

Caltrain Short-Term Service and Fleet Study

FINAL REPORT

Prepared for the
Peninsula Corridor Joint Powers Board

By
SYSTRA Consulting

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1. Acknowledgements

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2. Executive Summary

For nearly a decade, the Peninsula Corridor Joint Powers Board (PCJPB) has been providing a vitally important public transportation service to San Francisco Bay Area residents. Caltrain is part of a regional, multi-modal public transportation system that provides access and mobility to residents, traffic congestion relief, and improved air quality.

Ridership on Caltrain has been on the rise over the past decade. Over the past year, the PCJPB embarked on a long-term capital investment program to support major infrastructure improvements and the purchase and rehabilitation of new train equipment. In conjunction with the capital investment program, Caltrain is planning to grow its ridership by providing expanded passenger rail service.

The scope of work for the Caltrain Short-Term Service and Fleet Study was framed in the context of these long-term plans. For example, the scope of this study is consistent with the Rapid Rail Study's recommendation for the development of additional, detailed service plans to support capital improvements. This study also reflects the awareness of JPB staff that future service expansion goals need to be addressed in the context of market demand and the plans of other transportation providers, such as the Bay Area Rapid Transit District (BART) and the Santa Clara Valley Transportation Authority (VTA).

An interdepartmental team including representatives from Planning, Rail Services, Engineering, and the VTA developed the scope of the study and guided the work once it was underway. The basic components of the scope of work are listed below:

- Develop initial Caltrain service standards for future use by Caltrain staff.
- Summarize ridership trends and issues from existing data.
- Develop and quantify service patterns for up to six near- (1-3 years) and medium-term (3-5 years) scenarios, including identification of opportunities to reduce dwell time or otherwise improve running time.
- Describe impacts of the service patterns on fleet requirements, yard and terminal capacity, and costs.
- Provide a formula for staff use in determining the utility of potential third track segments.
- Recommend tiered service and capacity increases and modifications over the next five years.

Results and Conclusions

Service and performance standards in various categories were provided to Caltrain staff, who will utilize their internal planning process to develop and implement standards in the future. Ridership trends were described. In order to achieve its overall goal of increasing ridership by 45 percent to 12.5 million annual trips by 2009, and to address specific reverse peak and intra-county trends, Caltrain must continue to improve reliability and adjust and increase service to match demand. This study plays an important role in the planning process by analyzing the most effective ways of utilizing new equipment and improved infrastructure to increase service.

The study team identified six short-term service options for analysis. The options were intended to capture both near- (1-3 years) and medium-term (3-5 years) scenarios and address the key issues facing JPB staff, such as integration with BART service at Millbrae and increased service within Santa Clara County.

It is important to note that Service Options No. 2 and 4 focused on expanded service at Millbrae, while Options No. 3 and 5 focused on expanded Gilroy service. The study, however, did not include a combined option with common improvements in both areas.

The service options are described below:

- **Service Option No. 1:** Current Caltrain service schedules were reviewed to identify potential modifications to optimize existing service in the immediate future. Peak and reverse-peak directions during both the morning and evening travel periods were addressed.
- **Service Option No. 2:** The primary goal of this effort was to “turn” 10 to 30 percent of the Caltrain trains at Millbrae to and from the south. The capital projects known collectively as “Ponderosa,” and the BART connection at Millbrae, were assumed to be complete and operational.
- **Service Option No. 3:** Provide new service enabling passengers to travel southbound (reverse-peak) during the morning peak period from Palo Alto to Gilroy, and northbound (reverse-peak) during the evening peak period from Gilroy to Palo Alto.
- **Service Option No. 4:** Increase service to a minimum of 84 weekday trains, including more midday service and a longer peak period. This service option reflects many planned changes and improvements to the existing railroad and BART, such as additional equipment, centralized traffic control for the trackage and new interlockings between San Francisco and San Jose, the BART/Caltrain transfer opportunity at Millbrae, and various station improvements and relocations.

- **Service Option No. 5:** Increase service to a minimum of 84 weekday trains, with bi-directional hourly peak service and more Gilroy service. This scenario assumes that the trackage from Tamien to Gilroy will be entirely double-tracked, and that the trackage surrounding Palo Alto will support the turning of trains to and from the south at Palo Alto.
- **Service Option No. 6:** Increase train service to a minimum of 84 weekday trains, incorporating repetitive zone patterns.

The table on the following page summarizes the operating and cost characteristics of the six options. All of the options are compatible with current plans for maintenance facilities.

