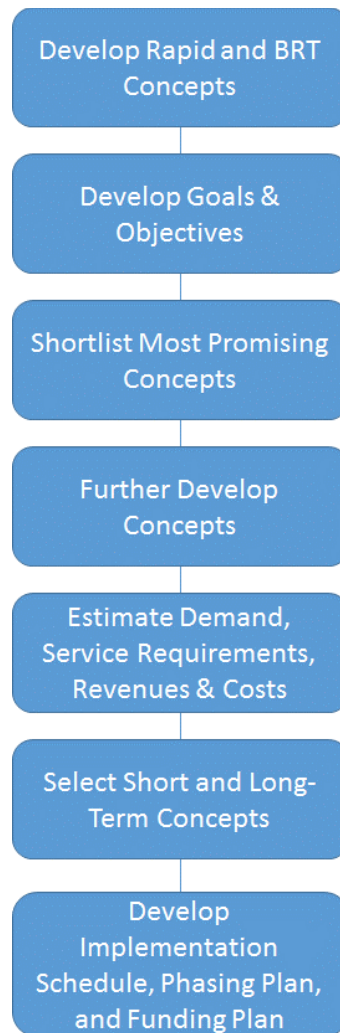
² As described in later chapters, Rapid service refers to an enhanced bus service with greater reliability and faster operating speeds due to longer stop spacing and/or transit signal priority. Rapid service operates in mixed flow lanes and is subject to conflicts with vehicular traffic. Full BRT service refers to a more capital-intensive form of bus service operating with significantly upgraded stations and segments of bus-only lanes that is able to operate faster and more reliably than Rapid service.



1.5 STUDY APPROACH

This study seeks to identify and develop a phased BRT plan for the Corridor that would improve transit rider access and mobility, increase corridor bus ridership, and complement existing Corridor land use and built environment planning efforts. This plan also seeks to identify feasible service that minimizes impacts and maximizes cost-effectiveness. The approach employed in this study to achieve this desired outcome was to take a set of initial service concepts through a two-stage screening process that ultimately yields a recommended phasing plan for BRT service on the Corridor. This approach is illustrated at the right.

For the near-term Rapid and long-term BRT, year 2020 and year 2040 were chosen as horizon years for modeling purposes. Each stage would occur when ongoing monitoring of financial, ridership, and growth conditions warrant the service enhancements along the Corridor.



1.6 REPORT CONTENTS

This report is divided into 16 sections:

1. **Introduction** (this section) – Introduces the study corridor and the BRT Phasing Plan
2. **Introduction to Rapid Bus and Bus Rapid Transit** – Describes typical attributes of Rapid Bus and BRT systems
3. **Corridor Characteristics** – Summarizes existing corridor conditions to identify need for an enhanced bus transit system along the Corridor
4. **Study Goals and Objectives** – Lists the study's goals and objectives that help guide the development and evaluation of Rapid Bus and BRT concepts
5. **Evaluation Framework** – Presents the quantitative and qualitative evaluation metrics used to perform a comparative evaluation of the Rapid Bus and BRT concepts as well as the screening process methodology



6. **Initial Service Concepts and Screening – Phase 1** – Describes the initial set of eight Rapid service concepts developed by the project team and conducts an initial screening to move forward high ranking concepts into detailed service plan development and evaluation
7. **Rapid Bus and BRT Alternatives Development – Phase 2** – Presents the detailed Rapid/BRT alternatives development process that includes defining stations, routing, headways, and service spans
8. **Service Concept Modeling** – Explains the modeling process used to develop quantitative data for each service concept moved to the detailed development and evaluation stage
9. **Operating Plan Development** - Presents the operating plans for the various service concepts identified for detailed analysis
10. **Operating & Maintenance Costs** - Presents the estimated operating and maintenance (O&M) costs for the various service concepts carried forward to the detailed evaluation
11. **Capital Costs** - Presents the estimated capital costs (infrastructure and vehicles) associated with the various service concepts carried forward to the detailed evaluation
12. **Ridership and Productivity** - Presents ridership and productivity statistics for the various service concepts carried forward to the detailed evaluation
13. **Detailed Concept Evaluation** – Summarizes the alternatives analysis of the various service concepts carried forward to the detailed evaluation utilizing the study's evaluation framework
14. **Recommended Phasing Plan and Key Implementation Considerations** – Describes two potential service strategy options for enhancing bus service on the Corridor in the future based on the detailed evaluation of service concepts and identifies key considerations when determining when/if to transition from the current to the proposed Rapid and BRT service concepts
15. **Implementation Timeframe and Schedule** - Presents the conceptual implementation schedule for the proposed near- and long-term service concepts
16. **Funding Plan** - Identifies potential funding sources for the service concepts that make up the two potential service strategy options for enhancing bus service on the Corridor in the future



2.0 INTRODUCTION TO RAPID BUS AND BUS RAPID TRANSIT

This section introduces key attributes that separate Rapid and Bus Rapid Transit (BRT) service.

2.1 RAPID VS. BUS RAPID TRANSIT DISTINCTION

Although there is no precise definition universally agreed upon, BRT is generally understood to connote bus services that operate faster than “local bus” service. BRT performance is facilitated by both operational and physical measures that may include some or all of the following elements:

- Limited stop service;
- Bus-only lanes;
- Bus priority at signals;
- Faster passenger boarding and fare collection;
- Transportation system management enhancements;
- Enhanced passenger amenities; and
- Unique branding.

Many variants of BRT operate in North America and throughout the world – each agency and entity has its own perspective on what constitutes BRT service in the local context. There is general industry consensus, however, that BRT can be delineated into two families based on the level of attributes and investment in each system: Rapid and Full BRT (or just BRT) – as shown in **Table 2-1**.



TABLE 2-1: THE TWO FAMILIES OF BRT

Type of BRT	Typical Attributes	Examples
Rapid	These systems typically operate in mixed flow lanes, with some degree of signal priority, and likely branded service and vehicles. Rapid systems, also sometimes known as “BRT Lite” have minimal capital investment.	<ul style="list-style-type: none"> • Alameda-Contra Costa (AC) Transit District 1R & Line 72R • Los Angeles County Metropolitan Transportation Authority (Metro) Rapid • Livermore Amador Valley Transit Authority (LAVTA) Rapid • Santa Clara Valley Transportation Authority (VTA) Rapid 522
BRT (or Full BRT)	These systems typically have a much higher degree of priority and enhancements than Rapid services. These systems operate vehicles in dedicated transit lanes (or segments of) that allow vehicles to operate faster and more reliably. Significant capital investments are made to upgrade corridor right-of-way and stations, to make the riding experience more “rail-like”.	<ul style="list-style-type: none"> • Greater Cleveland Regional Transit Authority HealthLine • Lane Transit District (LTD) Eugene Emerald Express (EmX) • Los Angeles Metro Orange Line • VTA Valley Rapid (Future) • San Francisco Municipal Transportation Authority Van Ness BRT (Future)

2.2 TYPICAL ATTRIBUTES OF BRT

Table 2-2 identifies four key attributes and various underlying strategies to achieve these attributes (as identified in Transit Cooperative Research Program Report 90). While some BRT systems may not incorporate all four of these attributes, they typically incorporate several of these attributes – which collectively separate BRT as a premium and enhanced service over local bus. More information can be found in the BRT Case Study Report (**Appendix A**).



TABLE 2-2: TYPICAL BRT ATTRIBUTES AND SPECIFIC STRATEGIES

Typical BRT Attribute	Specific Strategy/Strategies
Frequent All-Day Service	<ul style="list-style-type: none"> • Frequent all-day, bi-directional service
Fast and Reliable Service	<ul style="list-style-type: none"> • Longer stop spacing • Operational measures <ul style="list-style-type: none"> ◦ Turn prohibitions / exemptions ◦ Low-floor vehicles ◦ Level boarding facilities ◦ All-door boarding/alighting ◦ Off-board fare payment ◦ Transportation system management enhancements • Transit priority measures <ul style="list-style-type: none"> ◦ Transit Signal Priority (TSP) ◦ Bulbouts ◦ Queue jump lanes ◦ Dedicated transit lanes <ul style="list-style-type: none"> ▪ Reserved lanes ▪ At-grade busway ▪ Grade-separated busway
Enhanced Passenger Amenities	<ul style="list-style-type: none"> • More substantial stations • Real-time information
Distinctive Branded Service	<ul style="list-style-type: none"> • Branded and specially marketed service • Specialized vehicles

2.2.1 FREQUENT ALL-DAY SERVICE

"Frequent service" is a relative term that varies among agencies. Among agencies operating BRT-type service in North America, the typical peak operating headway can be between 10 to 12 minutes during the weekday, and 15 to 30 minutes during off-peak hours (and possibly longer during early morning, late evening, and Sunday operations).³

³ Most BRT systems also operate on a headway, rather than schedule basis – meaning that a bus is evaluated "early" or "late" against its expected arrival headway at a given station.



2.2.2 FAST AND RELIABLE SERVICE

Longer Stop Spacing

Along a long route, incremental delay and variability from frequent stops (including dwell times as well as merge times) can result in a significant reduction in travel speed and on-time performance. Reducing the number of stops served (and thus increasing stop spacing) is the easiest way to improve travel speeds and reliability.

Turn Prohibitions / Exemptions

Vehicles making left turns block intersections and contribute to delay in through traffic in the opposite direction. Vehicles making right turns can delay through traffic while waiting for pedestrians to cross the street. Prohibiting left and/or right turns at particular intersections can have significant benefits to transit travel times and reliability by minimizing interruptions to through transit and general traffic flow.

Faster Loading/Unloading

The time it takes to board and alight a transit vehicle has impacts on dwell time, which can collectively add up along a long route. Loading/unloading can be accelerated through one of the following strategies:

- Low-Floor Vehicles
- Level Boarding Facilities
- All-Door Boarding/Alighting

Off-Board Fare Payment

Off-board fare payment, typically facilitated for BRT with ticket vending machines (TVMs) can speed the boarding process significantly by minimizing the driver-rider interaction. Off-board fare payment is typically implemented along with all-door boarding.

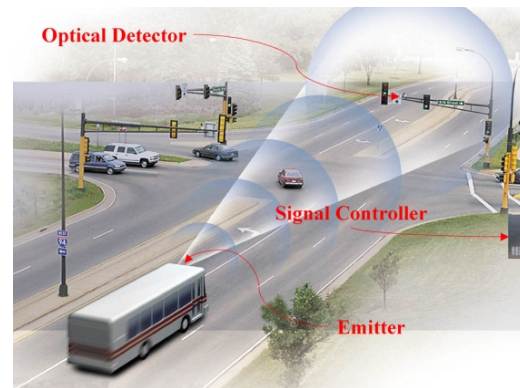
Transportation System Management Enhancements

The goal of transportation system management enhancements is to improve on-the-ground operations and effectiveness through schedule efficiencies, and changes in fleet type, service frequency, hours of operation, and network structure to allow operators to match the right type and level of service to areas with corresponding demand for transit. These enhancements also include in-line management strategies including real-time dispatching, real-time monitoring of bus movements and traffic conditions, refinement of layover time and deadheading, which assist operators in planning for delays due to peak-hour traffic.



Transit Signal Priority (TSP)

TSP, also known as Bus Signal Priority (BSP), can help reduce delay and variability in bus travel times and schedule arrival times. TSP can be implemented in a mixed flow context, but also for dedicated bus lanes and queue jump lanes to minimize delay to through bus movements. Generally, TSP can be implemented in two manners: (i) passively, where signals are programmed to align with transit running times or to optimize general traffic flow or (ii) actively, where priority is granted to a bus after it is detected. Active priority is either: (i) conditional, where only late buses are given priority or (ii) unconditional, where all buses are given priority regardless of whether they are early or late.



Source: Sustainable Transportation in the Netherlands

Bulbouts

Bulbouts can reduce bus merge times into and out of general mixed flow traffic lanes, while also creating more space for bus shelters and street furniture. Bulbouts can impact general traffic flow as buses stop in the mixed flow lanes, reducing throughput capacity, and forcing vehicles behind the bus to wait if they are unable to pass.

Queue Jump Lanes

Queue jump lanes, also known as queue jumpers or exempt lanes, are short segments of priority lanes at specific locations that allow transit buses to release at a signal-controlled intersection ahead of the platoon of vehicles in traffic lanes. In the US context, queue jump lanes are typically in right-hand turn lanes and allow for transit through movements.

Dedicated Transit Lanes

Transit operating in mixed flow lanes is subject to delay and conflict from other vehicles, cyclists, and pedestrians. Thus, stretches of dedicated transit lane(s) for exclusive transit use can be one of the most important factors, aside from implementing longer stop spacing, in achieving faster and more reliable service. Dedicated lanes are a visible and permanent commitment to providing priority to transit over general traffic.



Source: TheGreenCarWebsite.co.uk



2.2.3 ENHANCED PASSENGER AMENITIES

More Substantial Stations

Amenities can range from simple and more elegant stylized shelters to more elaborate rail-like stations with high platforms and large seated waiting areas. High quality materials may also be used for the facility. Other amenities may include better lighting, sheltered waiting areas, real-time passenger information, TVMs, etc.

Real-Time Information

Real-time information systems can reduce perceived waiting times and improve the attractiveness of transit and use of transit by providing customers with certainty about bus arrivals. This can be done by providing real-time passenger information such as expected arrival times and journey times both at the wayside and aboard vehicles through variable message signs and announcements, as well as through smartphones and other handheld devices.

2.2.4 DISTINCTIVE BRANDED SERVICE

Branded and Specially Marketed Service

Specialized branding may include:

- A unique name or route numbering for BRT, which can imply an distinct level of service over local bus;
- Unique painting, bus wrapping, or logo for BRT vehicles;
- Specially chosen colors schemes and logos for BRT marketing materials, stop signs, and maps; and
- Targeted marketing campaigns to extol the benefits of BRT over local bus and possibly the automobile.

Specialized Vehicles

Agencies typically deploy BRT buses that are distinctive from local buses both in appearance (for instance branding, color scheme, and logo), but also in make and model. Sleek and contoured vehicles that look more “rail-like” in appearance have been used at many agencies, with low-floors for faster entry and exit, and premium seating.



3.0 CORRIDOR CHARACTERISTICS

This section assesses the existing conditions along the Corridor today. The analysis draws heavily on existing studies and plans, including the *SamTrans Service Plan (SSP)* (2013), and *Grand Boulevard Initiative (GBI) Corridor Plan* (2010), *Economic and Housing Opportunities Assessment* (2010), and *Existing Conditions Report* (2011). The following sections highlight the need to provide enhanced bus service along the Corridor:

- Demographics and Land Use;
- Roadway Facilities and Performance;
- Transit Facilities and Performance; and
- Pedestrian and Bicycle Facilities.

More information can be found in the Existing Conditions Report (**Appendix B**).

3.1 DEMOGRAPHICS AND LAND USE

The Corridor includes the following demographic and land use characteristics:

- The population density in the Corridor is greater than the San Mateo County average. Population density along the Corridor (half-mile distance from El Camino Real) is slightly less than 14 persons per acre. In comparison, population density in the entire County is about two persons per acre.⁴
- The densest areas along the Corridor include: Daly City, Colma, San Bruno (east of the Corridor), Burlingame (east of the Corridor), and Redwood City.
- Employment is predicted to grow at an average of 7.2% every five years from 2010 to 2035 (from approximately 104,000 to 147,000 jobs).
- The highest employment densities occur in South San Francisco, San Bruno, Burlingame, San Mateo, and Redwood City.
- Median household income is increasing at the same time low-income households are making up a greater share of residents along the Corridor.
- Daly City, San Mateo, Belmont, Redwood City, Menlo Park, and San Bruno have high percentages of transit supportive land use. Daly City, San Mateo and Belmont are the cities with the highest

⁴ Grand Boulevard Initiative – Existing Conditions Report. November 2011.



percentage of multi-family residential land use. Redwood City, Menlo Park, and San Bruno have the highest percentage of retail/office/commercial land use.

- There are numerous major destinations along or near the Corridor – schools, city halls, medical centers, shopping centers, downtown areas, commercial corridors, and multi-modal transit hubs that are conducive to transit usage.
- The drive alone rate along the Corridor is slightly lower than San Mateo County overall.

3.1.1 KEY DESTINATIONS

Major destinations are primary generators of person trips, and their intensity and density are attractive to alternate transportation modes, such as transit. There are numerous major destinations along or near the Corridor, including:

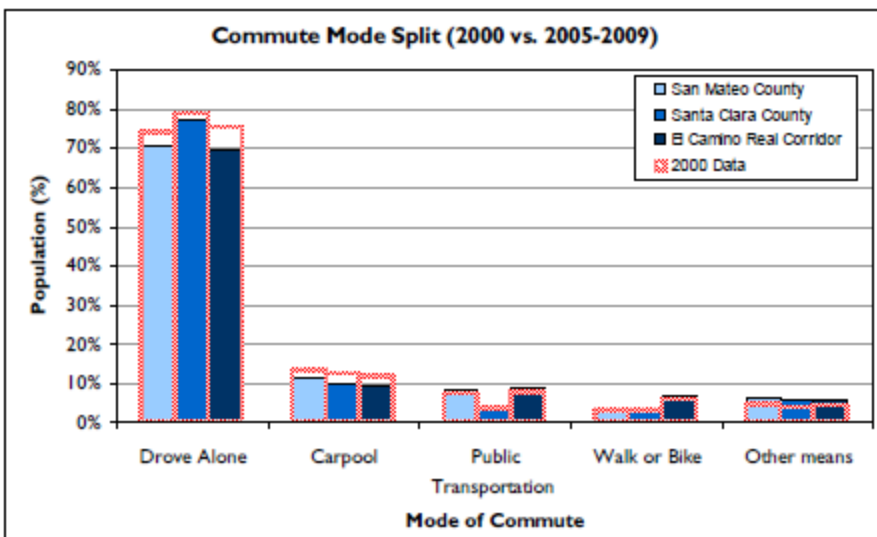
- Educational institutions such as Menlo College (Menlo Park) and Stanford University (Palo Alto);
- City halls and other municipal buildings. Daly City, Colma, South San Francisco, San Bruno, Millbrae, Hillsborough, Burlingame, San Mateo, Belmont, San Carlos, Redwood City, Atherton and Menlo Park city halls are all within easy walking distance of the Corridor;
- Medical facilities such as Kaiser Permanente Medical Center (South San Francisco), Peninsula Hospital (Burlingame), and Mills Health Center (San Mateo);
- Shopping centers such as The Shops at Tanforan (San Bruno), Hillsdale Shopping Center (San Mateo), and Stanford Shopping Center (Palo Alto);
- Downtowns and commercial corridors such as Broadway and Burlingame Avenue (Burlingame), Downtown San Mateo, Laurel Street (San Carlos), Downtown Redwood City, and Downtown Menlo Park; and
- BART (Daly City, Colma, South San Francisco, San Bruno, and Millbrae) and Caltrain (Millbrae, Burlingame, San Mateo, Hayward Park, Hillsdale, Belmont, San Carlos, Redwood City, Menlo Park, and Palo Alto) stations that provide access to regional destinations such as Downtown San Francisco, Oakland/East Bay, and San Jose/Santa Clara County).

3.1.2 TRAVEL CHARACTERISTICS

According to the 2005-2009 American Community Survey, about 70% of workers along the Corridor (not specific to San Mateo County) drive alone to work, 9% carpool, 9% ride public transit, 6.5% walk or bike, and 6% take other means. The drive alone rate decreased from 75% in 2000. The drive alone rate along the Corridor is slightly lower than that in San Mateo County overall. **Figure 3-1** details mode split.



Figure 3-1: Commute Mode Split



Source: U.S. Census Bureau – Census 2000
2005-2009 American Community Survey 5-year Estimates

Source: Grand Boulevard Initiative – Existing Conditions Report. November 2011.

3.2 ROADWAY FACILITIES AND PERFORMANCE

El Camino Real ranges between two and three general purpose lanes per direction. There are no designated bus-only or bicycle lanes. Landscaped or painted medians exist on the majority of the Corridor. Right-of-way varies considerably, which presents both opportunities and constraints for bus preferential treatments. Some of the key takeaways from the assessment of current roadway facilities and performance include:

- Intersections with exclusive right turn lanes may be good locations for potential queue jump lanes for transit. There are two existing intersections which allow buses to proceed straight through right turn lanes that have “bus exempt” signs (southbound Hillsdale Boulevard in San Mateo and northbound Ravenswood Avenue in Menlo Park). SamTrans is currently installing exemption signs at an additional five locations (northbound 2nd Avenue in San Mateo, southbound Broadway and northbound/southbound Jefferson Avenue in Redwood City, and Valparaiso Avenue in Menlo Park).
- Some of the intersections along the Corridor with the highest roadway volumes include Westborough Boulevard in South San Francisco, I-380 in San Bruno, and SR-92 in San Mateo.



- The majority of intersections evaluated are operating within the County's Level of Service (LOS) E standard for El Camino Real (LOS E or better), with the exception of El Camino Real / Millbrae Avenue.⁵
- On-street parking is available on the majority of the Corridor. However, on-street parking is prohibited at any time in some sections with constrained curb-to-curb width including the residential areas of Hillsborough, Burlingame, and Atherton, as well as on segments adjacent to major intersections. Segments of downtown San Mateo and Redwood City have metered parking. Commercial districts in Daly City, San Carlos, Redwood City, and Menlo Park have free time-restricted parking.⁶

3.3 TRANSIT FACILITIES AND PERFORMANCE

Transit operators within the corridor include SamTrans, Caltrain, San Francisco Municipal Transportation Agency (SFMTA), Santa Clara Valley Transportation Authority (VTA), Bay Area Rapid Transit (BART), and public and private first/last mile shuttles.

3.3.1 SAMTRANS

SamTrans routes which serve large segments of the Corridor include routes ECR (formerly 390 and 391), 397, and 398/KX. Implementation of the SamTrans SSP recommendations included the following service changes along the Corridor:

- In August 12, 2013, routes 390 and 391 were replaced by Route ECR, which runs every 15 minutes between the Palo Alto Transit Center and the Daly City BART Station. This change eliminated stops at the San Bruno and South San Francisco BART stations, as well as service into San Francisco. Alternative service into San Francisco for Route 391 customers is available on Route 292, Route KX (peak-hour only), Muni 14, BART and Caltrain.
- On January 26, 2014, Route ECR reinstated service to the San Bruno BART Station and eliminated service to the Millbrae BART Transit Center. KX began operation between Redwood City and San Bruno BART, via the San Francisco International Airport, with service to San Francisco only offered on weekdays during the peak-hour/peak-direction.
- On June 15, 2014 Route KX was reduced to peak-period only service (four northbound AM and four southbound PM trips) and Route 398 was introduced as a truncated version of Route KX that mirrors the KX route between Redwood City and San Francisco International Airport with a terminus at the San Bruno BART Station rather than downtown San Francisco.

⁵ City/County Association of Governments (C/CAG), 2011

⁶ Grand Boulevard Initiative – Existing Conditions Report. November 2011.



Route 397 was not affected by the SSP changes. Route 397 is a late night ("owl") service.

Route ECR Ridership Analysis

El Camino Real service has the highest level of service productivity, strongest farebox recovery ratios, and lowest subsidy per passenger boarding in the SamTrans system. In October-November 2013, the ECR served 5,300-5,400 daily weekday boardings in either direction (thus daily corridor boardings totaled about 10,600-10,700 in both directions). Saturday boardings were about 60% of the average weekday, while Sunday boardings were about 55% of the average weekday. The average weekday total was about 20% lower than 2010 weekday combined boardings on the 390 and 391 along a similar stretch of El Camino Real, which, according to the SSP, can be explained by customer adjustment to the new route structure and lack of a one seat ride to downtown San Francisco (formerly provided by Route 391). Ridership totals since this detailed analysis was conducted indicate increasing ridership on Route ECR. **Figure 3-2** depicts the average daily ECR boardings per weekday, Saturday, and Sunday over a two-month time period (October-November 2013). **Figure 3-3** shows average weekday stop level boardings on Route ECR over the same time period.

In total, 102 southbound (SB) and 104 northbound (NB) stops are served by the ECR. In October and November 2013, average weekday combined ons/offers ranged from over 400 daily ons/offers at the busiest stops to fewer than 20 daily ons/offers at the least utilized stops.

As shown in **Table 3-1**, about 40% of all stops in either direction have over 100 combined daily ons/offers, but fewer than 10% of stops have more than 250 combined daily ons/offers. These 10% of stops account for about one-fourth of daily activity along the entire corridor.

Figure 3-2: Average Daily ECR Boardings by Direction (October/November 2013)

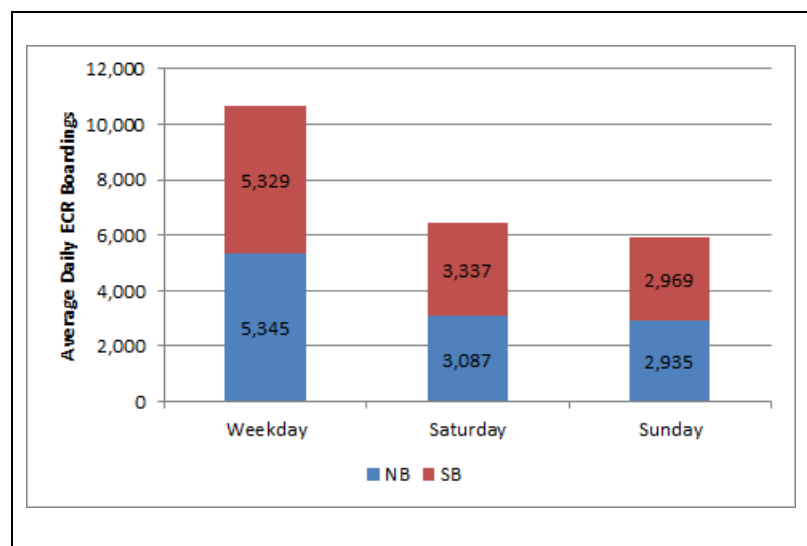


Figure 3-3: Existing Route ECR Stop Level Ridership (October-November 2013)



TABLE 3-1: NUMBER OF STOPS BY ECR ON/OFF ACTIVITY (OCTOBER/NOVEMBER 2013)

Average Weekday Ons+Offs	# of SB Stops	# of NB Stops
100+	39	39
125+	29	33
150+	19	21
200+	13	13
250+	7	8
Total Stops	102	104

Source: SamTrans, 2013.