Table 1: Summary Table of Findings

	Service Option	Operating Characteristics					Cost Indices		
		No. of New Trains	Total No. of Trains	No. of Gilroy Trains	No. of Cars	No. of Engines	Revenue Train Hours	Revenue Car Miles	Revenue Locomotive Miles
	Near-Term (1-3 Years)								
1	Near-Term Service Optimization	2	70	8	72	16	38,073	5,252,847	1,201,064
2	Turn Selected Trains at Millbrae	2 / 12 turn	70	8	72	16	36,633	5,023,595	1,151,584
3	Palo Alto - Gilroy Additional Train Service	2 / 6 Gilroy service ext.	70	14	72	16	39,269	5,447,264	1,258,781
	Medium-Term (3-5 Years)								
4	Medium-Term Service Optimization	18 (10 off peak)	86	8	79-80	18	44,475	6,071,264	1,396,790
5	Gilroy Service Extension	18 (10 off peak)	87	20	81	19	49,386	6,484,218	1,555,052
6	Completely New Schedule - Repetitive Zone Patterns	32 (10 off peak)	100	8	88	28	50,345	6,302,599	2,024,120

3. Introduction and Purpose

During the past two years, the staff of the Peninsula Corridor Joint Powers Board (JPB) completed two significant plans that set goals, policies, and implementation priorities for Caltrain for the next twenty years: the Caltrain 20-Year Strategic Plan and the Rapid Rail Plan. These plans established long-term guiding principles, policies and specific objectives for the rehabilitation, enhancement, and expansion of the entire system.

The scope of work for the Caltrain Short-Term Service and Fleet Study was framed in the context of these long-term plans. For example, the scope of this study is consistent with the Rapid Rail Study's recommendation for the development of additional, detailed service plans to support capital improvements. This study also reflects the awareness of JPB staff that future service expansion goals need to be addressed in the context of market demand and the plans of other transportation providers, such as BART and the Santa Clara VTA.

The goal of this study was to improve passenger rail service with the intent of creating conditions (more capacity and reliable service) that will contribute to increased ridership.

An interdepartmental team including representatives from JPB Planning, Rail Services, Engineering, and the VTA developed the scope of the study and guided the work once it was underway. The basic components of the scope of work are listed below:

- Develop initial Caltrain service standards for future use by Caltrain staff.
- Summarize ridership trends and issues from existing data.
- Develop and quantify service patterns for up to six near- (1-3 years) and medium-term (3-5 years) scenarios, including identification of opportunities to reduce dwell time or otherwise improve running time.
- Describe impacts of the service patterns on fleet requirements, yard and terminal capacity, and costs.
- Provide a formula for staff use in determining the utility of potential third track segments.
- Recommend tiered service and capacity increases and modifications over the next five years.

The study reviewed two distinct improvement concepts in Options No. 2 and 4 and Options No. 3 and 5, covering Millbrae and Gilroy services. The study did not include a combined option with common improvements in both areas.

4. Service and Performance Standards

Service standards are designed to provide guidance for the planning and development of rail system service. Service standards can be used to guide a variety of areas, such as passenger comfort and satisfaction, system planning and schedule design.

Performance standards are designed to measure how the Caltrain system is performing. These standards can be used to quantify Caltrain performance characteristics, such as service delivery and system productivity.

Both service standards and performance standards will assist system managers in determining whether Caltrain service is satisfactory or needs improvement. It should be noted that Caltrain's service standards and performance standards are intrinsically linked, and that modification to a service standard will be reflected by a change in performance.

The development of service and performance standards is a multi-step process. The first step in the development of standards is adopting system goals, such as the 20 Year Strategic Plan. The goals represent an ideal state of development, or the highest standard of achievement that Caltrain hopes to reach. The goals will provide a clear sense of direction to Caltrain managers, and serve as a basis of comparison for Caltrain's present state, and what it should be in the future.

The next step in the development of standards is the creation of categories for service and performance standards, and an articulation of objectives and standards within those categories. Taken together, these standards will assist in clarifying the role of the Caltrain system, and will help to prioritize Caltrain efforts toward potential improvement projects. Recommended standards quantify the desired result, such as measurements for operating a safe service or completing scheduled rail trips. Categories for service and performance standards are as follows:

Service Standards

- Station Operating and Access Standards
- System Planning Standards
- Schedule Design Standards

Performance Standards

- Service Delivery Standards
- Economic and Productivity Standards

Station Operating and Access Standards measure the ambience that Caltrain riders experience when using the system. This includes customer service and information, and passenger environmental conditions such as station cleanliness and staffing.

System Planning Standards set guidelines for the development of current Caltrain services and the consideration of potential new services. These standards include criteria for ongoing planning studies, improvements in passenger transfer movements and intermodal linkages, and improved coverage of the Caltrain service area.

Schedule Design Standards set guidelines for the development and revision of operating schedules. These criteria provide schedule policies related to frequency of service, hours of service, and the differences between peak and off-peak services.

Service Delivery Standards indicate how Caltrain should perform on a daily basis, and measure the service actually delivered to the passenger. These criteria include measurements of vehicle availability, on-time performance, headway adherence, and the successful completion of scheduled trips.

Economic and Productivity Standards measure the financial performance of the system. These measurements include the farebox recovery ratio, operating costs per passenger, financial stability, fare pricing, and fare policy.