Route ECR Speed, Reliability and Productivity

Route ECR averages speeds of approximately 12 mph, which are characteristic of a local bus route. This speed, combined with a 25.9 mile one-way route length, translate into long end-to-end travel times that make it difficult to attract choice riders. During peak periods when congestion occurs along El Camino Real, it can take more than two and a half hours to travel between Daly City and Palo Alto. During off-peak periods end-to-end travel time is still around two hours.

SamTrans has an on-time performance goal of 85%. Early results for Route ECR (August 2013) indicate that the service is performing below that goal (combined 71.5%). The length of the route, number of stops, and congestion on El Camino Real all contribute to poor on-time performance. With substandard on-time performance, reliability is a major concern. Unreliable service increases wait time and uncertainty and discourages ridership, especially by choice riders.

Even with these challenges, El Camino Real service has the highest level of service productivity, strongest farebox recovery ratio, and lowest subsidy per passenger boarding figure in the SamTrans system. According to the SSP, a system-wide analysis of SamTrans operations, ECR service generated 42 passenger boardings per revenue hour on weekdays, 43 on Saturday, and 34 on Sunday, respectively. Systemwide, SamTrans recovers approximately 18.6% of operating costs through farebox revenues. El Camino Real services have the strongest farebox recovery in the system (at close to 22%) mainly due to the strong ridership along the Corridor compared to other routes in the system.



3.3.2 CALTRAIN

Caltrain provides commuter rail service along the San Francisco Peninsula and through the South Bay to San Jose and Gilroy. In San Mateo County, Caltrain generally runs parallel to the Corridor. In San Mateo County, Caltrain has 13 stations (2 only active on weekends). In general, ridership has been steadily increasing since 2003 and many Caltrain trains are currently at or over capacity on portions of the rail corridor. Millbrae, Redwood City, and Hillsdale are the three most popular stations that parallel the Corridor. Caltrain will be implementing its Modernization Program to upgrade the performance, operating efficiency, capacity, safety and reliability of Caltrain's commuter rail service with conversion to electrified operations. The Caltrain Modernization Program is scheduled to be operational by 2020.

3.3.3 SFMTA (MUNI)

Muni provides bus and Light Rail Transit (LRT) service, primarily within the borders of the City and County of San Francisco, serving approximately 700,000 average weekday boardings. Muni service that connects with SamTrans ECR is provided at Daly City BART and on Mission Street at Evergreen Avenue. Four Muni routes currently serve the Daly City BART Station: the 14L Mission Limited (serves the station during peak hours), the 28 19th Avenue, 28L 19th Avenue Limited, and 54 Felton. ECR customers can also connect to the 14 Mission, 14L Mission Limited, and 14X Mission Express on Mission Street.

3.3.4 VTA

The VTA is the operator of bus and LRT service for Santa Clara County. VTA also provides some connecting services to San Mateo and Alameda Counties. VTA routes that connect with SamTrans Route ECR at the Palo Alto Transit Center include:

- Local Route 22: from Palo Alto Transit Center to Eastridge Transit Center with 12- to 60-minute headways;
- Rapid Route 522: from Palo Alto Transit Center to Eastridge Transit Center with 15- to 30-minute headways; and
- Local Route 35: Downtown Mountain View to Stanford Shopping Center with 30-minute headways.

Along the entire Corridor (including San Mateo and Santa Clara counties), the Palo Alto Transit Center has the most weekday boardings⁷. VTA is in the planning stages for Bus Rapid Transit (BRT) service along El

⁷ Grand Boulevard Initiative – Existing Conditions Report. November 2011. VTA, May 2011.



Camino Real in Santa Clara County. Route 522 will be converted to BRT and it is expected to be constructed and operational by 2018.

3.3.5 BART

BART is a regional heavy rail system connecting the counties of San Francisco, Alameda, Contra Costa, and San Mateo. Within San Mateo County, BART has six stations (Daly City, Colma, South San Francisco, San Bruno, San Francisco International Airport (SFO), and Millbrae). All stations (except for SFO) are within one-quarter of a mile of the Corridor. BART ridership at most San Mateo County stations has increased over the past decade. Ridership at Colma Station dropped after the SFO Extension opened. Today, Daly City, SFO, and Millbrae have the highest ridership in San Mateo County.

3.3.6 PUBLIC AND PRIVATE SHUTTLES

Shuttles offer first mile/last mile connections to regional transit providers such as Caltrain and BART as well as community based service. These shuttles provide service to rail stations, residential neighborhoods, and employment sites. Some of the major shuttles in the Corridor include:⁸

- Weekday commute shuttles operated by Caltrain;
- Shuttles operated by SamTrans;
- Shuttles and on-demand commuter taxi program operated by the Peninsula Traffic Congestion Relief Alliance (Alliance); and
- Private shuttles from BART and/or Caltrain stations to tech employers on the Peninsula.

3.4 PEDESTRIAN AND BICYCLE FACILITIES

Pedestrian facilities provided along the Corridor consist mainly of crosswalks and sidewalks. The majority of crosswalks across El Camino Real are at signalized intersections. There are a limited number of crosswalks at unsignalized intersections and at mid-block locations.⁹ Crossing El Camino Real is challenging for pedestrians due to the heavy traffic volumes, high travel speeds, the long crossing distance (ranging from four to six vehicle travel lanes), and long distances between signalized crosswalks.

⁸ Ibid.

⁹ Ibid.



Along the Corridor, there are several segments with sidewalk gaps. There are no sidewalks along the Corridor in Atherton. Segments along Colma, Burlingame, South San Francisco, and San Mateo, and San Carlos are also missing sidewalks on one or both sides of the street. Most of the sidewalks along the Corridor are functional by design. They tend to lack pedestrian-oriented elements such as landscaping, street furniture, bulb outs, and attractive streetscapes. The sidewalks are also generally narrow (4'). Poor placement of benches, transit shelters, and information signage poles in the sidewalk further narrow the effective walkable area.

Heavy traffic, high vehicle speeds, and lack of bicycle facilities along El Camino Real make the Corridor a difficult route for bicyclists to travel on. In addition, multiple freeways, along with the BART and Caltrain right of ways, create barriers to bicycle travel. Some cities have established dedicated bicycle routes on streets parallel to El Camino Real to provide a safer means of travel down the Peninsula. However, many of these parallel routes rely on side streets that are often noncontiguous and disjointed.



4.0 STUDY GOALS & OBJECTIVES

This section highlights the overarching goals and objectives of this Study. The study's goals and objectives help guide the development and evaluation of the Rapid and Bus Rapid Transit (BRT) service concepts designed to enhance bus service on the Corridor. The study's goals and objectives are outlined in **Table 4-1**.

TABLE 4-1: PROJECT GOALS AND OBJECTIVES

Goal	Objective
1. Increase bus ridership along the Corridor by improving service for existing customers and attracting new customers	1.1. Increase ridership 1.2. Improve passenger experience
2. Complement the Grand Boulevard Initiative's vision of realizing El Camino Real as a "grand boulevard of meaningful destinations" by building consensus on transit improvements that promote livability and commercial vitality	2.1. Improve pedestrian safety 2.2. Increase access to households, employment and retail opportunities 2.3. Support planned growth in corridor
3. Minimize system capital and operating cost increases and operational impacts by developing a conceptual bus operating plan that optimizes local, Rapid and Full BRT services along the corridor	3.1. Provide cost-effective service 3.2. Minimize ECR operating impacts
4. Minimize corridor traffic and parking impacts while maximizing the benefits of Rapid and Full BRT services	4.1. Minimize traffic impacts 4.2. Minimize physical changes to corridor infrastructure



5.0 STUDY SCREENING PROCESS & EVALUATION FRAMEWORK

This section presents the study's screening process and evaluation framework for developing service concepts, then identifying and recommending a preferred service concept. More information on the development of the evaluation framework can be found in **Appendix C**.

5.1 SCREENING PROCESS

The screening process is a multi-step framework to identify a recommended service concept.

- **Initial Screening Options** – Based on an analysis of the existing corridor conditions including ridership, travel trends, and current ECR/KX service, eight Rapid service concepts for the ECR Corridor were developed (near-term implementation potential).
- **Phase 1 Evaluation (Initial Screening)** – This evaluation represented a qualitative screening of the Rapid service concepts to identify a shortlist of candidate concepts for more detailed development (e.g., elaboration on headways, spans of service, stop locations, travel times). (A Bus Rapid Transit (BRT) concept would also be brought forward for detailed development as part of a long-term implementation strategy.) A subset of representative screening criteria was used for this evaluation, based on the larger project goals and objectives.
- **Detailed Service Plan Development** – For the initial Rapid concepts that passed the initial screening process and the BRT concept, detailed service plans were developed. Building on the service parameters outlined in the initial screening options, each concept carried forward was modeled for ridership, operating and maintenance (O&M) costs, and capital costs.
- **Phase 2 Evaluation (Detailed Analysis)** – This was a quantitative and qualitative analysis of shortlist Rapid concepts and the BRT concept that was based on data and outputs from the detailed service plan development process and the City/County Association of Governments of



San Mateo (C/CAG) Bi-County Model. This alternatives analysis evaluation was based on the detailed evaluation framework.

- **Recommended Service Concept** – Based on the results of the feasibility screen, concepts that should be considered for near- and long-term ECR Corridor service enhancements are presented along with the pros and cons of each alternative.

5.2 EVALUATION FRAMEWORK

In order to understand the relative benefits and costs of each conceptual alternative and their ability to complement local (e.g. SamTrans Routes ECR and KX) and regional (e.g., Bay Area Rapid Transit, Caltrain, and Santa Clara Valley Transportation Authority (VTA)) transit along the Corridor, an evaluation framework with measurable criteria was developed for this study. The framework matches project goals and objectives with a series of quantitative and qualitative evaluation criteria to ensure that each service concept meets the desired outcomes of the Phasing Plan, including increasing ridership, complementing the complete streets approach planned through the Grand Boulevard Initiative, minimizing system capital and operating cost increases, and minimizing corridor traffic and parking impacts.

The study's evaluation framework is presented in **Table 5-1** and includes each evaluation criteria used, the type of metric (quantitative/qualitative) along with the data sources that were used to conduct the detailed evaluation. This full evaluation framework is intended for the detailed service concept evaluation (Phase 2); the screening performed for the initial screening (Phase 1) utilizes a subset (qualitative only) of these criteria to identify the most promising concepts that should be moved into detailed service plan development.



TABLE 5-1: EVALUATION FRAMEWORK

Goal	Objective	Metric	Evaluation Criteria	Type of Metric	Explanation of Metric	Data Source
1. Increase bus ridership along the Corridor by improving service for existing customers and attracting new customers	1.1. Increase ridership ^{A, B}	1.1A	Increase in corridor-level boardings	Quantitative	<ul style="list-style-type: none"> Measures the increase in corridor-level boardings (including all SamTrans routes operating on the Corridor) compared to baseline (no project) service. Higher corridor-level boardings generate more corridor revenue. 	C/CAG Bi-County Model
		1.1B	Increase in system-level boardings	Quantitative	<ul style="list-style-type: none"> Measures the increase in system-level boardings (including all SamTrans routes operating in the system) compared to ECR Local service. Higher system-level boardings generate higher total fare revenue for SamTrans. 	C/CAG Bi-County Model
		1.1C	Corridor boardings per Revenue Vehicle Hours (RVH)	Quantitative	<ul style="list-style-type: none"> Measures corridor boarding productivity (boardings/Revenue Vehicle Hour (RVH)) for all SamTrans routes on the El Camino Real Corridor. Boardings/RVH is an indicator of service productivity. 	C/CAG Bi-County Model Operating Plan
	1.2. Improve passenger experience	1.2A	Improve station experience and security	Quantitative	<ul style="list-style-type: none"> Measures the extent to which a service concept improves the customer experience at the stop/station (based on the number of enhanced stops or BRT stations in one direction). More satisfied customers may translate into higher ridership. 	Physical plan Operating plan



TABLE 5-1: EVALUATION FRAMEWORK

Goal	Objective	Metric	Evaluation Criteria	Type of Metric	Explanation of Metric	Data Source
		1.2B	Improve in-vehicle experience	Qualitative	<ul style="list-style-type: none"> Measures the extent to which a service concept improves in-vehicle experience (based on average travel speed of the enhanced service (i.e., the non-ECR Local service). Average travel speed acts as a proxy for in-vehicle time, thus faster travel speeds likely means shorter in-vehicle time and a better experience and possibly higher ridership. 	Physical plan
		1.2C	Create unique service branding/identity	Qualitative	<ul style="list-style-type: none"> Measures how well a service concept creates a unique service and branded identify, separate from the existing SamTrans ECR Local. A more unique brand identity helps eliminate confusion for riders and may attract riders looking for an enhanced service beyond ECR Local. 	Physical plan
		1.2D	Legible and easy to understand routing and service	Qualitative	<ul style="list-style-type: none"> Measures how easy and intuitive the routing and service pattern is for a given service concept against the current situation. A more legible and understandable service is convenient and easier to use for riders, and may translate to higher ridership. 	Physical plan
2. Complement the Grand Boulevard Initiative's vision of	2.1. Improve pedestrian safety ^c	2.1A	Pedestrian safety assessment	Qualitative	<ul style="list-style-type: none"> Measure intended to assess scale of pedestrian improvements including bulbouts, medians, sidewalks, and safer crossing opportunities. Not applicable for the Rapid Bus concept evaluation as specific design details for pedestrian enhancements were not developed. 	Physical plan



TABLE 5-1: EVALUATION FRAMEWORK

Goal	Objective	Metric	Evaluation Criteria	Type of Metric	Explanation of Metric	Data Source
realizing El Camino Real as a “grand boulevard of meaningful destinations” by building consensus on transit improvements that promote livability and commercial vitality	2.2. Maintain or improve access to households, employment and retail opportunities ^{D, E}	2.2A	# of households and jobs accessible within a 15-minute walk from a station	Quantitative & Qualitative	<ul style="list-style-type: none"> Measures the extent to which a service concept maintains or improves access to households and employment. This metric measures the relative accessibility to jobs and housing provided by each service concept. Concepts with more households and jobs within the walking catchment area may generate higher ridership. 	C/CAG Bi-County Model
		2.2B	Convenient and direct pedestrian/bicycle access between stations and adjacent land uses	Qualitative	<ul style="list-style-type: none"> Measure intended to assess how well a service concept facilitates cycling. Not applicable for the near-term Rapid bus concept evaluation as specific design details for service concepts were not developed. 	Physical plan
	2.3. Support planned growth in corridor	2.3A	Serve key commercial and residential growth areas	Qualitative	<ul style="list-style-type: none"> Measures the extent to which a service concept serves key commercial and residential growth areas along the corridor. Service to key commercial and residential growth areas is necessary to generate sustainable levels of ridership. 	Physical plan
3. Minimize system capital and operating cost increases and	3.1. Provide cost-effective service ^{F, G, H}	3.1A	Capital cost	Quantitative	<ul style="list-style-type: none"> Measures total capital costs (inclusive of infrastructure and vehicle costs). Higher total costs may mean more difficulty in securing funding, local commitments, and ultimately implementation. 	Operating plan Capital plan



TABLE 5-1: EVALUATION FRAMEWORK

Goal	Objective	Metric	Evaluation Criteria	Type of Metric	Explanation of Metric	Data Source
operational impacts by developing a conceptual bus operating plan that optimizes local, Rapid and Full BRT services along the corridor		3.1B	Capital cost per mile	Quantitative	<ul style="list-style-type: none"> Measures average capital cost per route mile (inclusive of infrastructure and vehicle costs). This is intended to provide another capital cost metric – for instance, a service concept may have a lower overall capital costs, but may be implemented on only a portion of the corridor. This metric better captures such projects and gives a better sense of “return on investment” than the straight comparison of capital costs. Higher average costs may mean more difficulty in securing funds and local commitments. 	Operating plan Capital plan
		3.1D	Subsidy per boarding (corridor-level)	Quantitative	<ul style="list-style-type: none"> Measures corridor subsidy per boarding, which indicates the amount of public funding necessary to “generate” one boarding (subsidy is the difference between total O&M costs and fare revenue). This metric can also serve as a proxy for productivity, farebox recovery (although normalized by boardings instead of at a corridor level), and general “return on investment”. 	Operating plan Capital plan
		3.1E	Incremental O&M cost per new boarding (corridor-level)	Quantitative	<ul style="list-style-type: none"> Measures the additional O&M costs required in the corridor to serve one new boarding above the O&M costs for ECR Local service. Thus, additional (or marginal) O&M costs are estimated by subtracting O&M costs for a given service concept by the ECR Local O&M costs. Higher incremental costs per boarding imply a less productive service. 	Operating plan Capital plan



TABLE 5-1: EVALUATION FRAMEWORK

Goal	Objective	Metric	Evaluation Criteria	Type of Metric	Explanation of Metric	Data Source
	3.2. Minimize ECR operating impacts	3.2A	Minimize operating demands for peak vehicles	Quantitative	<ul style="list-style-type: none"> Measures the number of vehicles required to provide peak service. The more peak vehicles required, the higher the chance that new vehicles must be procured and thus additional capital costs will be required. 	Operating plan
		3.2B	Reliability	Qualitative	<ul style="list-style-type: none"> Measures the expected reliability of the service based on the length of the corridor operated and the number of enhanced stops served. This serves as a proxy for on-time performance. Concepts with poorer reliability may require additional vehicles or corrective measures to ensure that schedules are being met. Note – travel demand models are generally unable to estimate reliability of travel times. 	Operating plan
4. Minimize corridor traffic and parking impacts while maximizing the benefits of Rapid and Full BRT services	4.1.Minimize traffic impacts	4.1A	Length of segments operating at LOS E or F	Quantitative	<ul style="list-style-type: none"> Measures the number of corridor segments in miles (both northbound and southbound) that operate at Level of Service (LOS) E or F during the AM & PM peak hours for each service concept. LOS can serve as a proxy of expected congestion on the corridor and thus reliability. 	C/CAG Bi-County Model
	4.2. Minimize physical changes to corridor infrastructure	4.2A	Net change in on-street parking	Quantitative	<ul style="list-style-type: none"> Measure intended to assess the loss of curbside parking and thus the relative impact on the business community from inconvenience and possible lost business. Not applicable for the near-term evaluation as no changes to on-street parking provision are proposed. 	Physical plan



TABLE 5-1: EVALUATION FRAMEWORK

Goal	Objective	Metric	Evaluation Criteria	Type of Metric	Explanation of Metric	Data Source
		4.2B	Extent of new turn restrictions	Qualitative	<ul style="list-style-type: none"> Measure intended to assess the implementation of new turn restrictions and thus the extent to which traffic is negatively impacted. Not applicable for the near-term evaluation as no changes to turning restrictions are proposed. 	Physical plan

^A Increase in ridership along key segments of the corridor is no longer part of the evaluation. Increases in corridor and system ridership are perceived as better overall metrics.

^B Increase in new riders is no longer part of the evaluation. This is already effectively measured by: (i) increase in corridor ridership; and (ii) increase in system ridership.

^C The qualitative assessment of pedestrian safety has been removed from the near-term analysis as detailed urban design treatments were not developed as part of the ECR Phasing Plan.

^D The volume of households and jobs accessible within a 15-minute walk from a stop/station has been combined into a single metric.

^E The qualitative analysis of convenient and direct pedestrian/bicycle access between stops/stations and adjacent land uses has been removed from the near-term analysis as detailed urban design and land use integration treatments were not developed as part of the ECR Phasing Plan.

^F Capital costs per route mile were added to provide another indicator of capital cost investment required.

^G O&M cost per RVH has been removed from the analysis, as operating costs are originally built on an assumed figure of \$210/RVH for an articulated, 60' bus.

^H Subsidy per boarding has been added to the analysis an indicator of how productivity and farebox recovery.



6.0 INITIAL SERVICE CONCEPTS AND SCREENING – PHASE 1

This section presents initial Rapid service concepts and screening of concepts for the initial Phase 1 evaluation. More information on the development of the initial service concepts and Phase 1 screening is contained in **Appendix D**.

6.1 PHASE 1 SERVICE CONCEPTS

As discussed, Rapid service would be the first phase of service improvements proposed as part of the El Camino Real BRT Phasing Plan. The project team developed an initial set of eight Rapid service concepts. These near-term service concepts define a potential operating plan for a Rapid service and the inter-relationship of Rapid service with current ECR and KX-398 services. With the exception of Concept 3 and 4, KX-398 service (which operates part of its route on El Camino Real) is assumed to operate with no changes. Details such as headways, spans of service, and specific stop locations were not defined at this stage. These concepts are listed below and described in **Table 6-1**:

- Concept 1 – Rapid + ECR Local/KX-398
- Concept 2 – Rapid + KX-398
- Concept 3 – Rapid + ECR Local
- Concept 4 – Rapid Only
- Concept 5 – “Split” Rapid + ECR Local/KX-398
- Concept 6 – “Overlap” Rapid + ECR Local/KX-398
- Concept 7 – “Truncated” Rapid + ECR Local/KX-398
- Concept 8 – “Hybrid Rapid” + ECR Local/KX-398



TABLE 6-1: INITIAL RAPID SERVICE CONCEPTS FOR THE ECR CORRIDOR

#	Concept	Description	Rapid Service	ECR Service	KX Service	Schematic Diagram (Concept Only) Purple = Rapid; Blue = ECR; Red = KX-398
1	Rapid + ECR / KX-398	<ul style="list-style-type: none"> Rapid service is introduced into the corridor (~ 0.5-1.0 mile stop spacing) ECR operates similar to today KX-398 operates per June 2014 runbook 	X	X	X	<p>Concept 1: Rapid / ECR / KX</p>
2	Rapid + KX-398	<ul style="list-style-type: none"> Rapid service is introduced into the corridor and absorbs ECR service Stop spacing of Rapid (~0.3-0.5 miles) is shorter than that of a "typical" Rapid service due to Rapid's role as "local" route KX-398 operates per June 2014 runbook 	X		X	<p>Concept 2: Rapid/KX</p>



TABLE 6-1: INITIAL RAPID SERVICE CONCEPTS FOR THE ECR CORRIDOR

#	Concept	Description	Rapid Service	ECR Service	KX Service	Schematic Diagram (Concept Only) Purple = Rapid; Blue = ECR; Red = KX-398
3	Rapid + ECR	<ul style="list-style-type: none"> Rapid service is introduced into the corridor (~0.5-1.0 mile stop spacing) ECR operates similar to today KX-398 is discontinued No direct service is provided to San Francisco International Airport (SFO) (riders must transfer to Bay Area Rapid Transit (BART) at Millbrae/San Bruno) 	X	X		<p>Concept 3: Rapid/ECR</p>
4	Rapid Only	<ul style="list-style-type: none"> Rapid service is introduced into corridor and absorbs ECR/KX-398 service Stop spacing (~0.3-0.5 mile stop spacing) is shorter than that for "typical" Rapid service due to Rapid's role as a "local" route No direct service is provided to SFO (riders must transfer to BART at Millbrae/San Bruno) 	X			<p>Concept 4: Rapid Only</p>



TABLE 6-1: INITIAL RAPID SERVICE CONCEPTS FOR THE ECR CORRIDOR

#	Concept	Description	Rapid Service	ECR Service	KX Service	Schematic Diagram (Concept Only) Purple = Rapid; Blue = ECR; Red = KX-398
5	Split Rapid + ECR / KX-398	<ul style="list-style-type: none"> Rapid service is introduced into corridor as two separate routes – possibly a northern Rapid and a southern Rapid Split routes are feasible if travel demand analysis shows strong internal demand within the north and south parts of corridor, respectively, with low end-to-end demand ECR operates similar to today KX-398 operates per June 2014 runbook 	X	X	X	<p>Concept 5: Split Rapid</p> <p>Green = Rapid North Purple = Rapid South</p>
6	Overlap Rapid + ECR / KX-398	<ul style="list-style-type: none"> Rapid service is introduced into corridor as two routes – possibly a northern Rapid and a southern Rapid – with overlapping service segments Overlapping split routes are feasible if travel analysis shows split in demand between north and south parts of corridor, respectively, with strong demand along a shared segment in the middle of the corridor and low end-to-end demand ECR operates similar to today KX-398 operates per June 2014 runbook 	X	X	X	<p>Concept 6: Overlap Rapid</p> <p>Green = Rapid North Purple = Rapid South</p>



TABLE 6-1: INITIAL RAPID SERVICE CONCEPTS FOR THE ECR CORRIDOR

#	Concept	Description	Rapid Service	ECR Service	KX Service	Schematic Diagram (Concept Only) Purple = Rapid; Blue = ECR; Red = KX-398
7	Truncated Rapid + KX-398	<ul style="list-style-type: none"> Rapid service is only introduced on a portion of the corridor (e.g., north/south half or two-thirds) Truncated Rapid is feasible if most origin-destination activity focused on one portion of the corridor compared to the other Truncated Rapid is also feasible if service is duplicated by BART or other regional transit service along a portion of the corridor ECR operates similar to today KX-398 operates per June 2014 runbook 	X	X	X	<p>Concept 7: Truncated Rapid</p>
8	Hybrid Rapid + ECR / KX-398	<ul style="list-style-type: none"> "Hybrid" Rapid service denotes <i>local</i> service (closely spaced stops) in high demand portions of the corridor and <i>limited-stop</i> service in low demand portions of the corridor. Hybrid Rapid is feasible if demand warrants additional stops in high demand area (beyond those served by other Rapid service concepts) Hybrid Rapid operates slower than other concepts except Concepts #2 and 4 ECR operates similar to today KX-398 operates per June 2014 runbook 	X	X	X	<p>Concept 8: Hybrid Rapid</p>



6.2 PHASE 1 SCREENING CRITERIA

The set of criteria (**Table 6-2**) used to screen the eight initial Rapid service concepts developed for this study is based off the detailed evaluation framework, but applied at a high level for purposes of moving favorable concepts into the detailed concept development and evaluation (Phase 2).