Many different types of service and performance standards can be selected to measure any area of Caltrain operations and management. In addition, different standards can be used to measure what is essentially the same area of service or performance. Finally, there is always some tension between various standards, as a significant achievement in one area may come at the expense of achievement in another area.

The adoption of service and performance standards will have significant impacts on the management and operation of Caltrain, as resources are focused towards measuring and meeting the standards. At the minimum, additional staff time will be needed to compile and assess the data used to measure achievement of, or progress towards, service and performance standards.

It is our recommendation that a limited number of key service and performance standards be selected and that Caltrain focus on achievement of those key standards. Issues to consider when selecting standards are as follows:

- Level of service or performance to be attained
- Validation requirements
- Reporting period
- Use of the standards
- Burden incurred in measuring the standard
- "New" versus "established" Caltrain services
- Impacts to other agencies

Staff will utilize the Caltrain internal planning process to develop and implement standards in the future.

5. Ridership Trends

Caltrain ridership has continually grown since the PCJPB assumed responsibility for the service in July, 1992, and has rebounded beyond its former peak level established in 1956. In 1998-99, about 26,800 passengers rode Caltrain on an average weekday, which translates to more than 8.6 million riders during that fiscal year. Approximately 80 percent of Caltrain passengers ride during the peak period. Over 50 percent of passengers board in San Francisco throughout the day.

Several trends are driving growth in Caltrain ridership. The unprecedented economic boom of the past five years, particularly in Silicon Valley, is contributing significantly to increased demand especially in the less traditional, yet growing travel markets of Gilroy (and beyond) and San Francisco (reverse peak direction) to Silicon Valley. More than 250,000 jobs have been added in Silicon Valley since 1992, with 60,000 being added in 1997 alone. The long-term forecast shows another 200,000 new jobs by 2010. Many of these new jobs will be in northwest Santa Clara County, but a significant amount of growth will also occur in the southern county area, such as around Blossom Hill (IBM campus) and Morgan Hill (Abbott Labs, Cisco campus).¹

Intra-county commuting on Caltrain is also on the rise in Santa Clara County, primarily due to the rapid growth in Silicon Valley and service extension to Gilroy starting in 1992. Historically, approximately 90 percent of the people who live in Santa Clara County also work in the county. The number of trips on transit is also projected to grow faster than the number of autos in the county.²

In addition, Caltrain's ridership is growing due to improving connectivity and service expansions in other transit systems, providing more direct, convenient and seamless public transportation in the San Francisco Bay Area. Connecting services include:

- Bus - Bus service is provided extensively throughout the corridor by the Muni (San Francisco Municipal Railway), VTA (Valley Transportation Authority), and SamTrans (San Mateo County Transit District);
- Light rail - Existing light rail service is provided by the Muni Metro (from Embarcadero to the Fourth and King Caltrain Terminal) and the VTA (from southern San Jose to the Caltrain Tamien station, and from North San Jose to the new intermodal Mountain View Transit Center);
- Shuttles - Thirty-three shuttles are provided by Caltrain with financial support from the AQMD and employers along the corridor. The Caltrain shuttle program has grown tremendously over the past six years, carrying over 3,400 riders per day, which accounts for 13 percent of daily Caltrain ridership;

¹ Silicon Valley Projections 99, 1999.

² Ibid.

- Other trains – Weekday commuter rail service is also provided by the Altamont Commuter Express (ACE) from Stockton to the San Jose Diridon Caltrain station. Intercity rail service is provided by the Capitol Corridor from Sacramento to San Jose Diridon (three round trips per day) and by Amtrak with its Coast Starlight, which makes one stop per day each way at San Jose Diridon.

In addition to these existing services, there are intermodal service extensions being planned and implemented that have the potential to significantly increase Caltrain ridership, as follows:

- BART at Millbrae - The new BART/Caltrain intermodal station is scheduled to be completed in fiscal year 2001-02. The new SFO extension is expected to boost BART ridership by 70,000 when it opens, and the estimated daily ridership at the Millbrae station is projected to be 33,000 by 2010.³
- Muni Third Street Light Rail Extension - Muni plans to begin construction in 2000, with service operating in 2003. With a projected ridership of 71,000 in 2015, a relocated Caltrain Bayshore station would provide an important intermodal link for those traveling further south.
- VTA Vasona Light Rail Extension - This VTA light rail extension would connect to the Caltrain San Jose Diridon station, providing greater access throughout the urban core of San Jose and the southwest suburbs to Campbell.
- Fremont-South Bay Commuter Rail - VTA is considering a near- to mid-term commuter rail connection from San Jose to BART in southern Alameda County. An intermodal station would be located at either San Jose Diridon or Tamien.

Ridership Profile

A growing number of San Francisco residents have been riding Caltrain in the reverse peak direction. From 1990 to 1996, 25 percent more San Francisco residents rode to jobs in San Mateo and Santa Clara counties during weekday mornings.⁴ San Francisco residents also have a greater propensity to use transit than residents in the other two counties; according to the 1990 Census, 18 percent of San Francisco residents used transit to get to work.

Due to its comparatively large land area, population, and employment engine of Silicon Valley, Santa Clara County also represents a significant market for Caltrain ridership. In 1996, 25 percent of all morning trips were made within this county, making it the top county-to-county commute market that year. This was largely attributed to the Gilroy extension, which had over 80 percent of patrons traveling within the county.⁵ Strong job growth is likely to contribute to an expanded ridership in Santa Clara County. More than

³ San Francisco Chronicle, June 15, 1999.

⁴ Caltrain 20-Year Strategic Plan, October 1997.

⁵ Caltrain 20-Year Strategic Plan.

25 percent of the Bay Area's jobs, just over one million, are expected to exist in Santa Clara County by 2010.⁶

San Mateo residents commute mostly outside of their county. Projected job growth along the Highway 101 corridor for such places as the San Francisco International Airport, Oyster Point and Redwood Shores, has the potential to grow ridership in this county. The Caltrain shuttle program plays an important role in San Mateo County, connecting riders from Caltrain stations west of Highway 101 to employment sites to the east of the highway.

Future Ridership

According to the Short Range Transit Plan (1999), Caltrain is planning to increase its ridership to 12.5 million annual trips by 2009, which represents a 45 percent increase from the 8.6 million in FY 1998-99. Caltrain also anticipates a doubling in ridership by 2017.⁷ New ridership is expected as a result of the factors shown in the table below.

Table 2: Factors Expected to Influence Ridership Increases

Factor	Riders
Population and Job Growth	4,300
Regional Rail Connections (Muni Metro at SF terminal and Bayshore, BART at Millbrae, VTA light rail at Mtn. View and SJ terminal)	3,800
Service Level Increases (from 60 to 86 trains)	2,300
Run-time Reductions (20%)	5,400
Airport Connections (SFO, SJ Airport)	3,200
Transit-Oriented Development	2,700
Shuttle Connections	1,800
Gilroy Service Extension (from 8 to 24)	3,000
Parking Expansion	1,800
TOTAL	28,300

Source: Caltrain 20-Year Strategic Plan

By 2010, the Caltrain Market Demand Study projected that 10,000 San Mateo County residents would use Caltrain to get to work in San Francisco; 7,000 residents from Santa Clara County would use Caltrain to travel to work in San Francisco; and, the 3,500 Santa Clara County residents would use Caltrain to travel within their county.

Consistent with previous findings, a recent MTC forecast for commuting in the Bay Area shows that the most growth in the near term (2000-2010) will occur in the reverse peak direction for San Francisco residents (24.6 percent) followed by San Mateo residents

⁶ Caltrain Market Demand Study.

⁷ Caltrain Market Demand Study, Caltrain 20-Year Strategic Plan.

(15.0 percent) – both traveling to Santa Clara County / Silicon Valley jobs (see table below). For Santa Clara County residents the most growth will occur with intra-county commuting (11.1 percent), with a decline in northbound commuting to San Mateo and San Francisco counties. For the long term (2000-2020), current trends will continue with the most growth occurring with Santa Clara intra-county commuting (18.8 percent), followed by San Francisco reverse peak commuting to Santa Clara County (18.6 percent) and to San Mateo County (18.5 percent).

Table 3: County-to-County Commuting in the San Francisco Bay Area 1990-2020

County of Residence	County of Work					Percent Change		
		1990	2000	2010	2020	1990 to 2000	2000 to 2010	2000 to 2020
San Francisco	San Francisco	299,926	305,617	343,348	358,014	1.9%	12.3%	17.1%
San Francisco	San Mateo	32,170	37,633	42,837	44,590	17.0%	13.8%	18.5%
San Francisco	Santa Clara	7,992	9,296	11,587	11,026	16.3%	24.6%	18.6%
San Francisco	TOTAL	371,409	383,770	435,741	453,131	3.3%	13.5%	18.1%
San Mateo	San Mateo	199,760	226,127	245,457	262,353	13.2%	8.5%	16.0%
San Mateo	San Francisco	78,832	79,254	85,360	91,209	0.5%	7.7%	15.1%
San Mateo	Santa Clara	44,001	49,376	56,781	56,946	12.2%	15.0%	15.3%
San Mateo	TOTAL	342,107	373,388	409,484	433,885	9.1%	9.7%	16.2%
Santa Clara	Santa Clara	710,582	795,064	883,522	944,139	11.9%	11.1%	18.8%
Santa Clara	San Francisco	7,536	7,214	7,015	8,215	-4.3%	-2.8%	13.9%
Santa Clara	San Mateo	31,896	34,186	34,092	37,984	7.2%	-0.3%	11.1%
Santa Clara	TOTAL	783,680	868,452	960,240	1,030,554	10.8%	10.6%	18.7%

Source: MTC DataMart website, Updated 10/13/99

Service Implications

Caltrain’s challenge is to continue to improve reliability and adjust and increase service to match demand. This is evident in the careful planning for expanded special event service to the new Pac Bell Stadium near the San Francisco terminal, where Caltrain is planning to add service in order to meet the needs of an anticipated 4,000 additional riders. Caltrain must also continue to provide flexible shuttle service for new riders commuting to Silicon Valley jobs. The intermodal hubs at such stations as Mountain View and Tamien will continue to play a prominent role as the VTA light rail system expands and matures. This study plays an important part in the planning process by analyzing the most effective ways of utilizing new equipment and improved infrastructure to increase service.