TABLE 6-2: PHASE 1 SCREENING CRITERIA FOR SERVICE CONCEPTS

Screening Criteria	Qualitative Assessment	Relationship to Project Goals & Objectives
Faster Service	<ul style="list-style-type: none"> Is service improved for existing users? Are new users attracted to the service? 	<ul style="list-style-type: none"> Goal 1 - Objectives 1.1/1.2
Ease of Use	<ul style="list-style-type: none"> Is the service easy to understand? Is a one-seat ride provided (without multiple transfers)? Is the service confusing (i.e., which destinations are served)? 	<ul style="list-style-type: none"> Goal 1 – Objective 1.2
Access to Transit	<ul style="list-style-type: none"> Is access for existing users maintained and/or improved? Is greater access provided for potential new riders and new destinations? 	<ul style="list-style-type: none"> Goal 2 – Objectives 2.2/2.3
Need for Additional SamTrans Resources	<ul style="list-style-type: none"> Are significantly more resources required than currently needed (e.g., vehicles, drivers, costs)? 	<ul style="list-style-type: none"> Goal 3 – Objective 3.2
Operating Efficiency	<ul style="list-style-type: none"> Is reliability and efficiency improved (i.e., on-time performance, less variable travel times, reduced travel time, etc.)? Does the concept allow for more flexibility in resource deployment to meet targeted demand (i.e., can resources be targeted at highest activity areas or markets with greatest potential)? Does the service accommodate interlining efficiencies? 	<ul style="list-style-type: none"> Goal 1 – Objective 1.2 Goal 3 – Objective 3.2



6.3 INITIAL SCREENING RECOMMENDATIONS

Each of the eight service concepts was assessed against the five initial screening criteria. **Figure 6-1** summarizes the results and provides insight into the performance of a given service plan against select criteria.

Figure 6-1: Summary of Service Plan Performance and Composite Scores

#	Service Concept	Initial Screening Criteria					Composite Score
		Faster Service	Ease of Use	Access to Transit	Need for Additional SamTrans Resources	Operating Efficiency	
		A	B	C	D	E	
1	Rapid + ECR/KX-398	■	■	■	□	■	12
2	Rapid + KX-398	■	□	□	■	□	8
3	Rapid + ECR	■	■	■	■	■	12
4	Rapid Only	■	□	□	■	□	8
5	Split Rapid + ECR/KX-398	■	□	■	■	■	11
6	Overlap Rapid + ECR/KX-398	■	□	■	■	■	11
7	Truncated Rapid + ECR/KX-398	■	■	■	■	■	13
8	Hybrid Rapid + ECR/KX-398	■	■	■	■	■	12

Scoring Scale: ■ □

 Highest Moderate Lowest

 Performing Performing Performing

 (3 Points) (2 Points) (1 Point)

Key findings from the initial screen are as follows. Full detail of the initial screen can be found in Table 3 of **Appendix D**.

- The Truncated Rapid service concept scored the highest with a composite score of 13 points. This option performs well in providing faster service, access to transit, and operating efficiency. This concept scored higher in operating efficiency than other service concepts in which the Rapid operates along the entire corridor, rather than along a portion of it.
- The Rapid/ECR/KX-398 and Rapid/ECR service concepts scored 12 points each, with high performance in faster service, ease of use, and access to transit. As noted, both these options operate the Rapid along the entire length of the corridor, thereby potentially subjecting the service to more variability and travel time delay.
- The Hybrid Rapid service concept scored 12 points, scoring well in ease of use, access to transit as well as moderate scores in faster transit service and operating efficiency. This service would provide limited stops in low demand areas, but operate local service in high demand areas. It may require a moderate increase in resources depending on the service headway selected.



- The Split and Overlap Rapid service concepts scored 11 points each. From operational and access to transit perspectives, these concepts scored highly as they would provide more operating flexibility and improve reliability with shorter Rapid routes. However, these concepts impose a mid-corridor transfer, thus longer-distance trips from the north portion of the corridor to the south would require a transfer. If delayed or improperly coordinated, this transfer could impose a significant time penalty as well as being inconvenient and confusing.
- The Rapid/KX-398 and Rapid Only service concepts scored the lowest at 8 points each. While each of these concepts performs well in reducing the need for additional SamTrans resources, they perform poorly in terms of maintaining access for current passengers as the ECR would be absorbed into the Rapid and some current ECR stops would be eliminated.

Based on the findings of the initial screening process, **Table 6-3** shows which concepts were carried forward to the detailed evaluation in Phase 2.

TABLE 6-3: RECOMMENDED SERVICE CONCEPTS FOR DETAILED PLANNING/ANALYSIS

#	Service Concept	Carry Forward for Detailed Analysis	Notes
1	Rapid + ECR Local / KX-398	YES	<ul style="list-style-type: none"> • Carry forward.
2	Rapid + KX-398	NO	<ul style="list-style-type: none"> • Do not carry forward, as elimination of the ECR Local would require the Rapid to stop much more frequently, but also eliminates many local bus stops currently in use by ECR riders.
3	Rapid + ECR Local	YES	<ul style="list-style-type: none"> • Carry forward but as Concept 1. • Further analysis of KX-398 service would be needed at a later phase/study
4	Rapid Only	NO	<ul style="list-style-type: none"> • Do not carry forward, as elimination of the ECR would require the Rapid to stop much more frequently, but also eliminates many local bus stops currently in use by ECR riders.
5	Split Rapid + ECR Local / KX-398	NO	<ul style="list-style-type: none"> • Do not carry forward, as concept requires passengers to transfer if they are traveling between the north and south halves of the corridor – imposing a time penalty and inconvenience to the riders.
6	Overlap Rapid + ECR Local / KX-398	NO	
7	Truncated Rapid + ECR Local / KX-398	YES	<ul style="list-style-type: none"> • Carry forward.
8	Hybrid Rapid + ECR Local / KX-398	YES	<ul style="list-style-type: none"> • Carry forward.



The initial screen included SamTrans KX-398 service as a variable in the service concept development process. Based on the limited number of daily runs (in terms of operating cost savings if discontinued) and partial operation on El Camino (in terms of travel markets served) it was determined that subsequent phases of the study would assume KX-398 service in parallel with all proposed service concepts.



7.0 RAPID BUS & BRT ALTERNATIVES DEVELOPMENT – PHASE 2

This section presents details on the Rapid and Bus Rapid Transit (BRT) service concepts developed as part of the Phase 2 evaluation.

7.1 PHASE 2 SERVICE CONCEPT FAMILIES

The Phase 1 screening process presented and evaluated eight service concepts for potential Rapid service and its relationship to the existing ECR and KX/398 service.¹⁰ Four “families” of service concepts were recommended for detailed analysis (Phase 2) using the City/County Association of Governments of San Mateo County (C/CAG) Bi-County Travel Demand Model: three Rapid service concept families for near-term introduction and one BRT service concept family for long-term introduction.

For the near-term Rapid and long-term BRT, years 2020 and 2040 were chosen as horizon years for modeling purposes. Each phase would occur when on-going monitoring of financial, ridership, and growth conditions by SamTrans warrant service enhancements to ECR service.

Phase 2 service concepts are as follows:

- **Rapid Concepts** – This concept calls for Rapid service along the entire Corridor with the same termini as existing Route ECR (Palo Alto in the south and Daly City in the north). This service concept family includes a “Full Rapid”, which would operate all day along the entire corridor and “Peak Rapid” concept, which would operate along the entire corridor but just during peak periods. Under these concepts, Rapid service would be overlaid on top of existing ECR Local service.
- **Truncated Rapid Concepts** - This concept calls for Rapid service that is truncated within the Corridor and excludes areas of lower ridership demand. This service concept family includes a “Redwood City to Daly City Truncated Rapid” and “Redwood City to San Bruno Truncated Rapid” concept. Under these concepts, Rapid service would be overlaid on top of existing ECR Local service. Analysis of stop-level ridership data found that some segments of the corridor experienced low ridership – particularly in the very north of the corridor (for instance through Colma) and in the south of the corridor (between Redwood City and Palo Alto). These concepts assessed the benefits of “truncating” the corridor to minimize operations in these lower ridership segments.

¹⁰ For the Phase 2 analysis it was assumed that existing KX-398 service was fixed and no changes would be made.



- **Hybrid Rapid Concepts** - This concept calls for Rapid service that is a hybrid of a typical Rapid service and Local service, with fewer stops than ECR Local but more stops than ECR Rapid. This service concept family includes a "Hybrid Rapid A" and "Hybrid Rapid B" concept. Under these concepts, there would be no overlay – ECR Local would be replaced by Hybrid Rapid. The Hybrid Rapid A concept would provide local coverage in the higher demand segments (between Redwood City and San Bruno) and limited stop service (same pattern as Rapid) at either end of the Corridor. The Hybrid Rapid B concept follows a limited stop pattern throughout the Corridor, but with more stops than Rapid due to no ECR Local overlay.
- **BRT Concept** - This concept calls for BRT service along the entire Corridor with the same termini as existing Route ECR (Palo Alto in the south and Daly City in the north). This long term alternative would use the same service structure as the "Full Rapid" concept with additional transit preferential treatments such as transit-only lanes.

The detailed Rapid/BRT alternatives development process included defining stations, routing, headways, service spans, and resource impacts (in terms of revenue hours, miles, and vehicles) for these "families" of concepts. Concept definitions for the Phase 2 evaluation are shown in **Table 7-1**.

More information on the development of the service concepts moved forward to the Phase 2 evaluation can be found in **Appendix E**.



TABLE 7-1: RAPID/BRT ALTERNATIVES CARRIED FORWARD FOR DETAILED EVALUATION

#	Horizon Year for Modeling	Service Concept	Rapid/BRT Stops	Description of Service Tier(s)	Rationale
1	2020	Baseline	-	<ul style="list-style-type: none"> ECR (providing 15-minute headways, stopping at existing 102 northbound (NB) and 104 southbound (SB) stops) 	<ul style="list-style-type: none"> ECR operates existing schedule and serves current stop pattern
2	2020	Full Rapid	37	<ul style="list-style-type: none"> Rapid (providing 15-minute headways, stopping at 37 stops in each direction from Daly City to Palo Alto) ECR (providing 15-minute headways, stopping at existing 102 NB and 104 SB stops) 	<ul style="list-style-type: none"> Rapid service is introduced, providing faster service, making less frequent stops ECR operates existing schedule and serves the current stop pattern
3	2020	Truncated Rapid (Daly City-Redwood City)	32	<ul style="list-style-type: none"> Rapid (providing 15-minute headways, stopping at 32 stops in each direction between Daly City and Redwood City) ECR (providing 15-minute headways, stopping at existing 102 NB and 104 SB stops) 	<ul style="list-style-type: none"> Rapid service is introduced, providing faster service, making less frequent stops; no service is provided south of Redwood City (representing a low demand segment) ECR operates existing schedule and serves the current stop pattern
4	2020	Truncated Rapid (San Bruno-Redwood City)	23	<ul style="list-style-type: none"> Rapid (providing 15-minute headways, stopping at 23 stops in each direction between San Bruno and Redwood City) ECR (providing 15-minute headways, stopping at existing 102 NB and 104 SB stops) 	<ul style="list-style-type: none"> Rapid service is introduced, providing faster service, making less frequent stops; no service is provided north of San Bruno and south of Redwood City (representing lower demand segments) ECR operates existing schedule and serves the current stop pattern
5	2020	Hybrid A - 12 min	76	<ul style="list-style-type: none"> Hybrid Rapid (providing 12-minute service and stopping at 76 stops between Daly City and Palo Alto) 	<ul style="list-style-type: none"> Hybrid service will provide faster service than ECR, but provide more local access than the Rapid in higher demand segments (thus 76 stops versus 37) ECR service is discontinued



TABLE 7-1: RAPID/BRT ALTERNATIVES CARRIED FORWARD FOR DETAILED EVALUATION

#	Horizon Year for Modeling	Service Concept	Rapid/BRT Stops	Description of Service Tier(s)	Rationale
6	2020	Hybrid B - 12 min	50	<ul style="list-style-type: none"> Hybrid Rapid (providing 12-minute service and stopping at 50 stops between Daly City and Palo Alto) 	<ul style="list-style-type: none"> Hybrid service will provide faster service than ECR, but provide more local access than the Rapid in higher demand segments Similar to Hybrid A, except fewer stops are served (50 stops versus 76) (eliminates mid-Corridor low ridership stops) to increase travel speeds ECR service is discontinued
7	2020	Peak Rapid	37	<ul style="list-style-type: none"> Rapid (providing peak 15-minute headways, stopping at 37 stops in each direction from Daly City to Palo Alto) ECR (providing 15-minute headways, stopping at existing 102 NB and 104 SB stops) 	<ul style="list-style-type: none"> Rapid service is introduced in the peak only (lower operating cost than Concept #2), providing faster service, making less frequent stops ECR operates existing schedule and serves the current stop pattern
8	2020	Hybrid A - 10 min	76	<ul style="list-style-type: none"> Hybrid Rapid (providing 10-minute service and stopping at 76 stops between Daly City and Palo Alto) 	<ul style="list-style-type: none"> Hybrid service will provide faster service than ECR, but provide more local access than the Rapid in higher demand segments Similar to Hybrid A (Concept #5), except operates at 10-minute headways to assess ridership sensitivity to service frequency ECR service is discontinued
9	2020	Hybrid B - 7.5 min	50	<ul style="list-style-type: none"> Hybrid Rapid (providing 7.5-minute service and stopping at 50 stops between Daly City and Palo Alto) 	<ul style="list-style-type: none"> Hybrid service will provide faster service than ECR, but provide more local access than the Rapid in higher demand segments Similar to Hybrid B (Concept #6), except operates at 7.5-minute headways to assess ridership sensitivity to service frequency ECR service is discontinued



TABLE 7-1: RAPID/BRT ALTERNATIVES CARRIED FORWARD FOR DETAILED EVALUATION

#	Horizon Year for Modeling	Service Concept	Rapid/BRT Stops	Description of Service Tier(s)	Rationale
10	2040	Full BRT	37	<ul style="list-style-type: none"> BRT (providing 15-minute headways, stopping at 37 enhanced stations in each direction from Daly City to Palo Alto) ECR (providing 15-minute headways, stopping at existing 102 NB and 104 SB stops) 	<ul style="list-style-type: none"> BRT service is introduced, providing faster service via dedicated transit lanes on some corridor segments and serving enhanced BRT stations ECR operates existing schedule and serves the current stop pattern



7.2 RAPID STOP SELECTION PROCESS – FULL, PEAK, TRUNCATED

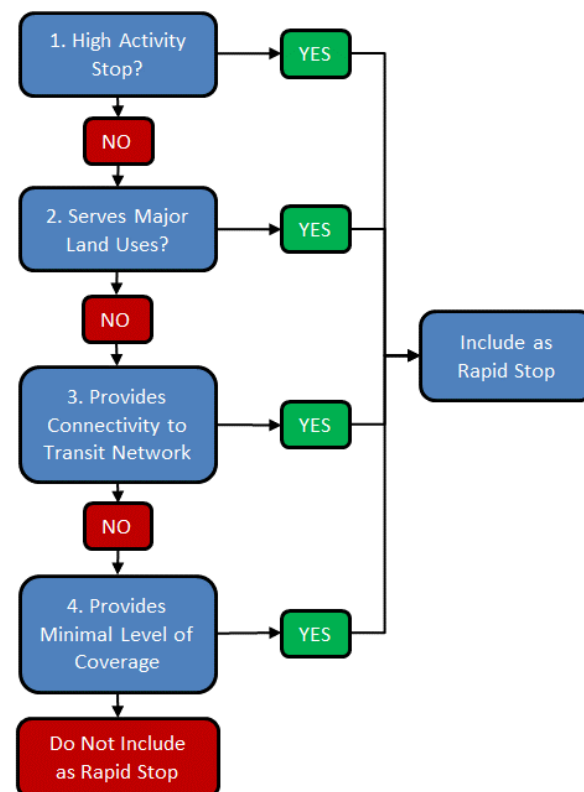
Along the 26-mile Corridor (Daly City Bay Area Rapid Transit (BART) Station to the Palo Alto Transit Center), the ECR stops on average every quarter mile (0.25 miles) in both directions. This average stop spacing is wider than the typical local route with a stop spacing of 0.125-0.25 miles.¹¹ Rapid service, as defined earlier in this study, typically has longer stop spacing than local service to increase travel speeds and reduce the number of times the vehicle stops, concentrating service at high activity nodes and major transit connection points.

A four-stage selection process was used to identify stops for proposed Full, Peak, and Truncated Rapid service along El Camino Real as depicted in **Figure 7-1** and as described below:

- **Stage 1: Experiences High On/Off Activity** – Rapid service should serve

the most heavily used stops along the corridor. A threshold of 125 combined daily ons/offers was used to identify high activity stops along El Camino Real.¹² The inventory shows that 29 SB and 33 NB stops meet this minimum threshold. If all of these stations were recommended for Rapid service, stop spacing would be roughly equivalent to a spacing of 0.70-0.80 miles - this aligns with Santa Clara Valley Transportation Authority (VTA)'s service design guidelines for BRT 1 (which is VTA's version of Rapid service) of 0.50-1.25 miles.¹³ The proposed activity threshold of 125 daily ons/offers provides a balance between serving high demand locations and providing reasonable corridor station spacing and coverage. A higher threshold would have resulted in fewer stops, and possibly lower ridership.

Figure 7-1: Stop Selection Process



¹¹ See Santa Clara Valley Transportation Authority (VTA) Service Design Guidelines, 2007.

¹² The initial stop selection along El Camino Real was based on the combined 390/391 ridership, using a daily on/off activity threshold of 150. As ECR ridership was about 20% lower than that of the combined 390/391 service, the Rapid activity threshold was lowered to 125 daily ons/offers.

¹³ See Santa Clara Valley Transportation Authority (VTA) Service Design Guidelines, 2007.



- **Stage 2: Serves Major Land Uses** – Stops not identified as high activity (i.e., with fewer than 125 daily ons/offers), were recommended for Rapid service if they also served a major land use (for instance a downtown shopping district, major retail, school, hospital, or civic institutions).
- **Stage 3: Provides Connections to Regional and Local Transit Network** – Stops not already identified in Stages 1 or 2 were recommended for Rapid service if they provided connections to the regional transit network (i.e., Caltrain and BART stations) and major local transit services (i.e., SamTrans local bus).
- **Stage 4: Provides Minimal Coverage/Access where Significant Gaps Exist between Consecutive Stations** – The resulting stop network recommended from Stages 1, 2 and 3 resulted in significant gaps in service (in terms of distance between stops) along some corridor segments. For instance to maintain minimal coverage and access for potential transit patrons, additional intermediate stops were recommended where spacing between consecutive stops exceeded 1.5-2.0 miles. In these cases, stops were recommended at intermediate locations with the most transit-supportive conditions to provide minimal coverage of 1.0-1.25 miles between stops. The stretch of the corridor between Colma BART and South San Francisco BART was one noticeable exception to this approach, since this stretch passes several cemeteries with no transit supportive land use to justify a minimal coverage stop (approximately 2.0 miles between stops).

Based on this assessment and stop selection process:

- Rapid and Peak Rapid service concepts would serve 37 stops in each direction;
- Truncated Rapid (Daly City-Redwood City) would serve 32 stops in each direction; and
- Truncated Rapid (San Bruno-Redwood City) would serve 23 stops in each direction.

A full list of Rapid concept stops can be found in **Appendix E**.

7.3 RAPID STOP SELECTION PROCESS – HYBRID

As part of the alternatives development process for the detailed Phase 2 evaluation, two stop pattern variants of the Hybrid Rapid concept were proposed for modeling and evaluation: Hybrid A and Hybrid B. **Appendix E** details the stops proposed for the two Hybrid Rapid concepts (A & B) and describes the full methodology used for the stop selection process.

7.3.1 HYBRID RAPID A

For Hybrid Rapid Concept A, 76 stops were included:

- All 37 stops served by the Full Rapid would also be served by the Hybrid Rapid.



- An additional 39 stops would be served in the “high demand” segment between Brentwood Drive (just north of San Bruno BART) to Center Street (south of Redwood City Caltrain). All ECR stops within this segment would be served by the Hybrid Rapid. It is noted that these 39 additional stops have varying levels of demand (ranging from moderate to low), provide access to civic facilities and institutional uses, and provide minimal coverage.

Combined, the 76 Hybrid Rapid Concept A stops over the length of the corridor equates to a stop every 0.33 miles, which is nearly half of the average stop spacing of the Full Rapid service (with 37 stops, equating to a stop every 0.69 miles).¹⁴ The Hybrid Rapid Concept A would have a stop spacing that is 50% longer than that of the existing ECR (with 102 stops, equating to a stop spacing of 0.25 miles).

7.3.2 HYBRID RAPID B

The 39 additional stops included in the Hybrid Rapid Concept A within the “high demand” segments have varying levels of ridership demand, ranging from moderate to low. Reducing low productivity stops could improve travel time.

Thus, to improve operating speed and reduce travel time for the Hybrid Rapid option, a second concept (Hybrid Rapid Concept B) was proposed with fewer stops in the “high demand” segment between Brentwood Drive and Center Street between the cities of South San Francisco and Redwood City. Based on an analysis of existing on-off activity from the ECR (from October and November 2013), approximately half of all 102 stops served by the current ECR generates an average of at least 75 combined daily ons/offs.

Assuming that all 37 Rapid stops would continue to be served, applying a threshold of 75 combined daily ons/offs within the “high demand” segment between Brentwood Drive and Center Street decreased the number of stops served under the Hybrid Rapid Concept A scenario by 26 stops to include a total of 50 stops served by this concept. This would equate to a stop spacing of 0.51 miles/stop compared to 0.25 miles/stop for the existing ECR and 0.69 miles/stop for the proposed Full Rapid, respectively.

7.4 RAPID CONCEPT STOPS AND ROUTING

Figure 7-2 through **Figure 7-6** detail the proposed Rapid stops for each service concept:

- **Figure 7-2** – Full Rapid and Peak Rapid (also BRT)

¹⁴ For the Full Rapid, ECR Local would still operate. In total, the combined stop spacing of both Rapid and ECR Local would be the same as today’s ECR Local.