6. Dwell Time Reduction

Caltrain's growing ridership, including users such as bicyclists, those using wheelchairs, and luggage carriers, has also created a general increase in station dwell time. Increased dwell time causes delays and reduced reliability for customers system-wide. Since the Caltrain corridor has substantial intermediate ridership over a lengthy route, local trains are necessary to serve all markets. Caltrain and the Study team have evaluated several options to serve customers reliably, including schedule re-timing, additional locomotives, consist revisions, and station reconfiguration. While some options are not feasible or funded in the short term, the following are examples of physical and operational changes that Caltrain has been making to improve running time:

- Capital improvements, such as platform relocation and center-line fencing, to eliminate the "hold-out rule" constraint that prevents two trains from occupying a station at the same time.
- The relocation of signals to increase visibility by engineers and eliminate speed restrictions in certain areas.
- Closure of Castro station, recently approved by the PCJPB.

The train performance calculations performed for this study show that running time is quite sensitive to the number of locomotives and cars in the trainset. For example, with a single locomotive, a five-car trainset will make the trip between San Francisco and Gilroy nearly four minutes slower than a four-car trainset. However, a five-car trainset with two locomotives will make the trip nine minutes faster than five cars with a single locomotive. These calculations suggest that Caltrain should consider the use of additional locomotives to increase speeds on existing trains. Also, the use of additional locomotives should be part of any plan to increase train lengths to five or six cars.

Table 4: Service Options Matrix

Service Option	Time Frame	Key Assumptions
Near-Term		
1 Short-term schedule optimization to address reverse peak trends.	1-3 years	<ol style="list-style-type: none"> Based on current schedule with minor reverse peak service increases. Complete and operational: Ponderosa Castro still open
2 Millbrae turns to and from south (10% - 30% of trains)		<ol style="list-style-type: none"> Builds on Option 1. Complete and operational: Ponderosa; BART connection at Millbrae; 93 cars in fleet
3 Palo Alto-Gilroy Extension service (peak)		<ol style="list-style-type: none"> Builds on Option 1. Complete and operational: Ponderosa; BART connection at Millbrae; 93 cars in fleet
Medium-Term		
4 Medium-term schedule optimization with focus on Millbrae turns <ul style="list-style-type: none"> more midday service longer peak period midday (9AM – 3PM) work windows using CTC and more crossovers 	3-5 years	<ol style="list-style-type: none"> Builds on Option 2. Ninety-three cars in fleet. Minimum of 84 trains. BART connection at Millbrae. Centralized train control. Third track between MP 14.2 and 16.8. No hold out rule at most stations on Peninsula. Paul Avenue is replaced by Oakdale/Palou. Third Street light rail is built; Bayshore is relocated about ½ mile south of present location. Millbrae turns are retained and perhaps increased. Bailey station (between Blossom Hill and Morgan Hill) is built.
5 Palo Alto-Gilroy Ext. service <ul style="list-style-type: none"> Hourly service in peak, both directions One midday and one evening roundtrip to Gilroy 		<ol style="list-style-type: none"> Builds on Option 3. Same as service option 4, except for item 10 (no Millbrae turns). Double track between Tamien and Gilroy with no hold-out rule at Gilroy Extension stations. Palo Alto station reconfigured for turnaround service.
6 Repetitive zone express patterns on 30 minute cycle		<ol style="list-style-type: none"> Builds on Option 4. Patterns will operate during morning and evening peaks, in both directions. Northbound, AM: arrive San Francisco 6-9AM; Southbound, AM; depart SF 6:30-8:30 AM Southbound, PM: depart SF 4-7 PM; Northbound, PM: arrive SF 5:30–7:30 PM Suggested patterns: AM North, PM South: Palo Alto Express, Hillsdale Express, South Bay Express (non-stop San Jose – Palo Alto except Santa Clara, Mtn. View), Local AM South, PM North: Reverse Commute Express, Local Millbrae turns (from Option 4) are retained. Gilroy trains make all Santa Clara stops.