- **Figure 7-3** – Truncated Rapid (Redwood City to Daly City)
- **Figure 7-4** – Truncated Rapid (Redwood City to San Bruno)
- **Figure 7-5** – Hybrid Rapid A
- **Figure 7-6** – Hybrid Rapid B



Figure 7-2: Proposed Stops - Full Rapid and Peak Rapid (also Applicable to BRT Concept)

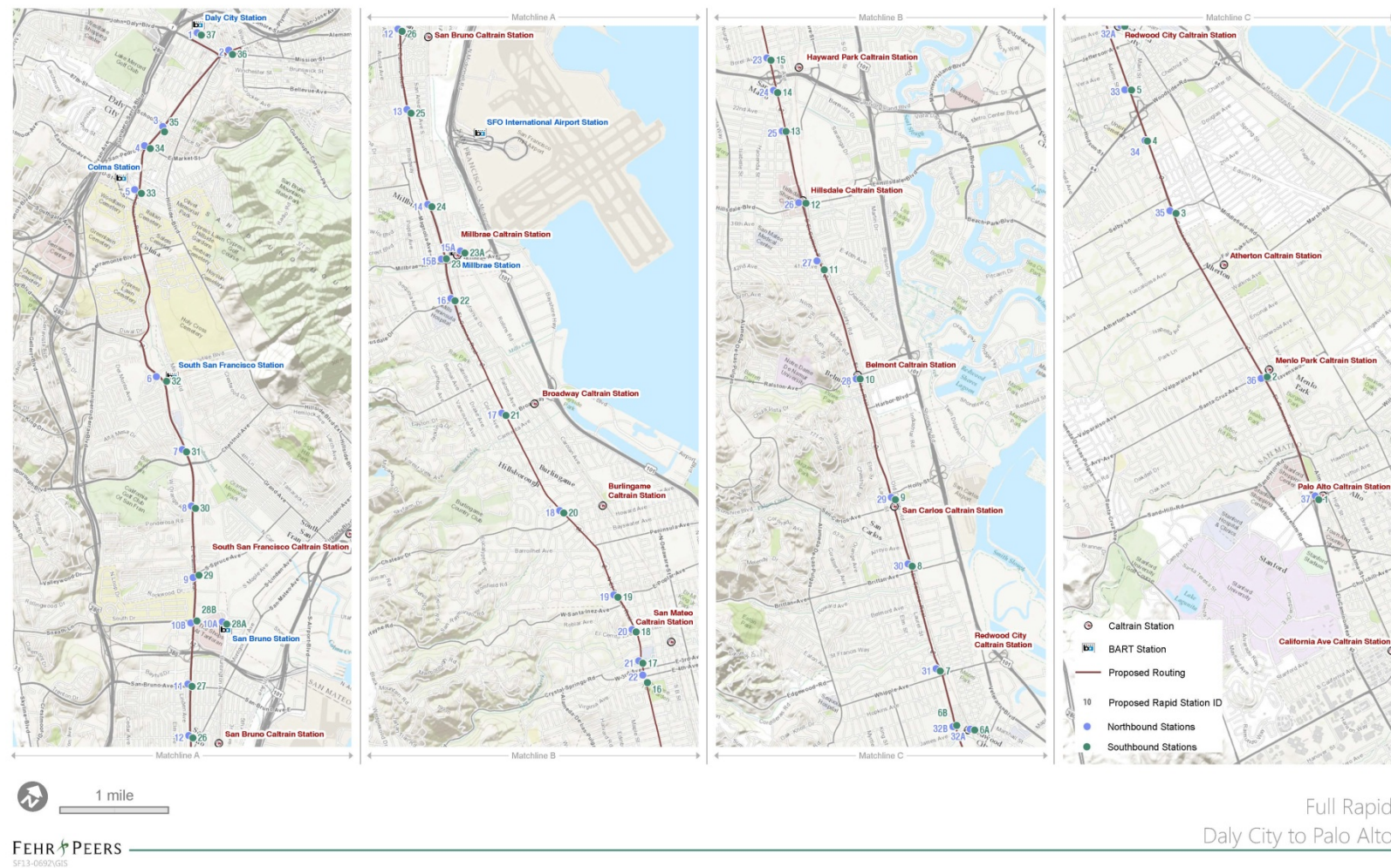


Figure 7-3: Proposed Stops - Truncated Rapid (Redwood City to Daly City)

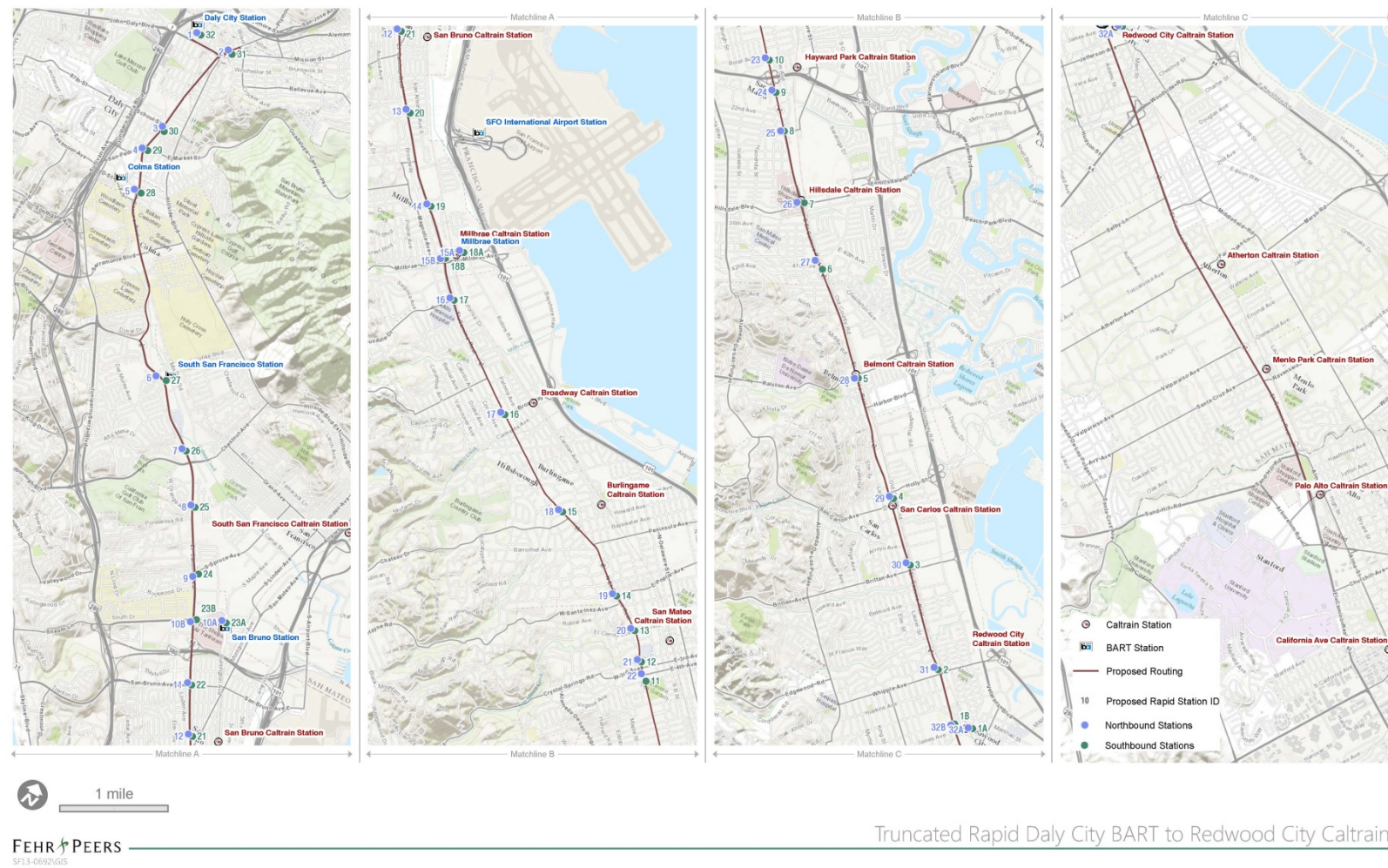
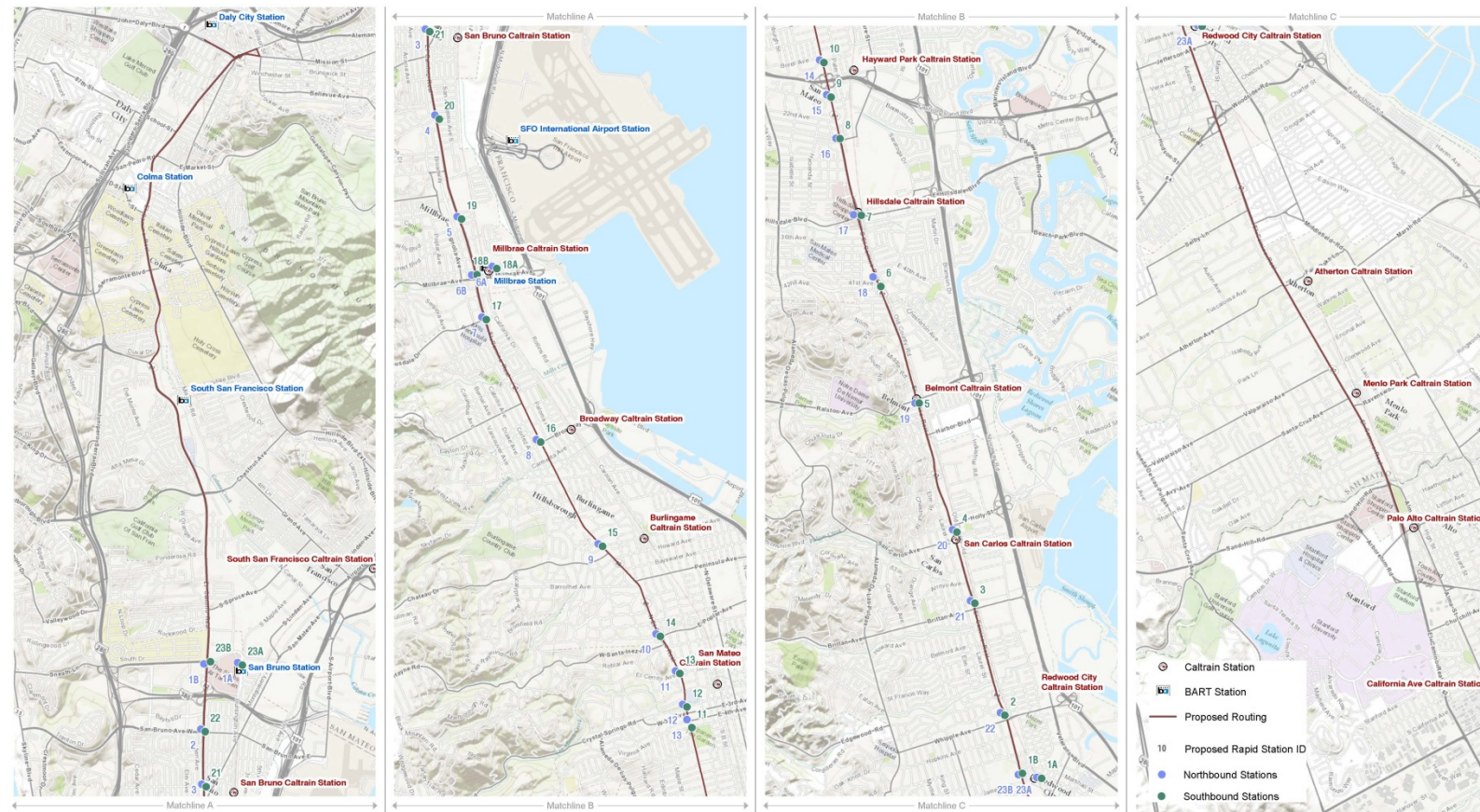


Figure 7-4: Proposed Stops - Truncated Rapid (Redwood City to San Bruno)



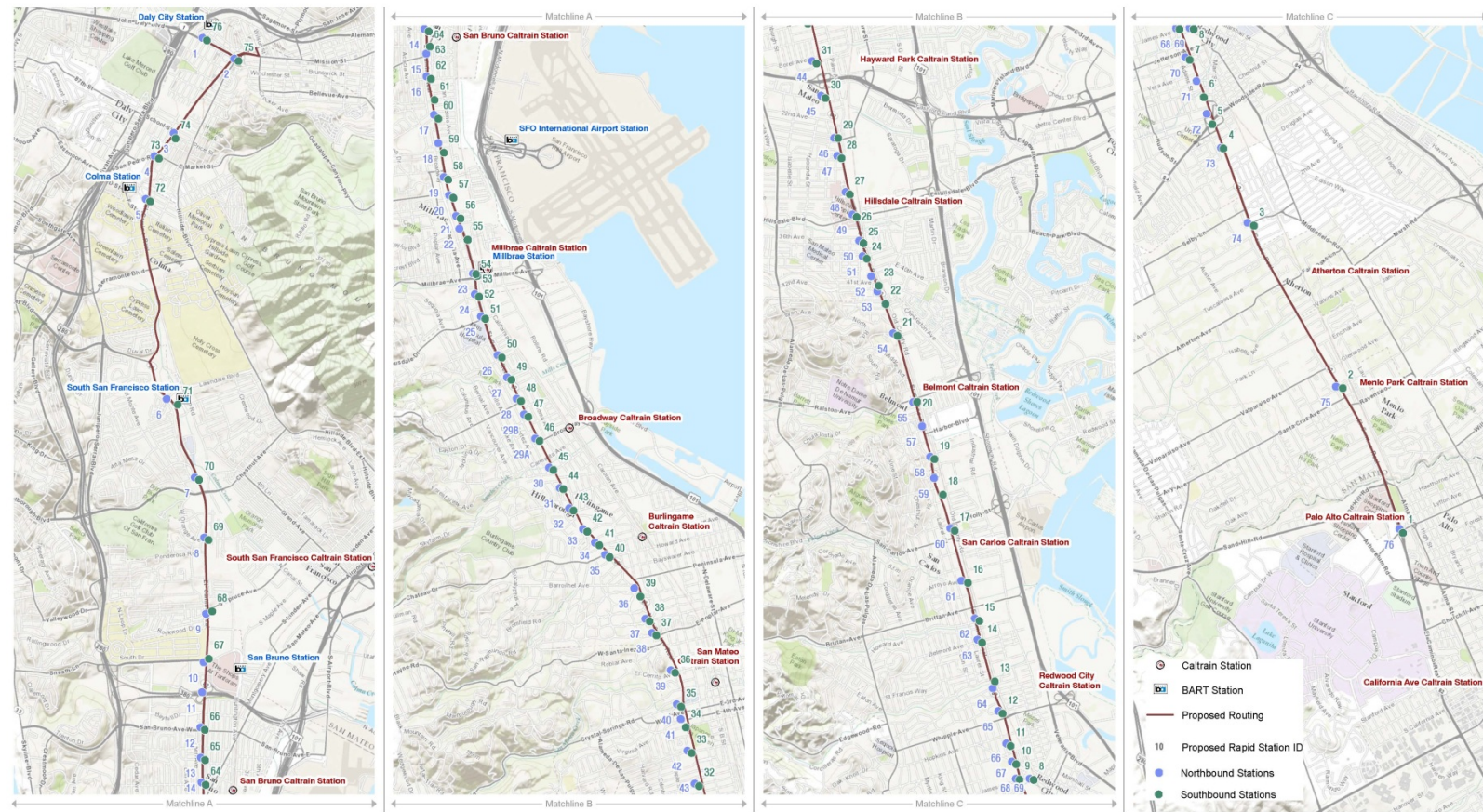
1 mile

FEHR PEERS
SF13-0692/GIS

Truncated Rapid San Bruno BART to Redwood City Caltrain

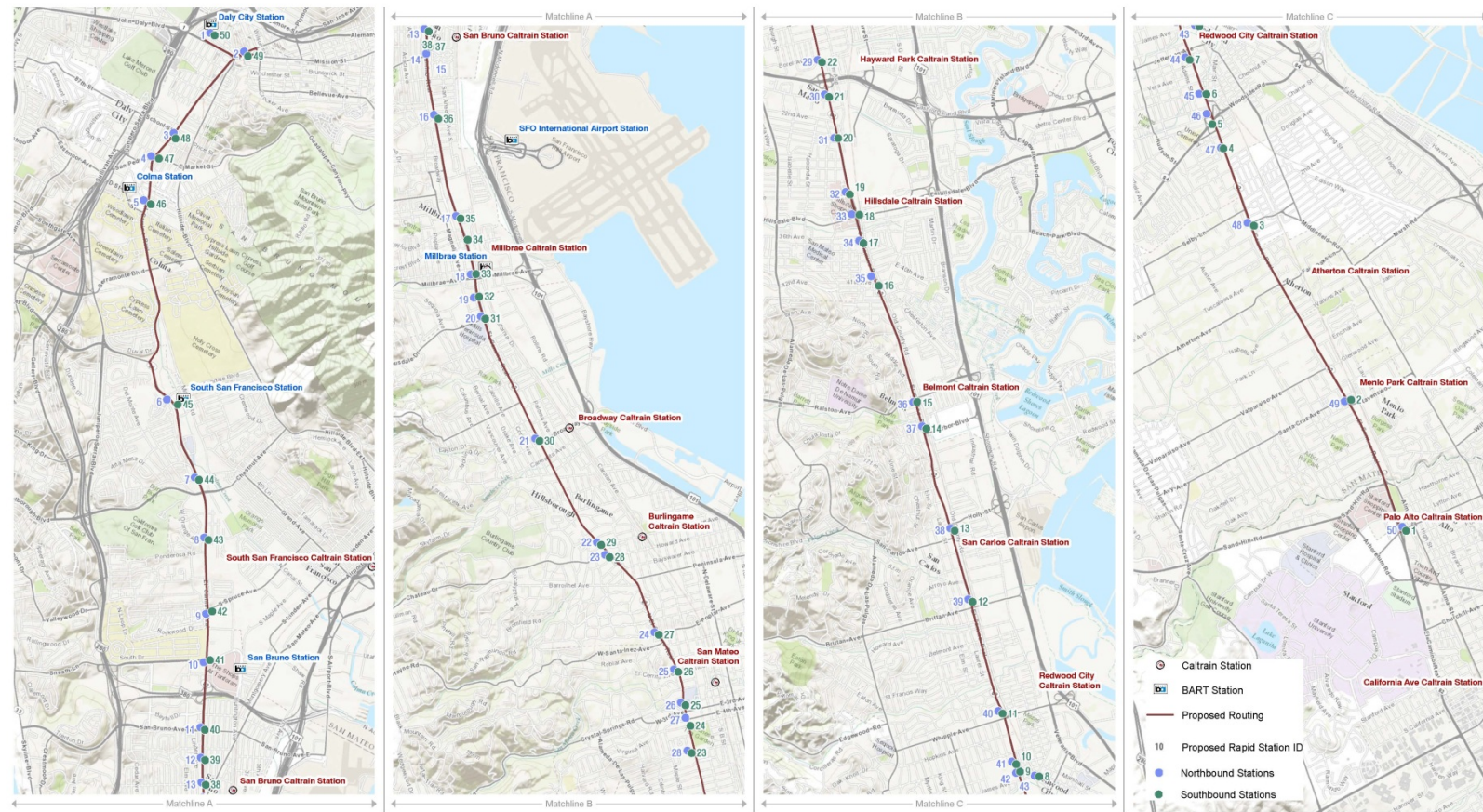


Figure 7-5: Proposed Stops - Hybrid Rapid A



Hybrid Rapid A
Daly City to Palo Alto

Figure 7-6: Proposed Stops - Hybrid Rapid B



Hybrid Rapid B
Daly City to Palo Alto



8.0 SERVICE CONCEPT MODELING

This section describes the ridership modeling process and key outputs of the modeling effort. For the near-term Rapid and long-term Bus Rapid Transit (BRT), years 2020 and 2040 were chosen as horizon years for modeling purposes. Each phase would occur when ongoing monitoring of financial, ridership, and growth conditions by SamTrans warrant the service enhancements to ECR service.

8.1 C/CAG BI-COUNTY TRAVEL DEMAND MODEL

The City/County Association of Governments of San Mateo (C/CAG) Bi-County Travel Demand Model was used to assess the performance of the service concepts. The Santa Clara Valley Transportation Authority (VTA) ran the model based on operating parameter inputs provided to the agency via the project team. Inputs used in the modeling process included frequency, service span, stops, and transit preferential treatments. The only transit preferential treatments included for Rapid modeling were signal priority (using VTA Rapid assumptions and empirical data for travel time savings input) and low floor vehicles (which decrease dwell time). Additional transit preferential treatments, such as bus-only lanes, queue jumps, off-board fare payment, enhanced stations, and bus bulbs were included in the Full BRT scenario.

The following outputs were made available through the modeling effort:

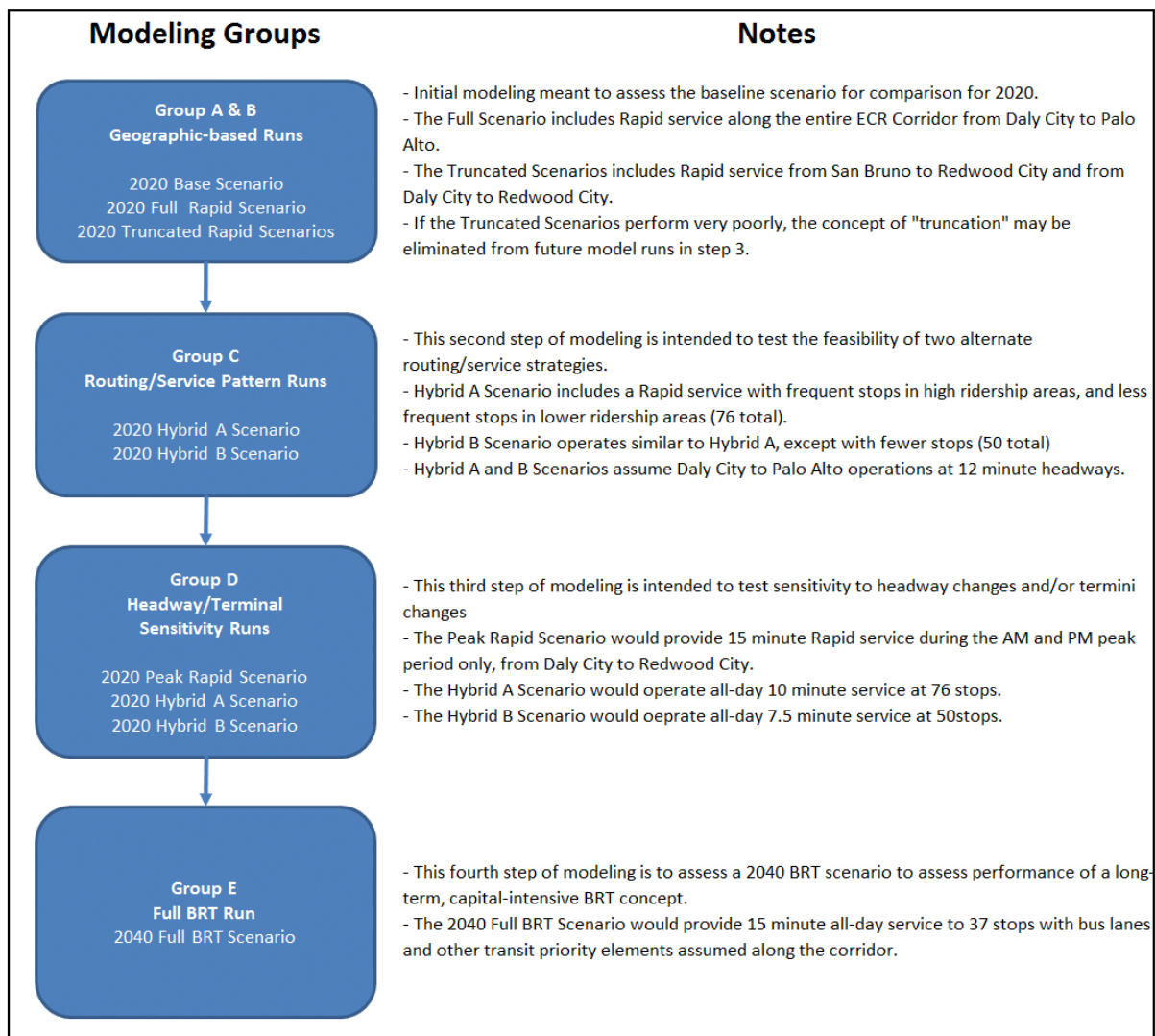
- Boardings – daily average weekday; peak period; off peak;
- Trip purpose;
- Segment-level and end-to-end travel times;
- Passenger load (i.e., maximum load);
- Segment-level and end-to-end average operating speeds; and
- Link-level Level of Service (LOS) using a volume to capacity (VC) ratio.

8.2 MODELING PROCESS

Figure 8-1 details the modeling process for the various service concept families.



Figure 8-1: Modeling Process



9.0 OPERATING PLAN DEVELOPMENT

This section presents various inputs to the operating plans for each service concept, identified for detailed analysis in Phase 2. The operating plan defines how SamTrans would provide revenue service for a given service concept. Overall, operating plans were developed for 10 service concepts, specifying operating details such as headway (or frequency), span of service, day of service, as well as peak vehicle requirements and cost productivity measures.

A detailed description of the operating plan development can be found in **Appendix F**.

9.1 DEFINITION OF OPERATING PLAN

The operating plan defines several key service parameters:

- **WHAT** - What services would be provided (i.e., Rapid and ECR, Rapid only, Hybrid, etc.);
- **HOW** - How often services would be provided (in terms of operating headway – for instance 15-minute peak service and 30-minute mid-day service);
- **WHEN** - When service would be provided (in terms of service span and operating days – for instance 8:00AM-11:00PM on Mondays-Fridays); and
- **WHERE** - Where service would be provided (in terms of route alignment and proposed stops).

Based on these “inputs”, resource requirements can be calculated, including cost and productivity metrics that are included in the evaluation framework, including:

- **Revenue Vehicle Hours (RVH)** – The number of hours that a vehicle is deployed in revenue hour service in which passengers may board and alight the vehicle.
- **Operating and Maintenance (O&M) Cost** – This represents the total cost to operate a given service. This is calculated by multiplying RVH by the average hourly operating cost per RVH (in this case it is assumed to be \$210.00/RVH as per SamTrans staff and as used in the Fiscal Year 2014 National Transit Database).
- **Vehicle Requirements** – The number of vehicles required is a product of the proposed service frequency and the round trip cycle time (assuming time for layover). Vehicle requirements during the peak (i.e., the peak vehicle requirements) dictate the maximum number of vehicles that must be assigned to a given service (and the number of drivers required), the ultimate system fleet size, as well as the size of storage yards.



9.2 OPERATING PLAN PARAMETERS

Several key assumptions underpin the development of the operation plan and estimation of various metrics such as RVH and peak vehicle requirements as shown below. These assumptions apply to all operating scenarios and service concepts, shown in **Table 9-1**.

TABLE 9-1: KEY ASSUMPTIONS FOR OPERATING PLAN DEVELOPMENT

#	Metric	Assumption	Description
1	Operating Speed (miles per hour (mph))	<ul style="list-style-type: none"> 2020 Horizon Year <ul style="list-style-type: none"> Local: 11.0 mph Rapid (Full, Peak and Truncated (San Bruno-Redwood City)): 14.21 mph Rapid (Truncated (Daly City-Redwood City)): 13.97 mph Hybrid (76 stop): 11.93 mph Hybrid (50 stop): 12.95 mph 2040 Horizon Year <ul style="list-style-type: none"> Local: 10.93 mph BRT: 18.03 mph 	<ul style="list-style-type: none"> Operating speeds are based on Santa Clara Valley Transportation Authority (VTA) 2020 and 2040 ECR model runs (from 2014). Operating speeds and the round trip length are used to estimate the round trip cycle times and thus estimate the vehicle requirements.
2	Layover Time	<ul style="list-style-type: none"> Assumed to be 15% of round trip travel time 	<ul style="list-style-type: none"> Layover time is the amount of time between when the bus arrives at end of one the trip and the start of the return trip. This percentage is based on industry practice.
3	Vehicle Type	<ul style="list-style-type: none"> All vehicles are assumed to be 60' articulated vehicles 	<ul style="list-style-type: none"> SamTrans operates mostly 60' vehicles on ECR today.
4	O&M Cost per Revenue Hour	<ul style="list-style-type: none"> \$210/RVH for 60' articulated vehicles 	<ul style="list-style-type: none"> The average cost per revenue hour is multiplied by the total RVH to estimate O&M costs. This figure is provided by SamTrans.
5	Equivalent # of Weekdays per Year	<ul style="list-style-type: none"> 300 weekdays/year 	<ul style="list-style-type: none"> This assumption is used to annualize weekday performance over the year.



9.3 ROUTE PARAMETERS

The total corridor travel time depends on the alignment and route length. The ECR currently operates between Daly City Bay Area Rapid Transit (BART) and Palo Alto Caltrain. Some proposed service concepts differ slightly from this routing, as shown in **Table 9-2**.

TABLE 9-2: ROUTE LENGTH BY SERVICE CONCEPT

#	Service Concept	Service Tier(s)	Route Length (Miles)
1	2020 Baseline	ECR	25.66
2	2020 Full Rapid	Rapid	25.66
		ECR	25.66
3	2020 Truncated Rapid (Daly City –Redwood City)	Rapid	20.81
		ECR	25.66
4	2020 Truncated Rapid (San Bruno-Redwood City)	Rapid	14.86
		ECR	25.66
5	2020 Hybrid A (76 Stops / 12 Minutes)	Hybrid	25.66
6	2020 Hybrid B (50 Stops / 12 Minutes)	Hybrid	25.66
7	2020 Peak Rapid	Rapid	25.66
		ECR	25.66
8	2020 Hybrid A (76 Stops / 10 Minutes)	Hybrid	25.66
9	2020 Hybrid B (50 Stops / 7.5 Minutes)	Hybrid	25.66
10	2040 BRT	BRT	25.66
		ECR	25.66

9.4 HEADWAY AND SPAN OF SERVICE PARAMETERS

Headway represents the duration between consecutive transit vehicle arrivals. Vehicles operate at different headways throughout the day, more frequently in the peaks and less frequently in the mid-day and shoulder periods. Operating headways and span of service under different service concepts are defined below in **Table 9-3**.



**TABLE 9-3: WEEKDAY SERVICE SPAN & OPERATING HEADWAY BY TIME PERIOD
BY SERVICE CONCEPT (MINUTES)**

#	Service Concept	Service Tier(s)	Span of Service	Early AM (4-7AM)	AM Peak (7-10AM)	Mid-Day (10-4PM)	PM Peak (4-7PM)	Late PM (7-11PM)	Owl (11PM-4AM)
1	2020 Baseline	ECR	4 AM – 1 AM	15	15	15	15	30	30
2	2020 Full Rapid	Rapid	6 AM – 8 PM	15	15	15	15	15	-
		ECR	4 AM – 1 AM	15	15	15	15	30	30
3	2020 Truncated Rapid (Daly City-Redwood City)	Rapid	6 AM – 8 PM	15	15	15	15	15	-
		ECR	4 AM – 1 AM	15	15	15	15	30	30
4	2020 Truncated Rapid (San Bruno-Redwood City)	Rapid	6 AM – 8 PM	15	15	15	15	15	-
		ECR	4 AM – 1 AM	15	15	15	15	30	30
5	2020 Hybrid A (76 stops / 12 minutes)	Hybrid	4 AM – 1 AM	15	12	12	12	15	30
6	2020 Hybrid B (50 stops / 12 minutes)	Hybrid	4 AM – 1 AM	15	12	12	12	15	30
7	2020 Peak Rapid	Rapid	6 AM – 8 PM	15	15	-	15	15	-
		ECR	4 AM – 1 AM	15	15	15	15	30	30
8	2020 Hybrid A (76 stops / 10 minutes)	Hybrid	4 AM – 1 AM	15	10	10	10	15	30
9	2020 Hybrid B (50 stops / 7.5 minutes)	Hybrid	4 AM – 1 AM	15	7.5	7.5	7.5	15	30
10	2040 BRT	BRT	6 AM – 8 PM	-	15	15	15	-	-
		ECR	4 AM – 1 AM	15	15	15	15	30	30



9.5 REVENUE VEHICLE HOURS

RVH are an important metric in estimating the total resources that an operator must provide, as well as in determining overall operating costs (when multiplied by the average cost per RVH). RVH is calculated by multiplying overall round trip time per trip (thus round trip distance divided by the average operating speed) by the total number of daily trips (multiply number of trips by hours by span of service). **Table 9-4** presents the total RVH by service concept and tier.

TABLE 9-4: ESTIMATED DAILY REVENUE VEHICLE HOURS (RVH) BY SERVICE CONCEPT

#	Service Concept	Service Tier(s)	Rapid	Hybrid	ECR	BRT	Total	Increase vs. 2020 Base Case	% Increase
1	2020 Base Case	ECR	0	0	336	0	336.0		
2	2020 Full Rapid	Rapid, ECR	202	0	336	0	538.2	202.3	60%
3	2020 Truncated (DC-RC)	Rapid, ECR	167	0	336	0	502.8	166.9	50%
4	2020 Truncated (SB-RC)	Rapid, ECR	117	0	336	0	453.1	117.1	35%
5	2020 Hybrid A (76 Stops - 12 Min)	Hybrid	0	396	0	0	395.9	59.9	18%
6	2020 Hybrid B (50 Stops - 12 Min)	Hybrid	0	365	0	0	364.6	28.6	9%
7	2020 Peak Rapid	Rapid, ECR	116	0	336	0	451.5	115.6	34%
8	2020 Hybrid A (76 Stops - 10 Min)	Hybrid	0	448	0	0	447.5	111.6	33%
9	2020 Hybrid B (50 Stops - 7.5 Min)	Hybrid	0	507	0	0	507.2	171.3	51%
10	2040 BRT	BRT, ECR		0	338	159	497.4	161.4	48%

Note: It is assumed that the 2040 Base Case for comparison to Concept 10 – 2040 BRT has the same operating plan and resource requirements as the 2020 Base Case (Concept 1).

Rapid + ECR Overlay (Concepts 1, 2, 3, 4, and 7) – All concepts consisting of a 15-minute Rapid and ECR overlay (i.e., Concepts 2, 3, 4 and 7) would require between 450-540 RVH – collectively this represents an increase of between 34%-60% in daily RVH or between 110-200 RVH above the 2020 Base Case (with ECR only service). As expected, Concept 2 (the Full Rapid) would require the most RVH since the service would operate the full length of the corridor from Daly City to Palo Alto compared to the Truncated concepts (Concepts 3 and 4) and would operate all day compared to the Peak Rapid concept (Concept 7).



Hybrid (Concepts 5, 6, 8 and 9) – RVH requirements for Hybrid concepts vary based on the proposed service headway – those with shorter headways (i.e., more frequent service) would require more RVH than those with longer headways (or less frequent service). Hybrid concepts making fewer stops along the route would operate marginally faster than those making more stops, thus resulting in fewer RVH required as well. As Table 9-3 shows, Concept 9 (Hybrid B with 7.5-minute service) would require the most service (about 510 RVH), representing an increase of 170 RVH (a 51% increase) over the 2020 Base Case. Next, Concept 8 (Hybrid A with 10-minute service) would require about 450 RVH or 110 RVH more (a 33% increase) than the 2020 Base Case. Concepts 5 and 6 with relatively longer headways require between 360-400 RVH, or 30-60 RVH more than the 2020 Base Case (a 9-18% increase).

BRT + ECR Overlay (Concept 10) – BRT service (operating in segments of dedicated bus lanes along the corridor) would require about 500 RVH, an increase of 160 RVH (48%) over the 2020 ECR Base Case (which can be assumed to be the same as what would be provided in 2040). The 2040 BRT service would operate about 25% faster than the 2020 Rapid concepts due to reduced vehicle conflicts from operating in bus lanes – thus resulting in a nearly commensurate lower volume of RVH than that required under Concept 1 – 2020 Full Rapid.



10.0 OPERATING & MAINTENANCE COSTS

This section presents the estimated operating and maintenance (O&M) costs for the various service concepts carried forward to the detailed evaluation. O&M costs are in Quarter 3 (Q3) fiscal year (FY)2014 costs – even for future years. Thus no cost escalation has been applied to bring costs into line with expected FY2020 or FY2040 costs.

10.1 O&M COST ELEMENTS

O&M costs can be divided into two elements:

- **Service O&M Costs** – Service costs relate solely to the provision of transit service (i.e., the operation and maintenance of the buses themselves for revenue service). Service costs include driver salaries and fringe benefits, bus maintenance fees, as well as fueling costs, etc. Service costs are based on the product of total revenue vehicle hours (RVH) and average operating cost per RVH.
- **Fixed Infrastructure O&M Costs** – These costs relate to the upkeep and maintenance of fixed infrastructure including bus lanes, transit signal priority, and bus stations.

O&M cost estimates for each of the concepts carried forward to Phase 2 are shown in **Table 10-1**. The cost estimates found that service options that operated overlay ECR service, had more frequent service, and operated along the entire corridor generally had higher annual operating costs. Besides costs to operate the vehicles in revenue service, there will also be O&M costs related to upkeep and maintenance of fixed infrastructure implemented for the Rapid, Hybrid, or BRT concepts including:

- Stations;
- Real-time passenger information systems;
- Transit signal priority (TSP);
- Ticket vending machines (TVM);
- Mixed flow lane enhancements;
- Dedicated bus lane segments; and
- Queue jump lanes.

Detailed information on O&M cost methodology and estimates are presented in **Appendix G**.



TABLE 10-1: ANNUAL O&M COSTS BY SERVICE CONCEPT (Q3 FY2014\$)

#	Service Concept	Annual O&M Costs to Provide Service	Annual O&M Costs to Maintain Fixed Infrastructure	Total Annual O&M Costs	% of Service O&M Costs to Total
1	2020 Base Case	\$21,300,000	\$-	\$21,300,000	100%
2	2020 Full Rapid	\$33,900,000	\$707,000	\$34,607,000	98%
3	2020 Truncated (Daly City-Redwood City)	\$31,800,000	\$616,000	\$32,416,000	98%
4	2020 Truncated (San Bruno-Redwood City)	\$28,800,000	\$459,000	\$29,259,000	98%
5	2020 Hybrid A (76 Stops - 12 Min)	\$24,900,000	\$806,000	\$25,706,000	97%
6	2020 Hybrid B (50 Stops - 12 Min)	\$23,100,000	\$742,000	\$23,842,000	97%
7	2020 Peak Rapid	\$28,500,000	\$707,000	\$29,207,000	98%
8	2020 Hybrid A (76 Stops - 10 Min)	\$28,200,000	\$809,000	\$29,009,000	97%
9	2020 Hybrid B (50 Stops - 7.5 Min)	\$32,100,000	\$749,000	\$32,849,000	98%
10	2040 BRT	\$31,200,000	\$5,686,000	\$36,886,000	85%

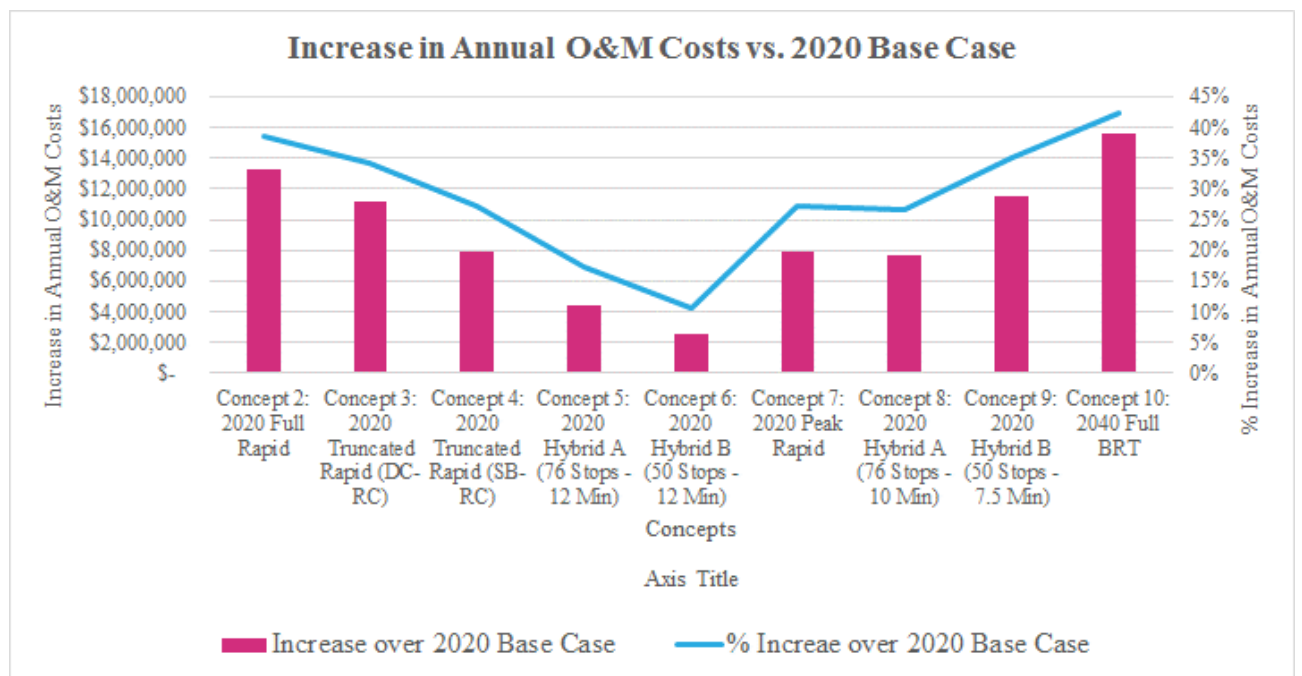
10.2 COST COMPARISON TO 2020 BASE CASE

Figure 10-1 depicts the increase in annual 2020 O&M costs over the 2020 Base Case (ECR only, generating \$21.3 million in annual O&M costs), and in the case of Concept 10, the assumed increase in costs over the presumed 2040 Base Case. Among 2020 Rapid concepts (i.e., Concepts 2, 3, 4, and 7), Concept 2 (2020 Full Rapid) has the largest increase in annual O&M costs relative to the 2020 Base Case at nearly \$13.3 million or 38% more the 2020 Base Case. Concept 7 (2020 Peak Rapid) has the smallest difference in annual O&M costs at \$7.9 million or 27% more than the 2020 Base Case.

Among 2020 Hybrid concepts, Concept 6 (2020 Hybrid B (50 Stops – 12 Min)) has the lowest increase in annual O&M costs over the 2020 Base Case (\$2.5 million or an 11% increase), while Concept 9 (2020 Hybrid B (50 Stops – 12 Min)) has the largest annual increase at \$11.5 million or a 35% increase. Concept 10 (2040 Full BRT) is expected to generate annual costs of \$15.6 million over the 2040 Base Case or a 44% increase.



Figure 10-1: Increase in Annual O&M Costs vs. 2020 Base Case (Q3 FY2014\$)



10.3 PEAK VEHICLE REQUIREMENTS

Operating speed (with consideration for number of stops) and round trip route distance (which may also account for recovery or layover time) are used to estimate round trip travel time. Peak vehicle requirements can be calculated by dividing the overall round trip travel time by the proposed service headway. The number of peak buses dictates overall fleet size, number of drivers, number of spares to be maintained, and the size of bus storage and maintenance facilities.

In general, concepts with larger peak vehicle requirements have longer cycle times due to operating along the full corridor length, make more frequent stops, operate a concurrent ECR overlay, and have more frequent service. Key findings are as follows (note these estimates do not include spare vehicles, which typically represent 10-15% of the fleet):

- **Rapid + ECR Overlay** – These four concepts (Concepts 2, 3, 4 and 7) would require between 32-39 peak vehicles, an increase of 10-17 vehicles (45-77%) from the 2020 Base Case.
- **Hybrid** – Hybrid concepts would require fewer peak vehicles (between 23-37 depending on the concept) due to the absence of an ECR overlay, less frequent stops and thus faster operating speeds and shorter roundtrip cycle times along the corridor. Hybrid options with less frequent



service (i.e., Concepts 5 and 6) would require 23-25 peak vehicles, an increase of 1-3 vehicles (5-14%) over the 2020 Base Case.

- **BRT + ECR Overlay** – BRT service as analyzed in this study (with ECR Local) would require 36 peak vehicles, or 14 more than the 2020/2040 Base Case. This equates to a 64% increase.



11.0 CAPITAL COSTS

This section presents the estimated capital costs associated with the various service concepts carried forward to the detailed evaluation. Capital costs are reported in Quarter 3 (Q3) Fiscal Year (FY) 2014 dollars – no escalation is applied for future 2020 and 2040 scenario capital costs.

11.1 CAPITAL COST COMPONENTS

The capital cost estimates presented in this study are rough order-of-magnitude estimates that are based on broad assumptions for future fixed infrastructure implementation. The cost estimates are intended to identify relative cost differences between service concepts, as well as to establish a baseline to identify future funding sources and availability. More detailed cost estimates will be prepared once additional details are finalized for these service concepts – particularly for Concept 10 – 2040 Full Bus Rapid Transit (BRT).

Capital costs are divided into two types:

- **Direct Costs** – These costs include labor, equipment, and material necessary for the contractor to place a permanent unit of work in the field; and
- **Other Costs** – Other costs include indirect costs related to workforce mobilization, contingency, soft costs, overhead, as well as profit.

Detailed information on capital cost methodology, assumptions, and estimates are presented in **Appendix H**.

11.2 FULL, PEAK, AND TRUNCATED RAPID INFRASTRUCTURE

Rapid service concepts include all concepts in which 2020 Rapid service is paired with an ECR service providing local access – this includes:

- Concept 2: 2020 Full Rapid;
- Concept 3: 2020 Truncated Rapid (Daly City-Redwood City);
- Concept 4: 2020 Truncated Rapid (San Bruno-Redwood City); and
- Concept 7: 2020 Peak Rapid.



For these concepts, Rapid service would operate exclusively in mixed flow lanes, thus no bus lanes have been proposed. Fixed infrastructure for this family of concepts would be proposed to improve passenger amenities and improve operating speeds and reliability. **Table 11-1** details the capital improvements and assumptions used to develop capital costs for these four concepts.

Infrastructure enhancements for Full, Peak, and Truncated concepts would include:

- **Enhanced Stops** – The number of enhanced stops would vary by service concept (between 46 and 74 stops northbound and southbound). Each enhanced stop would cost \$62,660 (for purposes of this study) and would include the following enhancements: one three-seat bench, 66 ft² canopy structure, removal and replacement of concrete platform, display cases, windscreens, lighting, signage, electrical and Pacific Gas and Electric (PG&E) service. Costs and quantities have been adjusted downward from proposed BRT stops included in the San Francisco County Transportation Authority (SFMTA)'s Van Ness BRT. It noted that ECR enhanced stops would be less robust and about one-third the size of the Van Ness BRT stops.
 - **Stops with Minor Improvements** – Only Rapid stops would be improved. Existing ECR Local stops would be unchanged (improvements would fall under SamTrans existing capital improvement program).
 - **Real-Time Passenger Information** – Real-time arrival displays and underlying infrastructure would be implemented at all enhanced stops (thus between 46 and 74 stops, depending on the service concept). Costs include those for the displays themselves as well as related system costs. Costs and quantities are based on discussions with an industry vendor (Luminator Technology Group).
- **New Additional Vehicles** – The number of additional vehicles needed would vary by service concept (between 10-17 additional vehicles). It is assumed that two vehicle types would be available – either a 60 ft. diesel or diesel-hybrid low floor bus. These buses would be equipped with a fare box (assumed to cost \$15,000), and Computer Aided Dispatch (CAD) / Automatic Vehicle Location (AVL) System (about \$30,000). Collectively, a single bus would cost between \$543,000 for a diesel vehicle to \$770,000 for the diesel-hybrid (based on discussions with New Flyer). Vehicle costs would also include fire suppression, methane detection, cameras, destination signs, and Americans with Disabilities Act (ADA) equipment. For this estimate, a conservative assumption has been made that new diesel-hybrid vehicles would be procured, although SamTrans may have vehicle availability within the existing bus fleet as replacement procurements occur.
- **TSP at Intersections** – TSP would be implemented at up to 120 signalized intersections, depending on the service concept (with truncated concepts requiring fewer TSP enabled signals). Cost would include installation, system costs and a 25% contingency. All-in TSP costs would include equipment costs (\$4,500/intersection), installation costs (\$1,500/intersection), and an all-



encompassing systems integration and implementation cost of \$445,500 – these are based on Caltrans estimates and exclude costs for TSP equipment and implementation aboard buses.¹⁵

- **TSP on Vehicles** – TSP would be implemented on all buses operating Rapid service (whether new or existing – thus a total of between 10-17 vehicles). TSP costs for equipment and installation would be \$5,000 per vehicle, based on a Caltrans estimate.

TABLE 11-1: CAPITAL COST ESTIMATES FOR 2020 RAPID SERVICE CONCEPTS (Q3 FY2014\$)

#	Service Concept	Length	Enhanced Stops (Both Directions)	Stops with Minor Improvements (Both Directions)	Total Vehicles Providing Rapid Service	Inter-sections	Total Cost	Cost / Mile
2	2020 Full Rapid	25.66	74	0	17	120	\$41,975,000	\$1,635,800
3	2020 Truncated Rapid (Daly City-Redwood City)	20.81	64	0	14	102	\$35,249,000	\$1,693,800
4	2020 Truncated Rapid (San Bruno-Redwood City)	14.86	46	0	10	77	\$25,545,000	\$1,719,000
7	2020 Peak Rapid	25.66	74	0	17	120	\$41,975,000	\$1,635,800

Note: Final costs are rounded up to the nearest thousand.

11.3 HYBRID RAPID INFRASTRUCTURE

Hybrid service concepts include the following:

¹⁵ For the purposes of this estimate, it is assumed that TSP costs are based on the costs for a distributed TSP system (whereby TSP equipment is placed aboard each bus and installed in signal cabinets), which is marginally more expensive than a centralized TSP system to provide a more conservative estimate. Please refer to the appendices for details on cost elements included in distributed and centralized systems.



- Concept 5: 2020 Hybrid A (76 Stops - 12 Min);
- Concept 6: 2020 Hybrid B (50 Stops - 12 Min);
- Concept 8: 2020 Hybrid A (76 Stops - 10 Min); and
- Concept 9: 2020 Hybrid B (50 Stops - 7.5 Min).

Hybrid service would operate exclusively in mixed flow lanes, thus no bus lanes would be implemented (thus no capital improvements to the existing roadway would be proposed). Fixed infrastructure enhancements would be made to improve passenger amenities, operating speeds, and reliability. **Table 11-2** details the capital improvements and assumptions used to develop capital costs for these four concepts.

Infrastructure enhancements for Hybrid A and Hybrid B concepts would include:

- **Enhanced Stops** – The number of enhanced stops would be the same for each Hybrid concept – 74 stops in total. These 74 stops represent the highest demand stops along the corridor and match those stops featured in the Full Rapid concept. Each enhanced stop would cost \$62,660 and would include the following enhancements: one three-seat bench, 66 ft² canopy structure, removal and replacement of concrete platform, display cases, windscreens, lighting, signage, electrical and PG&E service. Costs and quantities have been adjusted downward from proposed BRT stops included in the San Francisco Municipal Transit Agency (SFMTA)'s Van Ness BRT. It noted that ECR enhanced stops would be less robust and about one-third the size of the Van Ness BRT stops.
- **Stops with Minor Improvements** – Hybrid Concepts 5 and 8 serve a total of 152 stops along the corridor. Minor improvements would be made at all non-enhanced stops – thus 78 stops. Hybrid Concepts 6 and 9 serve a total of 100 stops along the corridor. Minor improvements would be made at all non-enhanced stops – thus 26 stops. Improvements would be less robust than those at enhanced stops and would include a three-person bench, a 32 ft² canopy structure, and signage. The average cost for minor improvements would be about \$11,500 per stop.
- **Real-Time Passenger Information** – Real-time arrival displays and underlying infrastructure would be implemented at all enhanced stops (thus 74 stops). Costs would include the displays themselves and related system costs. These costs and quantities are based on discussions with an industry vendor (Luminator Technology Group).
- **New Additional Vehicles** – The number of additional vehicles would vary by service concept (between 1-15 additional vehicles). It is assumed that two vehicle types would be available – either a 60 ft. diesel or diesel-hybrid low floor bus. These buses would be equipped with a fare box (assumed to cost \$15,000), and CAD/AVL System (about \$30,000). Collectively, a single bus would cost between \$543,000 for a diesel vehicle to \$770,000 for the diesel-hybrid (based on discussions with New Flyer). Vehicle costs would also include fire suppression, methane detection,



cameras, destination signs, and ADA equipment. For this estimate, it is assumed that diesel-hybrid vehicles would be procured.