EXHIBIT 1

Caltrain Timetable: Service Option No. 1

Near-term Schedule Optimization

		Gilroy/San Jose to San Francisco																												Weekdays									
		Mile-																																					
		Post	Rule	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	79A	81	83	85	87	89	
8	Gilroy	76.8		--	--	--	--	--	5:23	--	--	6:03	--	6:28	--	--	7:10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	San Martin	70.7		--	--	--	--	--	5:32	--	--	6:12	--	6:37	--	--	7:19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7	Morgan Hill	67.1		--	--	--	--	--	5:38	--	--	6:18	--	6:43	--	--	7:25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Blossom Hill	54.8		--	--	--	--	--	5:50	--	--	6:30	--	6:55	--	--	7:37	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6	Capitol	51.3		--	--	--	--	--	5:56	--	--	6:36	--	7:01	--	--	7:43	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Tamien	48.9		4:38	--	5:28	5:43	--	6:03	--	6:30	6:43	--	7:08	--	7:25	7:50	8:03	8:53	9:53	10:53	11:53	12:53	1:53	--	2:53	--	3:53	4:23	--	4:58	5:28	--	6:18	6:53	7:53	8:53	--	
5	San Jose Diridon	46.9		4:45	5:17	5:35	5:50	6:03	6:10	6:28	6:37	6:50	7:00	7:15	7:25	7:32	7:57	8:10	9:00	10:00	11:00	12:00	1:00	2:00	2:30	3:00	3:30	4:00	4:30	4:50	5:05	5:35	6:00	6:25	7:00	8:00	9:00	10:30	
	College Park	45.7	X	--	--	--	--	--	--	--	--	--	--	7:18	--	--	8:00	--	--	--	--	--	--	--	--	3:03	3:33	4:03	4:33	--	5:08	5:38	--	--	--	--	--		
4	San Clara	44.3	X	4:50	5:22	5:40	5:55	6:08	6:15	6:33	6:42	6:55	7:05	7:21	7:30	7:37	8:03	8:15	9:05	10:05	11:05	12:05	1:05	2:05	2:35	3:06	3:36	4:06	4:36	4:55	5:11	5:41	6:05	6:30	7:05	8:05	9:05	10:35	
	Lawrence	40.8	X	4:55	5:27	5:45	6:00	6:13	6:20	6:38	6:47	7:00	7:10	7:26	7:35	7:42	8:08	8:20	9:10	10:10	11:10	12:10	1:10	2:10	2:40	3:11	3:41	4:11	4:41	5:00	5:16	5:46	6:10	6:35	7:10	8:10	9:10	10:40	
3	Sunnyvale	38.8	X	4:59	5:31	5:49	6:04	6:17	6:24	6:42	6:51	7:04	7:14	7:30	7:39	7:46	8:12	8:24	9:14	10:14	11:14	12:14	1:14	2:14	2:44	3:15	3:45	4:15	4:45	5:04	5:20	5:50	6:14	6:39	7:14	8:14	9:14	10:44	
	Mountain View	36.1	X	5:03	5:35	5:53	6:08	6:22	6:28	6:46	6:55	7:08	7:18	7:34	7:43	7:50	8:16	8:28	9:18	10:18	11:18	12:18	1:18	2:18	2:48	3:19	3:49	4:19	4:49	5:08	5:24	5:54	6:18	6:43	7:18	8:18	9:18	10:48	
2	Castro (Rengstorff)	34.8	X	--	--	--	--	--	--	6:49	6:58	--	7:21	--	7:46	--	8:31	--	--	--	--	--	--	--	--	--	--	--	--	--	8:22	--	8:46	--	--	--	--		
	San Antonio	34.1	X	5:07	5:39	5:57	6:12	--	6:32	--	--	7:12	--	7:38	--	7:54	8:20	--	9:22	10:22	11:22	12:22	1:22	2:22	2:52	3:23	3:53	--	4:53	5:12	--	5:58	6:22	--	7:22	8:22	9:22	10:52	
1	California Avenue	31.8	X	5:10	5:42	6:00	6:15	--	6:35	6:53	7:02	7:15	7:25	7:41	7:50	7:57	8:23	8:35	9:25	10:25	11:25	12:25	1:25	2:25	2:55	3:26	3:56	4:26	4:56	5:15	5:31	6:01	6:25	6:50	7:25	8:25	9:25	10:55	
	Stanford Stadium	30.8	X	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	
0	Palo Alto	30.1	X	5:13	5:45	6:03	6:18	6:30	6:38	6:56	7:05	7:18	7:28	7:44	7:53	8:00	8:26	8:38	9:28	10:28	11:28	12:28	1:28	2:28	2:58	3:29	3:59	4:29	4:59	5:18	5:34	6:04	6:28	6:53	7:28	8:28	9:28	10:58	