- **TSP at Intersections** – TSP would be implemented at up to 120 signalized intersections, depending on the service concept (with truncated concepts requiring fewer TSP enabled signals). Cost would include installation, system costs and a 25% contingency. All-in TSP costs would include equipment costs (\$4,500/intersection), installation costs (\$1,500/intersection), and an all-encompassing systems integration and implementation cost of \$445,500 – these are based on Caltrans estimates and exclude costs for TSP equipment and implementation aboard buses.¹⁶
- **TSP on Vehicles** – TSP would be implemented on all buses operating Hybrid service (whether new or existing – thus a total of between 23-37 vehicles). TSP costs for equipment and installation would be \$5,000 per vehicle, based on a Caltrans estimate.

¹⁶ For the purposes of this estimate, it is assumed that TSP costs are based on the costs for a distributed TSP system (whereby TSP equipment is placed aboard each bus and installed in signal cabinets), which is marginally more expensive than a centralized TSP system to provide a more conservative estimate. Please refer to the appendices for details on cost elements included in distributed and centralized systems.



TABLE 11-2: CAPITAL COST ESTIMATES FOR 2020 HYBRID SERVICE CONCEPTS (Q3 FY2014\$)

#	Service Concept	Length	Enhanced Stops (Both Directions)	Stops with Minor Improvements (Both Directions)	Total Vehicles Providing Rapid Service	Inter-sections	Total Cost	Cost / Mile
5	Concept 5: 2020 Hybrid A (76 Stops - 12 Min)	25.66	74	78	25	120	\$21,025,000	\$819,400
6	Concept 6: 2020 Hybrid B (50 Stops - 12 Min)	25.66	74	26	23	120	\$16,464,000	\$641,600
8	Concept 8: 2020 Hybrid A (76 Stops - 10 Min)	25.66	74	78	30	120	\$29,268,000	\$1,140,600
9	Concept 9: 2020 Hybrid B (50 Stops - 7.5 Min)	25.66	74	26	37	120	\$39,544,000	\$1,541,100

Note: Final costs are rounded up to the nearest thousand.

11.4 BRT INFRASTRUCTURE

The Full Bus Rapid Transit (BRT) concept represents the long-term phasing approach and focuses on more capital intensive improvements compared to the near-term Rapid concepts. Improving travel speeds beyond the Rapid bus speed improvements previously described would involve dedicating lanes for transit-only use. Based on a corridor assessment of where transit-only lanes would be feasible, the Full BRT concept assumes that vehicles would operate in dedicated bus lanes for 10.9 miles and in mixed flow traffic lanes for 14.76 miles. (See **Appendix I** for an assessment of Corridor lane miles recommended for transit-only lanes). More robust enhancements would be implemented at stations and along the corridor to significantly improve the passenger experience and improve travel speeds and reliability.



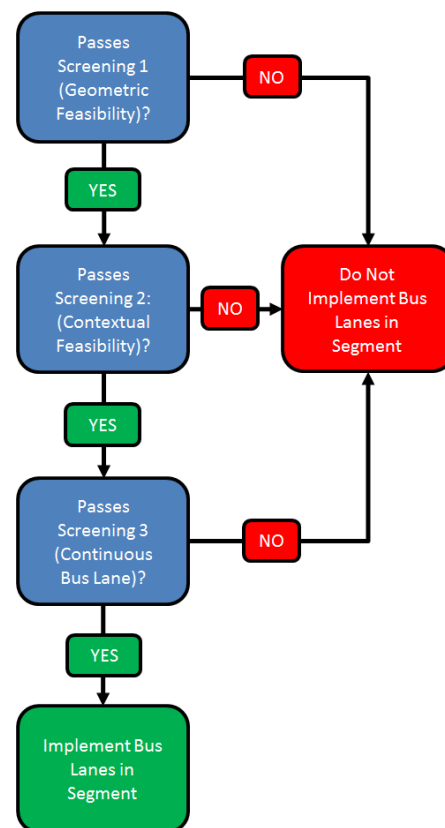
11.4.1 CORRIDOR BUS-ONLY LANE SCREENING PROCESS

Segments were identified as physically feasible for bus lanes if sufficient existing curb-to-curb width on El Camino Real exists for 24 feet of new bus lanes (i.e., two bus lanes, one in each direction), assuming no widening of the street from the current configuration (i.e., the sidewalks will not be narrowed and the existing curb-to-curb distance will not change). Breaking curbs, relocating utilities and especially private property acquisition would result in higher capital costs and public opposition, which could ultimately delay and/or preclude continuous bus-only segments of the Corridor.¹⁷

Bus-lane right-of-way would be obtained by converting existing medians and/or parking lanes, and narrowing existing general purpose (GP) travel lanes. Even in the context of planning within the existing roadway, it is recognized that such strategies may be politically controversial and subject to extensive public comment and vetting. For the purposes of this study, it is assumed that the community and cities would allow the conversion of medians, parking lanes, and some GP travel lanes when necessary for dual bus lanes. While the study considered average curb-to-curb, median, travel lane, turn lane, and parking lane widths for each block face along the Corridor it should be acknowledged that variations within those block faces may exist and more detailed analysis to determine whether any minor takings outside the curb-to-curb width would be needed during Preliminary Engineering.

The evaluation flowchart and process is presented in the graphic to the right. Based on this evaluation, the proposed bus lane segments along El Camino Real (heading southbound) are as follows:

- **Segment 1:** McClellan Dr. (South San Francisco, milepost 3.62) to Rosedale Ave. (Burlingame, milepost 9.78), a total distance of 6.16 miles (**Figure 11-1**).



¹⁷ The overall goal is to eliminate the need to acquire ROW outside of the curbs. However in subsequent design phases, it should be acknowledged that it may be necessary to acquire limited ROW outside of the existing curb-to-curb ROW. Analysis of these locations and the amount of land would be conducted at that time, if necessary.



- **Segment 2:** Baywood Ave. (San Mateo, milepost 13.32) to 43rd Ave. (Belmont, milepost 16.47), a total distance of 3.15 miles (**Figure 11-2**).
- **Segment 3:** Holly St. (San Carlos, milepost 18.61) to Claremont Ave. (Redwood City, milepost 20.20), a total distance of 1.59 miles (**Figure 11-3**).

In total, 10.9 miles out of the corridor are proposed for dual bus lanes for BRT operations. Bus lanes would be either center-running or side-running – the preferred configuration for the future is not discussed or analyzed in this study. Six queue jump lanes are proposed to access the bus lanes (three in each direction). Three would be located at the near-side of the following southbound intersections: McClellan Dr., Baywood Ave., and Holly St. Three would be located at the near-side of the following northbound intersections: Claremont Ave., 43rd Ave., and Rosedale Ave.

11.4.2 BRT INFRASTRUCTURE

BRT infrastructure would include:

- **Mixed Flow Enhancements** – Vehicles would operate in a combination of bus lanes (either center-running or side-running) and in mixed flow lanes (outside bus lanes). Road improvements for mixed flow operation would be limited to restriping and signage enhancements (for instance restriping and signage to indicate bus lane transition areas and prohibited entry to bus lanes by normal vehicles). Per mile improvements would cost \$77,000/mile. Per mile costs are based on the Santa Clara Valley Transportation Authority (VTA) El Camino BRT costs (from the *VTA BRT Strategic Plan*).
- **Dedicated Bus Lanes** – BRT could operate in 10.9 miles of dedicated bus lanes (in three distinct segments along the corridor). At this time, no recommendation has been made on whether buses should operate in median or side lanes. Median bus lanes would cost about \$4.2 million/mile and include costs associated with pavement improvements, excavating a 4 ft. wide median each way, striping, signage, and concrete curb replacement. Side lanes would cost about \$3.9 million/mile and include costs associated with pavement improvements, striping, signage, and concrete curb replacement. Per mile costs are based on the VTA El Camino BRT costs (from the *VTA BRT Strategic Plan*). For this estimate, it is assumed that all bus lanes would be median bus lanes.



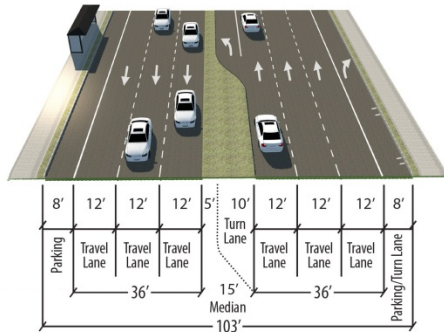
Figure 11-1: Segment 1 BRT Bus-Lane Concept

El Camino Real BRT - Cross Sections

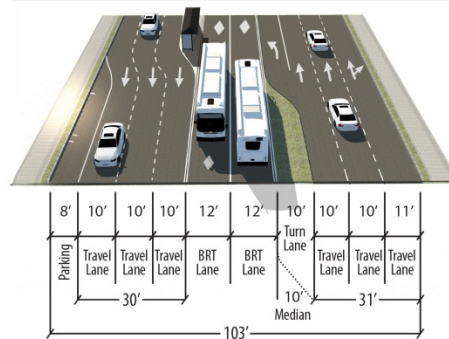
Segment 1: El Camino Real at Silva and Millbrae



Today's Conditions



Center Running BRT Concept



Side Running BRT Concept

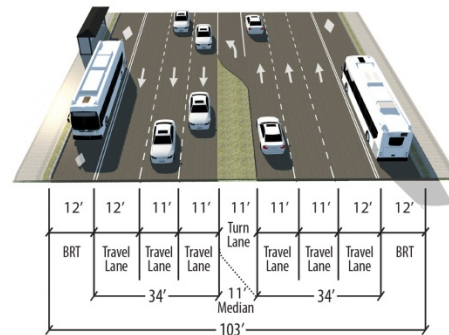


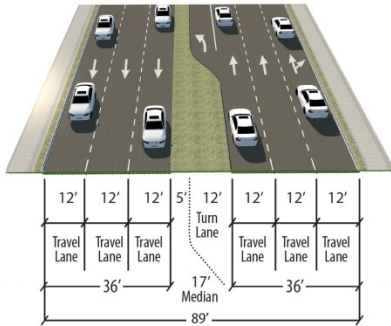
Figure 11-2: Segment 2 BRT Bus-Lane Concept

El Camino Real BRT - Cross Sections

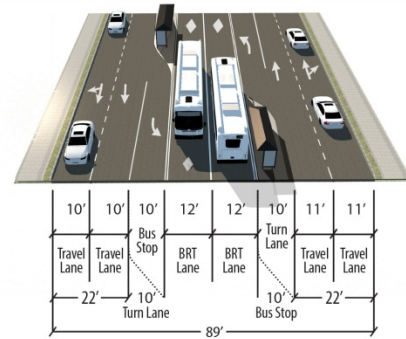
Segment 2: El Camino Real at 4th Street



Today's Conditions



Center Running BRT Concept



Side Running BRT Concept

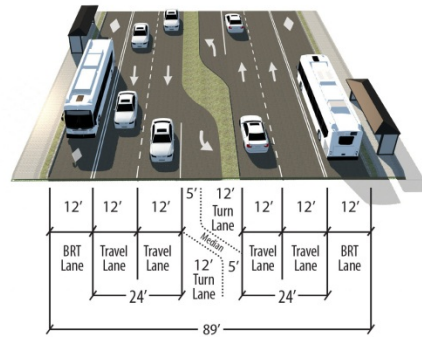
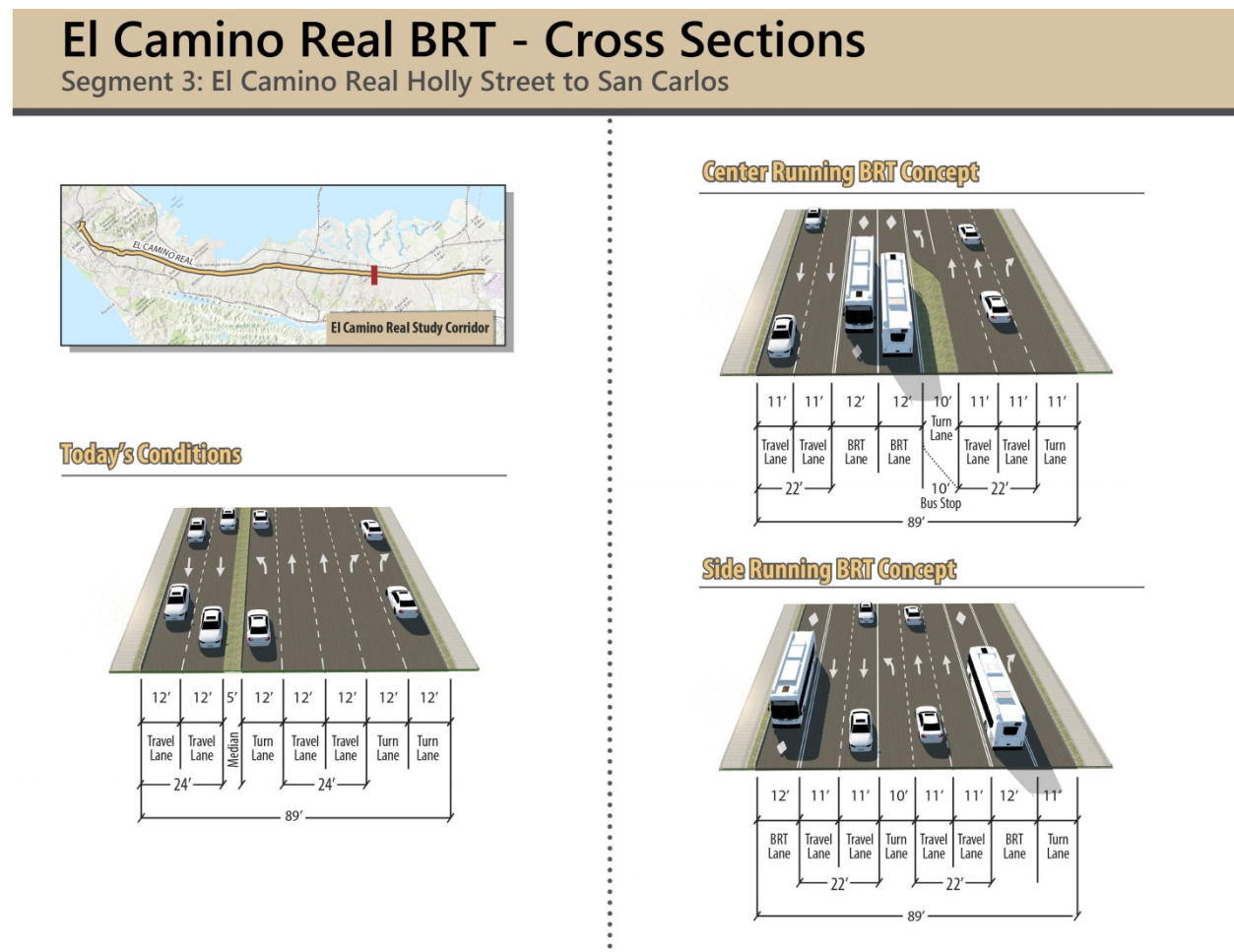


Figure 11-3: Segment 3 BRT Bus-Lane Concept



- Queue Jump Lanes** – Queue jump lanes allow vehicles to bypass queues at intersections and to enter the intersection prior to other traffic lanes. Queue jump lanes are assumed to be 180-feet long and would be placed at the start of bus lane segments to facilitate faster and more efficient access. Six (6) queue jump lanes would be installed, at a cost of \$63,000 per location (based on the *VTA BRT Strategic Plan*). Queue jump costs include pavement improvements, excavation of a 12 ft. wide curb each way, striping, signage, and concrete curb replacement.
- Drainage and Utility Relocation** - 5% drainage system relocation and 10% public utilities relocation have been included in the cost of bus lanes, mixed flow lanes and queue jump lanes.
- Enhanced Stations** – A total of 74 enhanced 60-ft. long BRT stations would be proposed. These stations would have significantly more robust amenities than enhanced stops proposed for the 2020 Rapid or Hybrid concepts. Each BRT station would include three three-seat seating, a 360 ft² canopy structure, removal and replacement of concrete platform, display cases, windscreens,

lighting, signage, other finishes, electrical broadband, and PG&E service. Each enhanced station would cost \$211,000 each (based on the *VTA BRT Strategic Plan* costs).

- **TVMs** – Each station would include one TVM, which would cost \$96,000 each (based on the *VTA BRT Strategic Plan*). TVMs would allow for off-boarding fare payment to reduce dwell time and increase total corridor travel speeds.
- **Real-Time Passenger Information** – Real-time arrival displays and underlying infrastructure would be implemented at all BRT stations. Costs include those for the displays themselves as well as related system costs. Costs and quantities are based on discussions with an industry vendor (Luminator Technology Group).
- **New Additional Vehicles** – Fourteen (14) additional vehicles would be required for 2040 Full BRT service. It is assumed that two vehicle types would be available – either a 60 ft. diesel or diesel-hybrid low floor bus. These buses would be equipped with a fare box (assumed to cost \$15,000), and CAD/AVL System (about \$30,000). Collectively, a single bus would cost between \$543,000 for a diesel vehicle to \$770,000 for the diesel-hybrid (based on discussions with New Flyer). Vehicle costs would also include fire suppression, methane detection, cameras, destination signs, and ADA equipment. For this estimate, it is assumed that diesel-hybrid vehicles would be procured.
- **TSP at Intersections** – TSP would be implemented at up to 120 signalized intersections. Cost would include installation, system costs and a 25% contingency. All-in TSP costs would include equipment costs (\$4,500/intersection), installation costs (\$1,500/intersection), and all-encompassing systems integration and implementation cost of \$445,500 – these are based on Caltrans estimates and exclude costs for TSP equipment and implementation aboard buses.¹⁸
- **TSP on Vehicles** – TSP would be implemented on all buses operating BRT service (whether new or existing – thus a total of 14 vehicles). TSP costs for equipment and installation would be \$5,000 per vehicle, based on a Caltrans estimate.

Total BRT capital costs amount to about \$176.9 million, or a per mile cost of \$6.9 million/mile.

11.5 CAPITAL COST ESTIMATES

Table 11-3 summarizes total capital costs and costs per mile for all ECR service concepts. Key findings from the capital cost estimation process are as follows:

¹⁸ For the purposes of this estimate, it is assumed that TSP costs are based on the costs for a distributed TSP system (whereby TSP equipment is placed aboard each bus and installed in signal cabinets), which is marginally more expensive than a centralized TSP system to provide a more conservative estimate. Please refer to the appendices for details on cost elements included in distributed and centralized systems.



- Rapid concepts that operate along the entire corridor with overlay ECR service generate the largest capital costs for 2020 concepts, at about \$42.0 million, equating to about \$1.64 million per mile. Truncated Rapid concepts with overlay ECR service are less costly from \$25.6-\$35.3 million, but equate to a similar per mile cost of \$1.7 million.
- Hybrid concepts at 12-minute headways generate the lowest total capital costs and are the most efficient in terms of capital cost per mile. This is based on the finding that these concepts would require the fewest number of additional vehicles. Concepts 5 and 6 both would cost \$16.5-\$21.0 million to build, equating to a per mile cost of \$642,000-\$819,000. Hybrid concepts at more frequent headways would generate higher capital costs - \$29.3-\$39.5 million or \$1.1-\$1.5 million per mile.
- The 2040 BRT concept would generate the largest capital costs and the highest costs per mile, due to the implementation of over 10 miles of dedicated bus lanes. The BRT concept would cost \$176.9 million with a per mile cost of \$6.9 million.

TABLE 11-3: CAPITAL COST AND COST PER MILE FOR ECR SERVICE CONCEPTS (Q3 FY2014\$)

#	Concept	Capital Cost	Cost per Mile
1	2020 Base Case	\$-	\$-
2	2020 Full Rapid	\$41,975,000	\$1,635,800
3	2020 Truncated Rapid (Daly City-Redwood City)	\$35,249,000	\$1,693,800
4	2020 Truncated Rapid (San Bruno-Redwood City)	\$25,545,000	\$1,719,000
5	2020 Hybrid A (76 Stops - 12 Min)	\$21,025,000	\$819,400
6	2020 Hybrid B (50 Stops - 12 Min)	\$16,464,000	\$641,600
7	2020 Peak Rapid	\$41,975,000	\$1,635,800
8	2020 Hybrid A (76 Stops - 10 Min)	\$29,268,000	\$1,140,600
9	2020 Hybrid B (50 Stops - 7.5 Min)	\$39,544,000	\$1,541,100
10	2040 Full BRT	\$176,850,000	\$6,892,000



12.0 RIDERSHIP AND PRODUCTIVITY

This section presents ridership and productivity statistics, including forecast ridership for each service concept, the total increase in corridor ridership, the total increase in SamTrans system ridership, and farebox recovery and subsidy per passenger estimates for the various service concepts carried forward to the detailed evaluation. Ridership was developed based on the City/County Association of Governments of San Mateo (C/CAG) Bi-County Travel Demand Model, operated by the Santa Clara Valley Transportation Authority (VTA) (as noted in Section 8.0). More information on ridership and other productivity metrics can be found in **Appendix J**.

12.1 RIDERSHIP

Table 12-1 presents the forecast corridor-level ridership (by service tier) as well as the system-level ridership (and associated changes from the 2020 Base Case (Concept 1)). **Figure 12-1** presents the daily corridor ridership and percentage growth over the 2020 Base Case (Concept 1).

Key findings are as follows:

- Among concepts with Rapid and ECR service, Concept 2 (2020 Full Rapid) generates the highest daily ridership at 10,600, compared to about 8,100 for Concept 3 (2020 Truncated Rapid (Daly City-Redwood City)). Concept 4 (2020 Truncated (San Bruno-Redwood City)) generates half the ridership of Concept 2 at 5,000 daily riders. Concept 7 (2020 Peak Rapid) generates slightly more riders at 5,500 daily riders.
- Daily ridership for Hybrid-only concepts ranges from 17,700 to 22,500. Concept 9 (2020 Hybrid B (50 Stops – 7.5 Min)) generates the highest daily ridership at 22,500, closely followed by Concept 8 (2020 Hybrid A (76 Stops – 10 Min)) at 21,200. Concept 5 (2020 Hybrid B (76 Stops – 12 Min)) produces daily ridership of 19,500. Concept 6, (2020 Hybrid B (50 Stops – 12 Min)), with the fewest stops and the longest headway among the Hybrid-only concepts, generates over 17,700 daily riders.
- Concept 10 (2040 BRT) generates about 20,800 riders, so nearly double that of Concept 2 (2020 Full Rapid).



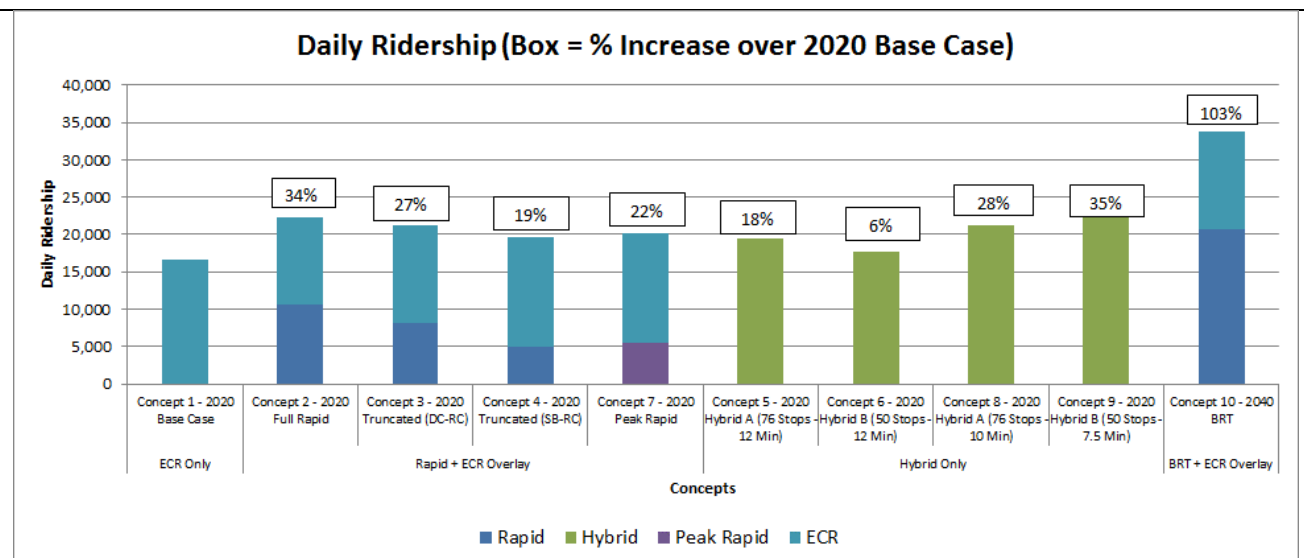
TABLE 12-1: SERVICE CONCEPT AND SYSTEM LEVEL RIDERSHIP

Tier	Service Concept	Daily Corridor-Level Ridership							Daily System-Level Ridership		
		Rapid	Peak Rapid	Hybrid	ECR	Total Corridor	Increase vs. 2020 ECR	% Increase vs. 2020 ECR	Riders	Increase vs. 2020 ECR	% Increase vs. 2020 ECR
ECR Only	Concept 1 - 2020 Base Case	0	0	0	16,598	16,598	-	-	57,613	-	-
Rapid + ECR Overlay	Concept 2 - 2020 Full Rapid	10,581	0	0	11,623	22,204	5,606	34%	64,975	7,362	13%
	Concept 3 - 2020 Truncated (DC-RC)	8,148	0	0	13,008	21,156	4,558	27%	64,183	6,570	11%
	Concept 4 - 2020 Truncated (SB-RC)	5,031	0	0	14,655	19,686	3,088	19%	63,152	5,539	10%
	Concept 7 - 2020 Peak Rapid	0	5,460	0	14,745	20,205	3,607	22%	63,343	5,730	10%
Hybrid Only	Concept 5 - 2020 Hybrid A (76 Stops - 12 Min)	0	0	19,513	0	19,513	2,915	18%	58,769	1,156	2%
	Concept 6 - 2020 Hybrid B (50 Stops - 12 Min)	0	0	17,675	0	17,675	1,077	6%	58,833	1,220	2%
	Concept 8 - 2020 Hybrid A (76 Stops - 10 Min)	0	0	21,238	0	21,238	4,640	28%	60,220	2,607	5%
	Concept 9 - 2020 Hybrid B (50 Stops - 7.5 Min)	0	0	22,468	0	22,468	5,870	35%	62,326	4,713	8%
BRT + ECR Overlay	Concept 10 - 2040 BRT	20,755	0	0	12,977	33,732	17,134	103%	90,968	33,355	58%

Source: VTA, 2014.



Figure 12-1: Corridor-Level Daily Ridership Forecast by Service Concept



12.2 PRODUCTIVITY

Service productivity of the service concepts was prepared for three typical metrics: (i) farebox recovery; (ii) subsidy per passenger; and (iii) incremental cost per new passenger.

12.2.1 FAREBOX RECOVERY

Farebox recovery measures how much of the operating costs can be paid for through fare revenues. Thus, farebox recovery is estimated by dividing fare revenues by operating costs. A higher farebox recovery rate means that a service concept is able to recoup more of its operating costs from fare revenues than another concept. **Table 12-2** shows corridor-level fare revenues and farebox recovery rates.

Key corridor findings (i.e., only those routes operating on the Corridor) are as follows:

- Concept 1 (2020 Base Case) generates a corridor 32% farebox recovery rate.
- All 2020 horizon year service concepts generate slightly lower corridor farebox recovery rates (between 27-31%), except for Concept 5 (2020 Hybrid A (76 Stops – 12 Min) with a 33% farebox recovery rate. Among service concepts with both Rapid and ECR service, Concept 7 (2020 Peak Rapid) generates the highest recovery rate at 29%. Among service concepts with Hybrid-only service, the noted Concept 5 generates the highest recovery at 32%.
- Concept 10 (2040 BRT) generates a farebox recovery rate of 45%.



TABLE 12-2: CORRIDOR-LEVEL FARE REVENUES AND FAREBOX RECOVERY RATE

Tier	Service Concept	Corridor Fare Revenue	Corridor Service O&M Cost	Corridor Farebox Recovery Rate
ECR Only	Concept 1 - 2020 Base Case	\$23,000	\$71,000	32%
Rapid + ECR Overlay	Concept 2 - 2020 Full Rapid	\$31,000	\$113,000	27%
	Concept 3 - 2020 Truncated (DC-RC)	\$29,000	\$106,000	27%
	Concept 4 - 2020 Truncated (SB-RC)	\$27,000	\$96,000	28%
	Concept 7 - 2020 Peak Rapid	\$28,000	\$95,000	29%
Hybrid Only	Concept 5 - 2020 Hybrid A (76 Stops - 12 Min)	\$27,000	\$83,000	33%
	Concept 6 - 2020 Hybrid B (50 Stops - 12 Min)	\$25,000	\$77,000	32%
	Concept 8 - 2020 Hybrid A (76 Stops - 10 Min)	\$30,000	\$94,000	32%
	Concept 9 - 2020 Hybrid B (50 Stops - 7.5 Min)	\$31,000	\$107,000	29%
BRT + ECR Overlay	Concept 10 - 2040 BRT	\$47,000	\$104,000	45%

Source: VTA, 2014.

Note: Corridor revenues and costs are rounded up to the nearest \$0,000.

12.2.2 SUBSIDY PER PASSENGER AND INCREMENTAL COST PER NEW PASSENGER

Farebox recovery can be a misleading evaluation of a new service. In the case of an existing corridor, the fluctuations in revenue and operating costs are sometimes too minute to discern significant differences in performance. Two additional metrics are often used to help differentiate the viability of different service concepts:

- Subsidy per Passenger** – Subsidy is the difference between operating costs and fare revenues (thus the amount that cannot be covered by fare revenues and must be paid for by the public). This metric measures the subsidy required to transport one passenger (calculated by dividing total subsidy by total passengers in the corridor). A lower subsidy per passenger indicates that a service concept is more self-sustaining than another.
- Incremental Cost per New Passenger** – This metric measures what the marginal cost is (above what service costs to operate now) in order to capture a new passenger. Incremental costs are determined by subtracting expected operating and maintenance (O&M) service costs from those O&M costs for Concept 1 (2020 Base Case). This incremental cost is then divided by the volume of new passengers (i.e., forecast passengers subtracted from the 2020 Base Case demand). A



lower incremental cost per new passenger means that the service concept can generate and carry new riders at a lower cost than another concept.

Table 12-3 and **Figure 12-2** present the average subsidy per passenger and incremental cost per new passenger within the ECR corridor. Key findings are as follows:

- **Subsidy per Passenger**

- Concept 1 (2020 Base Case) has a subsidy per passenger of \$2.89.
- 2020 horizon year service concepts require subsidies per passenger of between \$2.87-\$3.69. Hybrid-only concepts appear to generate lower subsidies per passenger figures, likely due to the lower operating costs from running a single service on the corridor (instead of the Rapid and ECR combination concepts).
- Among these 2020 horizon year service concepts, Concept 5 (2020 Hybrid A (76 Stops – 12 Min)) requires a subsidy of \$2.87, which is the only concept with a figure lower than that of Concept 1. Concept 2 (2020 Full Rapid) performs the worst at \$3.69/passenger.
- The BRT concept (Concept 10/2040 horizon year) has a subsidy of \$1.69/passenger, which is the lowest of any of the 2020 service concepts and about 40% less than Concept 1 (2020 Base Case).

- **Incremental Cost per New Passenger**

- 2020 horizon year service concepts generate incremental costs per new passenger ranging between \$4.12 and \$8.10. Hybrid-only concepts appear to generate lower incremental costs per new passenger, which is likely due to the lower operating costs from running a single service in the corridor (instead of the Rapid and ECR combination concepts).
- Among these 2020 horizon year service concepts, Concept 5 (2020 Hybrid A (76 Stops – 12 Min)) performs the best with an incremental cost of \$4.12 per new passenger. Concept 4 (2020 Truncated (San Bruno-Redwood City)) performs the worst at \$8.10 per new passenger, likely due to the fact that this concept does not serve higher ridership stops north of San Bruno Bay Area Rapid Transit (BART) Station, but still provides substantial amounts of service throughout the day in the corridor (with both a truncated Rapid and ECR).
- The BRT concept (Concept 10/2040 horizon year) has an incremental cost per new passenger of \$1.93, which is half as much as that for any of the 2020 concepts.



**TABLE 12-3: CORRIDOR-LEVEL SUBSIDY PER PASSENGER AND INCREMENTAL COST
PER NEW PASSENGER**

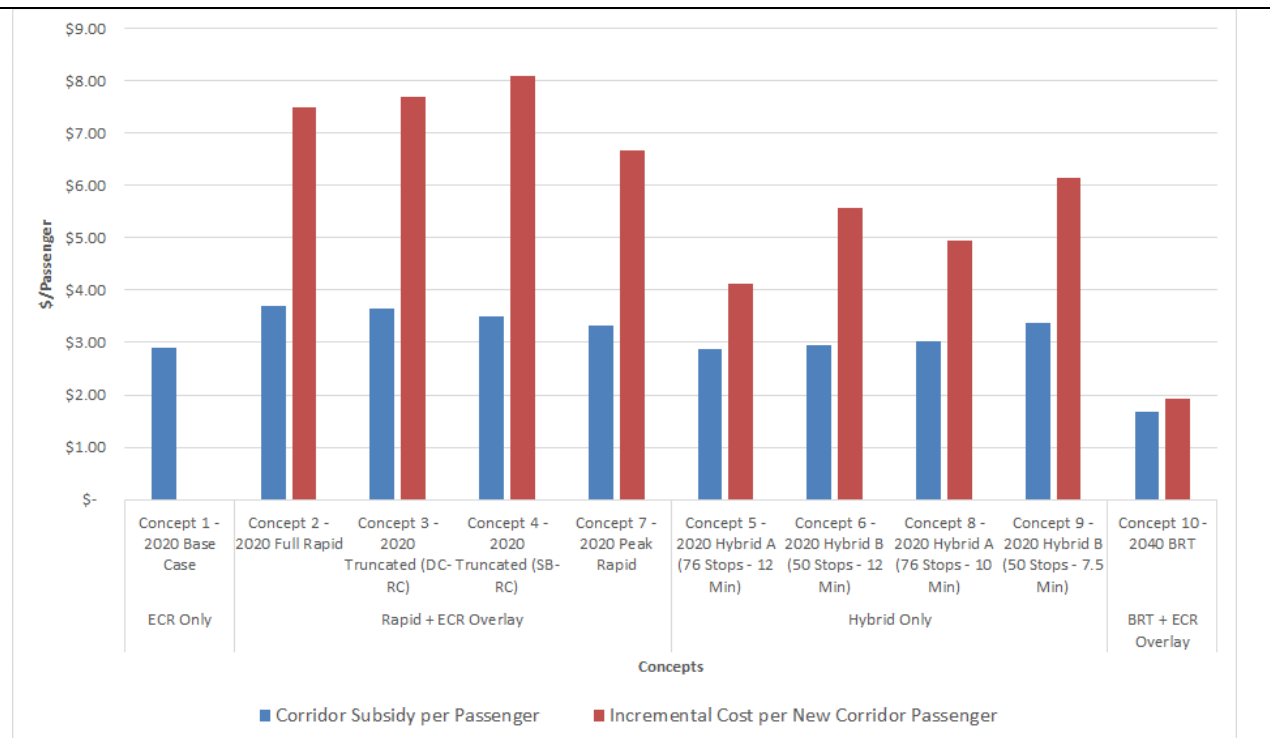
Tier	Service Concept	Subsidy per Passenger	Incremental Cost per New Corridor Passenger
ECR Only	Concept 1 - 2020 Base Case	\$2.89	-
Rapid + ECR Overlay	Concept 2 - 2020 Full Rapid	\$3.69	\$7.49
	Concept 3 - 2020 Truncated (DC-RC)	\$3.64	\$7.68
	Concept 4 - 2020 Truncated (SB-RC)	\$3.51	\$8.10
	Concept 7 - 2020 Peak Rapid	\$3.32	\$6.65
Hybrid Only	Concept 5 - 2020 Hybrid A (76 Stops - 12 Min)	\$2.87	\$4.12
	Concept 6 - 2020 Hybrid B (50 Stops - 12 Min)	\$2.94	\$5.57
	Concept 8 - 2020 Hybrid A (76 Stops - 10 Min)	\$3.01	\$4.96
	Concept 9 - 2020 Hybrid B (50 Stops - 7.5 Min)	\$3.38	\$6.13
BRT + ECR Overlay	Concept 10 - 2040 BRT	\$1.69	\$1.93

Source: VTA, 2014.

Note: Corridor revenues and costs are rounded up to the nearest \$0,000.



Figure 12-2: Corridor-Level Subsidy per Passenger and Incremental Cost per New Passenger



13.0 DETAILED CONCEPT EVALUATION

This section presents the detailed evaluation for the various service concepts (i.e., those with a model horizon year of 2020, thus nine service concepts including Concept 1 – 2020 Base Case) carried forward to this detailed evaluation (Phase 2). The Bus Rapid Transit (BRT) concept's (Concept 10) performance is not considered in the ranking of 2020 horizon year concepts. The evaluation was performed from both a quantitative and qualitative perspective. Performance among service concepts was then ranked on a scale of 1-to-5 for each evaluation criteria. The scores were summed up for all evaluation criteria to generate a composite score for each service concept. In total, there are 11 quantitative metrics and 5 qualitative metrics – thus the maximum score for a given service concept is conceivably 80 points.

The study's evaluation framework is presented in **Table 5-1** and includes each evaluation criteria used, the type of metric (quantitative/qualitative) along with their data sources that were used to conduct the detailed evaluation. **Appendix K** contains the full analysis of the detailed evaluation.

13.1 KEY QUANTITATIVE FINDINGS

In general, Hybrid concepts (and the 2020 Base Case) perform better due to lower operating and capital cost requirements (in terms of the number of additional peak vehicles required).

Concepts operating both Rapid and ECR services may perform well for ridership-based metrics, however, they perform worse overall due to higher associated operating and capital costs (from higher peak vehicle requirements) than Hybrid concepts.

Table 4 in **Appendix K** details the performance of each service concept with respect to each quantitative performance criteria. Table 5 in **Appendix K** presents the quantitative and qualitative rankings based on the study's scoring methodology (standard score ranking).

13.2 KEY QUALITATIVE FINDINGS

In general, concepts with Rapid and ECR service perform better qualitatively in that these concepts both maintain a high level of access (as the ECR still provides local service), while providing a faster, more reliable, and brand-distinguished overlay service (the Rapid). Rapid concepts that serve the entire Corridor score higher. They are more intuitive to use and less confusing than those that serve truncated portions of the Corridor.



Hybrid concepts provide a high level of service, but provide reduced access to jobs and housing along the corridor, since a significant number of stops are eliminated from service – and thus score lower than Rapid concepts.

Table 5 in **Appendix K** presents the quantitative and qualitative rankings based on the study's scoring methodology (standard score ranking).

13.3 OVERALL COMPOSITE FINDINGS

Table 13-1 presents the overall composite score, which was calculated by adding the quantitative and qualitative scores of each service concept. Key findings are as follows:

- **Concept 2 Performs the Best** - Concept 2 - 2020 Full Rapid generates a composite score of 53, which represents the best performance of the nine 2020 concepts. As noted, Concept 2 is extremely strong in its qualitative analysis, which makes up for its average performance in the quantitative analysis.
- **Concept 1 and 5 Are the Next Best Performers** – Concept 1 – 2020 Base Case and Concept 5 – 2020 Hybrid A (76 Stops – 12 Min) both have composite scores of 49, to finish second to Concept 2. Both Concepts 1 and 5 perform well in the quantitative analysis, buoyed by high ratings in cost-related categories. Both of these concepts have lower than average qualitative scores. This indicates for Concept 5 that perception of the service could be similar to, and not substantially better than the 2020 Base Case with ECR-only service.
- **Combined Rapid and ECR Concepts Perform Better than Hybrid Concepts** – Overall, concepts with combined Rapid and ECR service seem to perform better than Hybrid concepts. The reason is likely that access is a key element in the concept evaluation – thus loss of access by eliminating stops (as is done for all Hybrid concepts) has a significant negative impact on the rating of service concepts and the perceived level of service.
- **If Improvements Are Implemented, Concepts 2 and 5 Can Be Strong Options, But Each Brings Different Benefits** – As noted, the top scoring “build” alternatives (i.e., those where changes and modifications are made) are Concept 2 – 2020 Full Rapid, and Concept 5 – 2020 Hybrid A (76 Stops – 12 Min). There are key differences between each service concept, however, with different implications for the future scope/extent of BRT service and infrastructure:
 - **Concept 2 - Full Rapid** - While Concept 2 performs the best and offers the most robust enhancement to customer service and access with the full-corridor overlay Rapid service, it is more expensive overall in terms of both operating and maintenance (O&M) costs (as the number of Revenue Vehicle Hours (RVH) is significantly higher than the 2020 Base Case) and capital costs (due to the high number of additional peak vehicles required). Overlay Rapid service in Concept 2 is a natural precursor to BRT with dedicated bus lanes and more robust



bus stations. There are some shortcomings of Concept 2, in particular, higher costs may preclude enhancements if adequate budget is not available.

- **Concept 5 - Hybrid A** - Concept 5 on the other hand, may score lower in customer service and access, but has much lower O&M and capital cost (as it requires minimal increases in RVH and thus O&M costs, and does not require a significant number of new peak vehicles to be acquired). It may be easier to garner political support for Concept 5, with its cheaper price, and it can likely be implemented faster. Taking a long-term perspective, however, Concept 5 represents a minor change to existing ECR service – essentially creating a “limited stop” ECR. Concept 5 does allow for a transition to a future BRT system, which would have both local and BRT service running in parallel. Concept 5 would essentially become the local service in the long-term with a future BRT overlay. The steps of creating a Rapid-style service in the short-term and then rebranding as local service in the long-term would be confusing to customers and send conflicting messages to the public and policymakers.

TABLE 13-1: COMPOSITE SCORE AND RANKING BY SERVICE CONCEPT

Concept	Quantitative Analysis Score	Qualitative Analysis Score	Composite Score	Rank
Concept 1: 2020 Base Case	36	13	49	2
Concept 2: 2020 Full Rapid	31	22	53	1
Concept 3: 2020 Truncated Rapid (Daly City-Redwood City)	29	19	48	4
Concept 4: 2020 Truncated Rapid (San Bruno-Redwood City)	33	15	48	4
Concept 5: 2020 Hybrid A (76 Stops - 12 Min)	36	13	49	2
Concept 6: 2020 Hybrid B (50 Stops - 12 Min)	34	12	46	8
Concept 7: 2020 Peak Rapid	30	17	47	6
Concept 8: 2020 Hybrid A (76 Stops - 10 Min)	33	14	47	6
Concept 9: 2020 Hybrid B (50 Stops - 7.5 Min)	31	13	44	9

Note: Highest possible score is 80 (55 for the quantitative analysis and 25 for the qualitative analysis, respectively).



14.0 RECOMMENDED PHASING PLAN AND KEY CONSIDERATIONS

This section identifies the recommended phasing plan for Rapid/Hybrid and Bus Rapid Transit (BRT) service on the Corridor and key considerations for this decision. This section also discusses potential conditions that would trigger consideration of upgrading Rapid/Hybrid service to BRT.

14.1 SUMMARY OF RECOMMENDED STRATEGY OPTIONS

The primary purpose of this study was to identify a phased BRT plan for the Corridor. Because Full BRT service would require significant and complimentary investments in transit supportive land uses to justify the capital improvements, this study also considered a series of near-term, lower cost Rapid concepts. The recommended phasing plan includes near-term and long-term approaches and the recommended concepts are based on the findings of the detailed evaluation.

Two potential service strategy options for enhancing bus service on the Corridor in the future (i.e., out to the horizon year 2040) are recommended for further study. Both strategies are feasible options for enhancing transit service on the Corridor and complementing the Grand Boulevard Initiative (GBI) vision. The decision to pursue and implement either option will be based on a variety of decision factors, outlined at the end of this section. Table 14-1 highlights the pros and cons of each and **Appendix L** contains more information.

- **Option 1 – Near-Term Full Rapid and Long-Term BRT** consists of a phased approach that gradually upgrades trunk line transit along the Corridor from the current local service provided by the ECR Local, to a Rapid overlay on top of the ECR Local, to a BRT overlay (an upgraded Full Rapid) on top of the ECR Local.

This option has many benefits - increasing ridership, enhancing access, providing a faster, more reliable, more frequent, brand-distinguished overlay service, operational flexibility (the ability to modify Rapid service while maintaining consistent ECR Local service), and setting up the corridor for an efficient transition to BRT service. It also has its drawbacks, most notably, high operating and capital costs resulting in lower productivity compared to Option 2. Full BRT would require supporting land use (appropriate land use mix and higher densities) along the corridor that is far more intensive than today in order to justify the high capital costs (exclusive transit lanes) identified for this option.



- **Option 2 – Near Term Hybrid A (76 stops – 12-minutes) and Long Term BRT** consists of a phased approach that upgrades the ECR Local service along the Corridor to Hybrid Rapid in the near-term and introduces a BRT overlay on top of the Hybrid in the long term (Hybrid Rapid becomes the local service).

In the near-term this approach would require a minimal operating and capital cost increase while increasing speed, reliability, and ridership along the corridor. Due to the lower capital outlay and operating costs compared to Option 1, Option 2 would be easier to implement. Because it would eliminate lower productivity stops, overall access would decrease compared to existing ECR Local service. At a 12-minute service frequency, customers would see one additional bus per hour (a total of five) over existing service, which is far lower than the 8 buses per hour (4 Rapid, 4 local) that would be provided under Option 1. Option 2 would require a more difficult operational transition to long-term BRT service, as the BRT service would be introduced on top of the Hybrid service as opposed to a transition of Rapid service in Option 1.



TABLE 14-1: PROS AND CONS OF RAPID/BRT SERVICE STRATEGIES

	Description	Service Description	Pros	Cons
Option 1	Stage 1 Full Rapid overlay with ECR Local	Stage 1 (Near-Term)		
		<ul style="list-style-type: none"> ECR Local (Stage 1/2)- 15-minute headways, stopping at existing 102 northbound (NB) and 104 southbound (SB) stops Full Rapid (Stage 1) - 15-minute headways, stopping at 37 stops in each direction from Daly City to Palo Alto 	<ul style="list-style-type: none"> High ridership increase Improved accessibility and mobility Increased speeds Reduced wait times Improved reliability Operational flexibility 	<ul style="list-style-type: none"> Higher costs (operating and maintenance (O&M) and capital) Lower productivity than Option 2
		Stage 2 (Long-Term)		
		<ul style="list-style-type: none"> ECR Local operated as above BRT (Stage 2) - 15-minute headways, stopping at 37 enhanced stations in each direction from Daly City to Palo Alto 	<ul style="list-style-type: none"> Easy to understand Natural progression to BRT service in long term 	<ul style="list-style-type: none"> Supportive land use needed to sustain Stage 2 BRT investments
Option 2	Stage 1 Hybrid A with no overlay	Stage 1 (Near-Term)		
		<ul style="list-style-type: none"> Hybrid Rapid A (Stage 1/2) - 12-minute headways, stopping at 76 stops between Daly City and Palo Alto 	<ul style="list-style-type: none"> Increased speeds High ridership increase Low cost option (O&M and capital) 	<ul style="list-style-type: none"> Degraded overall accessibility and mobility More difficult transition to BRT (i.e., confusing to the public, and requires reinitiating ECR Local service as Hybrid A).
		Stage 2 (Long-Term)		
		<ul style="list-style-type: none"> Hybrid Rapid operated as above BRT (Stage 2)- 15-minute headways, stopping at 37 enhanced stations in each direction from Daly City to Palo Alto 	<ul style="list-style-type: none"> High productivity Easy to implement Improved reliability 	



14.2 DECISION TRIGGERS – OPTION 1 OR OPTION 2?

Both service alternatives are feasible and each would increase ridership on the Corridor. Available funding, customer needs, operational flexibility, ability to transition to BRT service, and complementary land use plans are all factors to be considered by SamTrans decision makers in determining which strategic transit option to pursue for El Camino Real.

Phase 1 Funding¹⁹

Transit operating budgets traditionally do not leave room for significant increases in operating costs. Capital needs can be obtained through a variety of federal, state, regional, and local funding sources, but operating fund sources are traditionally more limited and finite. Option 1 would increase the SamTrans ECR operating budget by approximately 38% (over current year costs). Option 2 would increase the SamTrans ECR operating budget by approximately 17% (over current year costs), which may be more feasible from a budgeting perspective. In terms of annual system wide O&M costs (\$107 million), Option 1 would result in a 12.4% annual increase in O&M costs (additional \$13.3 million) compared to a 4.1% annual increase (additional \$4.4 million) for Option 2.

Customer Needs / User Cost

Option 2 provides the corridor with an enhanced bus service with lower capital and operating cost expenditures and an overall net benefit in terms of attracting new ridership, reducing wait time and in-vehicle travel time, and improving reliability. Its primary drawback is that it reduces access for a wide range of customers, including those with potentially limited mobility by eliminating low productivity stops south of Redwood City and north of San Bruno. Option 2 has far lower agency costs than Option 1, but generates user costs in terms of reduced access, which Option 1 does not.

Operational Flexibility

Option 1 offers greater flexibility to modify service compared to Option 2. With ECR Local operating the same in the future as it is today, SamTrans has the ability to introduce Full Rapid service as a tiered approach (peak period first, all day second, etc.), increase or decrease service Rapid frequencies, or truncate Rapid service to meet demand. Option 2 would likely be limited to minor service adjustments such as frequency or stop relocation, with the absence of a local ECR.

¹⁹ Note: Current year (2014) costs have been assumed for this comparison.



Phase 2 BRT Need and Transition

Option 2 would effect a more challenging conversion of Rapid service to BRT whereas Option 1 would provide a natural transition to BRT. Determination of the long-term goal for transit in the Corridor, including fusion with planned GBI Corridor complete street enhancements, should factor into the decision of which service strategy to pursue in the near term. Corridor traffic congestion should also be a factor in the decision making process. Model forecasts show worsening traffic congestion in the County and along the Corridor. BRT would provide exclusive transit lanes on continuous segments of the Corridor that would allow buses to bypass congestion, improve speed, and enhance reliability. Another factor in considering the need for BRT in the long term and the decision to pursue Option 1 versus Option 2 is Caltrain service. Upon electrification (planned for 2020), Caltrain is proposing to improve off-peak headways to 30 minutes and add one additional train per hour per direction during the peak periods (from 5 trains per hour per direction to 6). Since ECR parallels a majority of the Corridor from Palo Alto to San Bruno, Corridor trips can be taken via Caltrain. While 2040 model runs showed a significant increase in ridership with BRT, the cost to implement BRT should be considered in the context of planned and funded improvements to Caltrain. Conversely, Caltrain ridership demand has continued to increase, and BRT could be an effective strategy to offer faster, more reliable, and more frequent parallel service along the Caltrain Corridor to reduce potential overcrowding.