	Menlo Park	28.9	X	5:16	5:48	6:06	6:21	6:33	6:41	6:59	--	7:21	7:31	7:47	7:56	8:03	8:29	8:41	9:31	10:31	11:31	12:31	1:31	2:31	3:01	3:32	4:02	4:32	5:02	5:21	5:37	6:07	6:31	6:56	7:31	8:31	9:31	11:01	
0	Atherton	27.8	X	5:18	--	6:08	6:24	--	6:44	7:02	--	--	7:34	--	--	8:06	--	8:44	9:34	10:34	11:34	12:34	1:34	2:34	3:04	3:35	4:05	4:35	5:05	--	5:40	--	6:33	6:58	7:33	8:33	9:33	11:03	
	Redwood City	25.4	X	5:24	5:55	6:14	6:30	--	6:50	--	7:13	--	7:40	7:54	8:03	8:12	--	8:50	9:40	10:40	11:40	12:40	1:40	2:40	3:10	3:41	4:11	4:41	5:11	5:28	5:47	6:14	6:39	7:04	7:39	8:39	9:39	11:09	
0	San Carlos	23.2	X	5:28	5:59	6:18	6:34	--	6:54	7:10	--	--	7:44	7:58	8:07	8:16	--	8:54	9:44	10:44	11:44	12:44	1:44	2:44	3:14	3:45	4:15	4:45	5:15	5:32	5:51	6:18	6:43	7:08	7:43	8:43	9:43	11:13	
	Belmont	21.9	X	5:31	6:02	6:21	6:37	6:45	6:57	7:13	--	--	7:47	--	8:10	8:19	--	8:57	9:47	10:47	11:47	12:47	1:47	2:47	3:17	3:48	4:18	4:48	5:18	--	5:54	--	6:46	7:11	7:46	8:46	9:46	11:16	
0	Hillsdale	20.3	X	5:34	6:05	6:24	6:40	--	7:00	7:16	--	7:34	7:50	8:03	8:13	8:22	--	9:00	9:50	10:50	11:50	12:50	1:50	2:50	3:20	3:51	4:21	4:51	5:21	5:38	5:57	--	6:49	7:14	7:49	8:49	9:49	11:19	
	Bay Meadows	20.0	X	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	
0	Hayward Park	18.9	X	5:37	--	6:27	--	--	7:03	--	7:23	--	7:53	--	--	8:25	--	9:03	9:53	10:53	11:53	12:53	1:53	2:53	3:23	3:54	4:24	4:54	5:24	--	6:00	--	6:52	7:17	7:52	8:52	9:52	11:22	
	San Mateo	17.9	X	5:39	6:09	6:29	--	6:51	7:06	--	7:26	--	7:56	8:07	--	8:27	8:42	9:05	9:55	10:55	11:55	12:55	1:55	2:55	3:25	3:56	4:26	4:57	5:26	5:42	6:02	6:27	6:54	7:19	7:54	8:54	9:54	11:24	
0	Burlingame	16.3	X	5:42	6:12	6:32	--	6:54	7:09	--	7:29	--	7:59	8:10	--	8:30	--	9:08	9:58	10:58	11:58	12:58	1:58	2:58	3:28	3:59	4:29	5:00	5:29	--	6:05	--	6:57	7:22	7:57	8:57	9:57	11:27	
	Broadway	15.2	X	5:45	--	6:35	--	6:57	7:12	--	7:32	--	8:02	--	8:20	8:32	--	9:11	10:01	11:01	12:01	1:01	2:01	3:01	3:31	4:02	4:32	5:03	5:32	--	6:08	--	7:00	7:25	8:00	9:00	10:00	11:30	
0	Millbrae	13.7	X	5:48	6:17	6:38	--	7:00	7:15	7:25	--	--	8:05	8:15	--	8:35	--	9:14	10:04	11:04	12:04	1:04	2:04	3:04	3:34	4:05	4:35	5:06	5:35	--	6:11	6:33	7:03	7:28	8:03	9:03	10:03	11:33	
	San Bruno	10.8	X	5:53	6:22	6:43	--	7:05	7:20	7:30	--	--	8:10	--	8:26	8:40	--	9:19	10:09	11:09	12:09	1:09	2:09	3:09	3:39	4:10	4:40	5:11	5:40	5:51	6:16	6:38	7:08	7:33	8:08	9:08	10:08	11:38	
0	So. San Francisco	9.3	X	5:56	6:25	6:46	--	7:08	7:23	7:33	--	--	8:13	8:22	--	8:43	--	9:22	10:12	11:12	12:12	1:12	2:12	3:12	3:42	4:13	4:43	5:14	5:43	--	6:19	--	7:11	7:36	8:11	9:11	10:11	11:41	
	Bayshore	5.2	X	6:01	--	6:51	--	7:13	7:28	--	--	--	8:18	--	--	8:48	--	9:27	10:17	11:17	12:17	1:17	2:17	3:17	3:47	4:18	4:48	5:19	5:48	5:58	6:24	6:45	7:16	7:41	8:16	9:16	10:16	11:46	
SF	Paul Avenue	4.1	X	--	--	--	--	--	7:31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4:21	--	--	5:51	--	--	--	--	--	--	--			
	22nd Street	1.9	X	6:07	--	6:57	--	7:19	7:35	--	--	--	8:24	--	--	8:54	--	9:33	10:23	11:23	12:23	1:23	2:23	3:23	3:53	4:25	4:54	5:25	5:55	6:04	6:30	6:51	7:22	7:47	8:22	9:22	10:22	11:52	
0	4th & King	0.0		6:15	6:40	7:05	7:10	7:27	7:43	7:49	7:56	8:01	8:32	8:38	8:43	9:02	9:08	9:41	10																				