Local Land Use and Commitments

In order to justify BRT (Phase 2 of Option 1 or 2), densities should be increased and a wider range of transit supportive land uses must be realized along the corridor.²⁰ Will the projected development, called for in GBI and Corridor cities' General Plans actually occur? Will communities (city leaders and residents) tolerate on-street parking loss, potential reduction in the number of general purpose lanes (never less than 2 per direction), and loss of medians to implement exclusive transit lanes, enhanced stations and the complete streets improvements (wider sidewalks, narrower crossings) called for in the GBI Corridor Plan? These questions about the long term are difficult to answer, especially considering the array of individual jurisdictions that line the Corridor, yet a certain degree of confidence is needed before pursuing BRT (notwithstanding the ability of BRT to induce development itself).

²⁰ GBI travel demand modeling and analysis found that BRT shows great potential along the GBI corridor, but would require significant financial investment and supporting land uses. (*Grand Boulevard Multimodal Transportation Corridor Plan*, October 2010).



14.3 PHASING IN FUTURE IMPROVEMENTS

The evolution of bus transit on the ECR corridor today – from ECR Local service to a Rapid/Hybrid (intermediate term) to Full BRT service (long-term) is not set in stone. Certain conditions, thresholds, and performance must be met to even consider enhancing service with more capital-intensive investments. In other words, certain “triggers” must be met in order to start considering and discussing enhancing service beyond what is provided today. Potential triggers are discussed below. (Note – this section is meant to discuss a few primary triggers, however, this does not mean that other triggers including business and political interests are not also important in this discussion).

14.3.1 LAND USE

Currently, land use throughout the corridor is largely low-density, with built-up pockets around certain downtown areas. Minimum and appropriate land use densities and development are required along the corridor to generate sustainable, all-day ridership to justify more capital-intensive concepts. Based on the similarities in land use and development scope, it is recommended that SamTrans develop its own density thresholds for both Rapid/Hybrid, but especially BRT service tiers (both residential and job densities) based on the Santa Clara Valley Transportation Authority (VTA) Service Design Guidelines. It is essential that BRT have supportive densities due to the capital costs that would conceivably be incurred with additional fixed route infrastructure such as BRT stations, queue jump lanes, and dedicated bus lanes.

Land use triggers thus may occur when the corridor on the whole starts to approach defined housing and job densities – designed to provide more supportive conditions and hopefully sustainable levels of ridership for higher investment services on the Corridor. The land use triggers will start the discussion. These discussions must also include close collaboration between SamTrans and local jurisdictions to assure supportive land use policies and that the “right” type of development is encouraged along the corridor.

14.3.2 RIDERSHIP / PERFORMANCE

Increasing the amount and level of service on the corridor can be rationalized if certain levels of performance (in terms of boardings per revenue hour, etc.) are being met and/or exceeded. Routes/corridors that perform below expectations should not be considered for additional service investments until they meet minimum performance thresholds.

Operators/agencies use different metrics to assess ridership and performance thresholds. Most commonly used metrics include: (i) ridership per revenue hour; (ii) load factor; and (iii) farebox recovery. From a



review of other agencies, there is no set agreement on the thresholds for minimum performance as each system is different – however, all operators clearly differentiate performance expectations among local, Rapid, and BRT service tiers. It is recommended that SamTrans develop service standards for both Rapid and BRT services for its refined service design guidelines.

From a review of other operators, it appears that a minimum 20% increase in performance is typically expected between local and Rapid services (with an even more pronounced increase in performance expected for BRT). It is recommended that the VTA thresholds serve as a guide for potential service thresholds (50% increase in boardings per revenue hour for the Rapid over the local, and an additional 20% increase in boardings per revenue hour for the BRT over the Rapid). Performance can thus trigger the need to consider service upgrades when local services meet and significantly exceed service standards for several consecutive years.

14.3.3 CONGESTION AND TRAVEL TIME TRIGGERS

Traffic congestion and mixed flow conflicts can significantly reduce bus operating speeds and elongate trip times. While the Rapid/Hybrid service concepts call for longer stop spacing and transit signal priority (TSP) to reduce stopping and increase average travel speeds, future traffic conditions may significantly reduce bus operating speeds and negate some of the enhancement measures put in place. Increasing physical segregation of buses from mixed flow traffic (i.e., one element of Full BRT) may be one strategy to increase operating speeds in the face of more serious congestion.

Thus one trigger for considering service enhancements on a corridor could be the amount of congestion and delay that is experienced in the corridor. For instance, if total bus running time consists of XX% of time spent in delay or on-time performance falls well below stated SamTrans standards, this could be a sign that new measures must be undertaken to improve reliability and speeds (such as TSP and reduced stops (i.e., the Rapid or Hybrid) or bus lanes (i.e., the Full Rapid). Furthermore, if XX% of intersections operate at Level of Service (LOS) E/F, then this could also be a trigger.

A more concrete means of considering congestion is travel time savings and operating speed. From a review of other agencies, a minimum travel time savings of 20% was generated or expected for most operators when upgrading from local to Rapid or local to BRT. Therefore, it is recommended that SamTrans quantify an approximate increase in travel speed or travel time savings between local and Rapid services, as well as Rapid and BRT services. Thus, one trigger to consider upgrading from Rapid to BRT service on the Corridor could be if operating speeds for the Rapid are falling well below the expected premium speed differential between the local (thus speed in this case acts as a proxy for corridor congestion and delay). It should be noted, however, that few operators quantified a speed target in their



service guidelines, as speed and travel time is subject to many different variables besides just the amount of transit priority provided along the route.

14.3.4 SUMMARY

The table below summarizes key phasing considerations and triggers.

TABLE 14-2: SUMMARY OF KEY PHASING CONSIDERATION AND TRIGGERS

Key Potential Trigger	Key Phasing Considerations and Triggers
Land Use	<ul style="list-style-type: none"> Based on the similarities in land use and development scope, it is recommended that SamTrans develop its own density thresholds for both Rapid/Hybrid, but especially BRT service tiers (both residential and job densities) based on the VTA Service Design Guidelines. Land use triggers may occur when the corridor on a whole starts to approach defined housing and job densities – designed to provide more supportive conditions and hopefully sustainable levels of ridership for higher investment services on the ECR corridor.
Ridership / Performance	<ul style="list-style-type: none"> It is recommended that SamTrans develop service standards for both Rapid and BRT services for its refined service design guidelines. VTA thresholds can serve as a guide for potential service thresholds (50% increase in boardings per revenue hour for Rapid over local, and an additional 20% increase in boardings per revenue hour for BRT over Rapid). Performance can trigger the need to consider service upgrades when local services meet and significantly exceed service standards for several consecutive years.
Congestion / Travel Time	<ul style="list-style-type: none"> It is recommended that SamTrans quantify an approximate increase in travel speed or travel time savings between local and Rapid services, as well as Rapid and BRT services. One trigger to consider upgrading from Rapid to BRT service on the Corridor could be if operating speeds for Rapid are falling well below the expected premium speed differential between local and Rapid (thus speed in this case acts as a proxy for corridor congestion and delay).



15.0 IMPLEMENTATION TIMEFRAME AND SCHEDULE

This section presents the conceptual implementation plan (i.e., schedule) for the proposed near- and long-term service concepts that comprise the two enhanced service levels of the El Camino Bus Rapid Transit (BRT) Phasing Plan. This implementation plan is high-level and provides generalized timeframes for implementation activities. The plan included for this study does not delve into durations for all detailed activities expected in the future.

More information on the proposed implementation plan is contained in **Appendix M**.

15.1 SUMMARY OF IMPLEMENTATION TIMEFRAMES

Table 15-1 summarizes the expected implementation timeframes for the three service concepts that represent the two potential service strategy options for enhancing bus service on the Corridor in the future, as well as potential factors that could impact implementation.

TABLE 15-1: SUMMARY OF IMPLEMENTATION TIMEFRAMES

Concept	Implementation Timeframe	Potential Factors to Consider that Could Impact Implementation Timeframe
Concept 2: Full Rapid	27 months	<ul style="list-style-type: none"> • Coordination with local jurisdictions and coming to agreement on final design for bus stops • Coordination with Caltrans during design and engineering • Difficulties in procuring full funding for improvements
Concept 5: Hybrid A	30 months	<ul style="list-style-type: none"> • Coordination with local jurisdictions and coming to agreement on final design for bus stops • Coordination with Caltrans during design and engineering • Difficulties in procuring full funding for improvements
Concept 10: Full BRT	123 months	<ul style="list-style-type: none"> • Coordination with local jurisdictions and coming to agreement on final design for bus stations • Coordination with Caltrans during design and engineering • Difficulties in procuring full funding for improvements • Environmental approvals (potential to have serious schedule implications) • Right of way acquisition if needed (potential to have serious schedule implications)



15.2 RAPID/HYBRID RAPID CONCEPT IMPLEMENTATION

Key activities for implementing Full Rapid and Hybrid Rapid service in the near-term are as follows (note conceptual planning and feasibility study have been undertaken with this study and no environmental clearance is assumed).

- **Engineering and Design** - Once the Board approves further studies, engineering and design will occur for about 9 months (Full Rapid and Hybrid Rapid). Engineering and design will principally focus on station improvements, vehicle specifications and requirements, and related Transit Signal Priority (TSP) specifications. Activities under this task will include utility coordination, permits and approvals.
- **Funding** - Funding activities will start concurrently with engineering and design and become more urgent once reliable cost estimates are developed. The funding activity may take up to 12 months (Full Rapid and Hybrid Rapid) and will likely continue after engineering and design are done. Funding activities include identifying sources, applying for funding, and procuring or obtaining agreements for funding.
- **Contractor Procurement** - Once funding is procured, the project will move into contractor procurement immediately, which is expected to take about 3 months (Full Rapid and Hybrid Rapid). This step includes notice to bid, bidding evaluation, and approval.
- **Construction** - Once the contractor is selected, construction, testing and commissioning activities will take place for the next 12 months (Full Rapid) or 15 months (Hybrid Rapid). This will include construction of enhanced stops, implementation of minor improvements at other stops (Hybrid Rapid only which is estimated to take an additional three months beyond Rapid-only stop improvements), as well as installation of the TSP systems. It is noted that the construction timeframe is based on a conservative estimate of resource deployment to minimize costs – a quicker construction timeframe could be achieved, with deployment of multiple work crews simultaneously and additional costs (including those for additional traffic management crews).
- **Vehicle Procurement** - Vehicle procurement for the 17 new vehicles will begin concurrently with construction for Full Rapid or at about 6 months into the construction period for the Hybrid Rapid (3 new vehicles). This activity will include notice to bid, evaluation of bids, and selection of a preferred vendor. This process, including testing of the vehicles, will take about 12 months. This timeframe is based on research that the bus delivery backlog is about 9 to 12 months to build and equip the buses to typical SamTrans requirements. It is assumed that the vehicles procured by SamTrans are similar to current models already being produced and do not require a new design (or assembly line) that would take longer to develop, build and deliver.
- **Opening** - Overall, the timeframe from initial Board approval to study to the first day of service will be about 27 months for Full Rapid and 30 months for Hybrid Rapid.



Potential factors that may delay implementation include:

- **Local Coordination** - Coordination with local jurisdictions and coming to an agreement on the final design may result in longer than anticipated implementation timelines. Coordination may revolve around stop design, TSP, etc.
- **Caltrans Coordination** – El Camino Real is a state highway under Caltrans’s ultimate jurisdiction. Negotiation over any changes along the corridor must be undertaken and could result in delays to the project.
- **Funding** – Procurement of full funding could take longer than expected as well.

15.3 FULL BRT CONCEPT IMPLEMENTATION

Key activities for implementing Full BRT service in the long-term are as follows:

- **Draft Environmental Studies and Conceptual Engineering (15%)** – Once the SamTrans Board approves further study, draft environmental studies and conceptual engineering will be conducted for 36 months or 3 years. Activities under this task will include 15% design for bus lanes and stations, fleet planning and initial specifications, operating plan development and cost development (operating and capital). For this three year duration, the majority of time will be spent developing the draft environmental studies, including public outreach and the collection and response to public comments. A preferred alternative will be identified and then vetted.
- **Preferred Alternative and Preliminary Engineering** – In this stage, the preferred alternative will be confirmed following outreach and finalization of the environmental studies. Preliminary engineering for the preferred alternative will follow, which represents the 35% design stage to refine conceptual engineering to improve the project scope, cost estimates, and traffic management plan. Although the goal is for all additional right-of-way (ROW) for transit-only lanes to be taken from existing median, traffic, and parking lanes, there may be select locations where minimal ROW might be needed (for instance encroachment into a curb bulb, etc.). This study made an initial assessment of continuous segments of the Corridor where median, traffic, and parking lanes could provide the necessary 24 feet of width for transit-only lanes. It considered average curb-to-curb, median, travel lane, turn lane, and parking lane widths for each block face along the Corridor but acknowledges variations within those block faces may exist. Preliminary engineering will identify any such locations and the extent of the takes, if necessary.²¹ Overall, this activity will take up to 18 months. An alternative to ROW acquisition, if needed.

²¹ Again, the overriding goal is to obtain ROW for bus lanes using existing traffic lanes and parking lanes. It is acknowledged that in some select locations, this may not be possible – thus minimal ROW acquisition outside of the curb-to-curb area may be needed. This will be identified in subsequent stages, after the engineering and design process.



- **Final Design, Construction Documents, and Funding** – About halfway through preliminary engineering, funding activities will commence. Once preliminary engineering is finalized, final design as well as production of construction documents will occur. This task thus includes preparing the full engineering package including the project management plan, quality control/quality assurance for construction, utility relocation, and obtaining permits, etc. Funding activities will include identifying sources, applying for funding, and procuring or obtaining agreement for funding. This stage will take about 24 months.
- **ROW Acquisition** – If ROW acquisition is required, it will start about halfway through the Final Design, Construction and Funding task, once the majority of funding has been arranged and the locations for potential ROW acquisition are finalized. ROW acquisition will include valuating property and seeking to purchase this ROW. ROW acquisition is estimated to take up to 18 months, although this could be highly variable depending on the extent of acquisition required.
- **Contractor Procurement** - Once final design, construction documents and ROW acquisition (if needed) are complete, the project will move into the contractor procurement immediately, which will take about 6 months (including notice to bid, bidding evaluation, and approval).
- **Construction** - Once the contractor is selected, construction, testing and commissioning activities will take place for the next 48 months. This will include construction of the new BRT stations, the bus lanes, as well as the queue jumps lanes. This activity also includes minor pavement improvements to mixed flow lanes, as well as final activities once the bus lanes are ready, including final signage and striping. It is noted that the construction timeframe is based on a conservative estimate of resource deployment to minimize costs – a quicker construction timeframe could be achieved however, with deployment of multiple work crews simultaneously which would raise costs (including those for additional traffic management crews).
- **Vehicle Procurement** – Twelve (12) months prior to initiation of BRT service, vehicle procurement for 14 new vehicles will begin. This activity includes notice to bid, evaluation of bids, and selection of a preferred vendor. This process, including testing of the vehicles, will take about 12 months. This timeframe is based on research that the bus delivery backlog is about 9 to 12 months to build and equip the buses to typical SamTrans requirements. It is assumed that the vehicles procured by SamTrans are similar to current models already being produced and do not require a new design (or assembly line) that would take longer to develop, build and deliver.
- **Opening** – Overall, the timeframe from initial Board approval to study to the first day of service will be about **123 months**.

Potential factors that may delay implementation include:

- **Local Coordination** - Coordination with local jurisdictions and coming to an agreement on the final design may result in longer than anticipated implementation timelines. Coordination may revolve around stop design, TSP, etc.



- **Caltrans Coordination** – El Camino Real is a state highway under Caltrans’s ultimate jurisdiction. Negotiation over any changes along the corridor must be undertaken and could result in delays to the project – particularly if design exceptions are required.
- **Funding** – Procurement of full funding could take longer than expected as well.
- **Environmental Approvals** – Depending on the level of changes to the street and ROW, the environmental approval process (along with any ROW acquisition, if needed) have the greatest chance of impacting and thus delaying implementation of the 2040 Full BRT.
- **ROW Acquisition** – If required, the amount of ROW required in sensitive or dense areas outside of the curb-to-curb area, the higher the likelihood for implementation delays due to potential opposition (from residents, businesses, etc.) as well as potential utility conflicts and relocation issues.



16.0 FUNDING PLAN

This section identifies potential funding sources for the capital costs for the three concepts that represent the two potential service strategy options for enhancing bus service on the Corridor in the future. These include:

1. Year 2020 Full Rapid (Rapid Overlay + ECR);
2. Year 2020 Hybrid A (76 stops with 12-minute service frequencies); and
3. Year 2040 Full Bus Rapid Transit (BRT).

More information on potential and recommended funding sources is contained in **Appendix N**.

16.1 POTENTIAL CAPITAL AND OPERATING FUNDING SOURCES

This section identifies potential funding sources and comments on their relevance to the service concepts. This section only identifies potential sources, but does not address the likelihood that SamTrans would be able to procure such funding. Recommended funding sources are presented in the following section.

16.1.1 REGIONAL LEVEL – MTC FUNDS

Transit Performance Initiative Program

In October 2012, the Metropolitan Transportation Commission (MTC) committed \$82 million over four years in federal Cycle 2 / Surface Transportation Program (STP) and Congestion Mitigation and Air Quality Improvement (CMAQ) funds to the Transit Performance Initiative (TPI) Incentive Program. The first two cycles of the program have passed. All regional agencies are eligible for funding from either TPI program.

Options studied under the ECR BRT Phasing Study will not be ready for consideration in the second round of funding, although there is \$27 million in funds remaining for the last two years of the program (Fiscal Year (FY) 2015-16).

Cap and Trade Funding Framework

In response to the adoption of Plan Bay Area, MTC created the Cap and Trade Funding Framework to address climate change concerns. The Cap and Trade Funding Framework will guide regional investment priorities for the \$3.6 billion in cap and trade revenues the Bay Area expects to receive over the next thirty years. MTC staff developed five investment categories and initial funding amounts. While the guidelines



and criteria for the categories have not been finalized, of the five categories, the Transit Operating and Efficiency Program has the most potential as a funding source for the options studied as part of the ECR BRT Phasing Plan Study. It is unclear at this time if the funds will be made eligible for either capital or operating costs, or both.

Regional Transportation Improvement Program

The State Transportation Improvement Program (STIP) provides capital funding for a significant number of transportation projects around the State. MTC is responsible for developing regional project priorities for the STIP for the nine counties of the Bay Area. The Regional Transportation Improvement Program (RTIP) is the region's proposal to the State for STIP funding. Only projects that have been identified within the RTIP are eligible for STIP funding consideration, so the first step for a project to be considered for STIP funds is to be listed within the RTIP. Each county within the state receives a fiscally constrained share target. For FY2014, San Mateo County's share was just over \$21 million, which covers programming for the five fiscal years from 2014-15 through 2018-19.

16.1.2 STATE LEVEL

The State of California has created a number of different funding mechanisms for transportation capital costs. Most of the funding mechanisms, such as the STIP, are distributed through to the regional metropolitan planning organizations, such as MTC, and those programs are described in the regional level section. The California State Infrastructure Bank, described below, is separate from the MTC funding programs.

California State Infrastructure Bank – Infrastructure State Revolving Fund Program

The Infrastructure State Revolving Fund (ISRF) Program provides loan financing to public agencies and non-profit corporations for a wide variety of capital funding for infrastructure and economic development projects. ISRF Program funding is available in amounts ranging from \$50,000 to \$25 million, with loan terms of up to 30 years. Interest rates are set on a monthly basis.

16.1.3 FEDERAL LEVEL

In 2012, Moving Ahead for Progress in the 21st Century (MAP-21) was signed into law, reauthorizing surface transportation programs through FY2014. All projects that receive any amount of federal funding or undergo a federally required action are required to be included in MTC's TIP, which prioritizes projects/programs within a financially constrained environment. Competition is quite strong both nationally and within the Bay Area to receive federal funds.



Transportation Investment Generating Economic Recovery Discretionary Grant Program

The Transportation Investment Generating Economic Recovery (TIGER) Discretionary Grant program is managed by the US Department of Transportation to invest in road, rail, transit and port projects that promise to achieve critical national objectives. In FY2014, \$600 million was appropriated through September 30, 2016 for national infrastructure investments. A highly competitive grant program, 72 projects were awarded funding through the FY14 TIGER program, out of 797 projects that applied. Project funding amounts ranged from \$85,000 for a planning study to \$105 million for an intermodal freight program.

New Starts/Small Starts

The Federal Transit Administration (FTA) sponsored New Starts/Small Starts Program provides grants for new and expanded rail, bus rapid transit, and ferry systems that reflect local priorities to improve transportation options in key corridors. Eligible BRT projects are those operating in mixed traffic that represent a substantial investment in the corridor, including:

- Traffic signal priority;
- Defined stations; and
- Operation of short-headway, bi-directional services for a substantial part of weekdays and weekend days

Elements that are emphasized as part of project justification include increased mobility, environmental benefits, congestion relief, relationship to economic development and higher density land uses, and cost effectiveness. Eligible New Starts projects must have a total project cost at or exceeding \$250 million, with funding requests above \$75 million. Eligible Small Starts projects must have a total project cost of less than \$250 million, with funding requests under \$75 million. Both programs require a 20% local match.

Bus and Bus Facilities (Section 5339)

Another federal program is the Bus and Bus Facilities Program which can be used to fund bus procurement, bus maintenance facilities, bus shelters and signage, transportation centers, intermodal terminals, and park-and-ride facilities. This method of funding is secured through Congressional earmarks and requires 20% local match. Previously grants have ranged from \$50,000 - \$15 million.

Urbanized Formula Funds (Section 5307)

Federal funding is provided for transit capital projects based on a formula of population, population density, and other factors associated with transit service and ridership. The formula grants are



appropriated annually by Congress and distributed through MTC. SamTrans currently uses this funding source for replacing buses.

Highway Funds/Flexible Funds

Highway funds may be used to finance transit capital projects through a mechanism called flexible funding. There are two mechanisms that, if flexed, add additional funds to the urbanized formula funds. These include:

- **STP:** STP can be used for roadway or transit improvements and facilities. These funds may be utilized (as capital funding) for public transportation capital improvements, car and vanpool projects, fringe and corridor parking facilities, bicycle and pedestrian facilities, and intercity or intracity bus terminals and bus facilities.
- **CMAQ:** CMAQ is apportioned based on population and the level of non-attainment for air quality standards. Its purpose is to fund projects and programs that help attain or maintain national ambient air quality standards and reduce congestion. These are considered “flexible funds” and can be used for Federal Highway Administration and FTA projects. Measures currently funded by the MTC include the, the Regional Bicycle and Pedestrian Program, Lifeline Program, the Free Transit Program, TransLink® (universal fare card), Regional Rideshare, and Traffic Operations Systems (TOS)/Incident Management strategies on the highway system.

16.2 PROPOSED SERVICE CONCEPT CAPITAL FUNDING STRATEGIES

16.2.1 2020 FULL RAPID

The 2020 Full Rapid service concept has estimated capital costs of \$42.0 million, including 17 new 60' diesel-hybrid vehicles. It is recommended that the 2020 Full Rapid service concept capital costs be provided through the MTC TPI program to the fullest extent (i.e., the maximum amount of funding should be sought from this program), with other funding sourced from regional sources such as the Cap and Trade fund, followed by federal sources in that order. **Table 16-1** highlights the proposed funding options for this service concept.



TABLE 16-1: PROPOSED FUNDING OPTIONS FOR FULL RAPID

Potential Federal Source(s)	Potential Regional Source(s)
<ul style="list-style-type: none"> • FTA Small Starts • FTA Section 5309 for vehicles 	<ul style="list-style-type: none"> • TPI for TSP • TPI for enhanced stations and real time information • Cap and Trade funds (fund request dependent on to-be-release eligibility rules)

16.2.2 2020 HYBRID RAPID A

The 2020 Hybrid A service concept has estimated capital costs of \$21 million, including 3 new 60' diesel-hybrid vehicles.

It is recommended that the 2020 Hybrid A service concept capital costs be provided through the MTC TPI program to the fullest extent (i.e., the maximum amount of funding should be sought from this program), with other funding sourced from regional sources such as the Cap and Trade fund, followed by federal sources in that order. **Table 16-2** highlights the proposed funding options this service concept.

TABLE 16-2: PROPOSED FUNDING OPTIONS FOR HYBRID RAPID A

Federal	Regional
<ul style="list-style-type: none"> • FTA Small Starts • FTA Section 5309 for vehicles 	<ul style="list-style-type: none"> • TPI for TSP • TPI for enhanced stations, stop improvements and real time information • Cap and Trade funds (fund request dependent on to-be-release eligibility rules)

16.2.3 2040 FULL BRT

The 2040 Full BRT service concept has estimated capital costs of \$176.9 million, including 14 new 60' diesel-hybrid vehicles and a number of roadway improvements. It is recommended that the 2040 Full BRT service concept capital costs be provided through the MTC TPI program to the fullest extent (i.e., the maximum amount of funding should be sought from this program), with other funding sourced from regional sources such as the Cap and Trade fund, followed by federal sources in that order. Options for funding beyond the MTC TPI program are shown in **Table 16-3**.



TABLE 16-3: PROPOSED FUNDING OPTIONS FOR FULL BRT

Federal	Regional
<ul style="list-style-type: none">• FTA New Starts• FTA Section 5309 for vehicles	<ul style="list-style-type: none">• TPI for mixed flow operations, queue jump lanes, TSP, and some station enhancements• Cap and Trade funds (fund request dependent on to-be-release eligibility rules)