Caltrain Timetable: Service Option No. 1

Near-term Schedule Optimization

		San Francisco to San Jose/Gilroy																												Weekdays								
		Hold-																																				
		Mile Post	Out Rule	22	22A	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	90
SF	4th & King	0.0		5:00	5:30	6:00	6:30	6:55	7:00	7:25	7:30	8:00	8:30	9:00	10:00	11:00	12:00	1:00	2:00	2:30	3:00	3:30	3:55	4:20	4:25	4:49	4:53	5:20	5:25	5:30	5:35	6:00	6:20	7:00	8:00	9:00	10:00	11:59
	22nd Street	1.9	X	5:05	5:35	6:05	6:35	7:00	7:05	7:30	7:35	8:05	8:35	9:05	10:05	11:05	12:05	1:05	2:05	2:35	3:05	3:35	4:00	—	4:30	—	4:58	—	—	5:40	—	6:25	7:05	8:05	9:05	10:05	—	
	Paul Avenue	4.1	X	—	—	6:07	—	—	—	—	—	8:08	—	—	—	—	—	—	—	—	—	—	4:02	—	—	—	—	—	—	—	—	6:27	—	—	—	—	—	
	Bayshore	5.2	X	5:10	5:40	6:11	6:40	7:05	7:10	7:35	7:40	8:11	8:40	9:10	10:10	11:10	12:10	1:10	2:10	2:40	3:10	3:40	4:06	—	4:35	—	5:03	—	—	5:45	—	6:31	7:10	8:10	9:10	10:10	12:09	
1	So. San Francisco	9.3	X	5:16	5:46	6:17	6:46	—	7:16	—	7:46	8:17	8:46	9:16	10:16	11:16	12:16	1:16	2:16	2:46	3:16	3:46	4:12	4:34	4:41	5:03	5:09	—	—	5:51	—	6:37	7:16	8:16	9:16	10:16	12:15	
	San Bruno	10.8	X	5:19	5:49	6:20	6:49	7:11	7:19	7:41	7:49	8:20	8:49	9:19	10:19	11:19	12:19	1:19	2:19	2:49	3:19	3:49	4:15	—	4:44	—	5:12	—	—	5:45	5:54	—	6:40	7:19	8:19	9:19	10:19	12:18
	Millbrae	13.7	X	5:24	5:54	6:25	6:54	—	7:24	—	7:54	8:25	8:54	9:24	10:24	11:24	12:24	1:24	2:24	2:54	3:24	3:54	4:20	—	4:49	—	5:17	—	—	5:59	6:19	6:45	7:24	8:24	9:24	10:24	12:23	
2	Broadway	15.2	X	5:27	5:57	6:28	6:57	—	7:27	—	7:57	8:28	8:57	9:27	10:27	11:27	12:27	1:27	2:27	2:57	3:27	3:57	4:23	—	4:52	—	5:20	—	—	6:02	—	6:48	7:27	8:27	9:27	10:27	12:26	
	Burlingame	16.3	X	5:29	5:59	6:30	6:59	—	7:29	—	7:59	8:30	8:59	9:29	10:29	11:29	12:29	1:29	2:29	2:59	3:29	3:59	4:26	—	4:54	—	5:22	—	—	6:04	—	6:50	7:29	8:29	9:29	10:29	12:28	
	San Mateo	17.9	X	5:32	6:02	6:33	7:02	7:21	7:32	7:50	8:02	8:33	9:02	9:32	10:32	11:32	12:32	1:32	2:32	3:02	3:32	4:02	4:29	—	4:57	—	5:25	—	—	6:07	6:25	6:53	7:32	8:32	9:32	10:32	12:31	
	Hayward Park	18.9	X	5:35	6:05	6:36	7:05	—	7:35	—	8:05	8:36	9:05	9:35	10:35	11:35	12:35	1:35	2:35	3:05	3:35	4:05	4:32	—	5:00	—	5:28	—	—	6:10	—	6:56	7:35	8:35	9:35	10:35	12:34	
	Bay Meadows	20.0	X	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Hillsdale	20.3	X	5:38	6:08	6:39	7:08	—	7:38	7:54	8:08	8:39	9:08	9:38	10:38	11:38	12:38	1:38	2:38	3:08	3:38	4:08	4:35	4:46	5:03	5:15	5:31	—	5:50	5:59	6:13	6:29	6:59	7:38	8:38	9:38	10:38	12:37	
Belmont	21.9	X	5:41	6:11	6:42	7:11	—	7:41	—	8:11	8:42	9:11	9:41	10:41	11:41	12:41	1:41	2:41	3:11	3:41	4:11	4:38	4:49	5:06	—	5:34	—	5:53	6:02	6:16	6:32	7:02	7:41	8:41	9:41	10:41	12:40	
3	San Carlos	23.2	X	5:44	6:14	6:45	7:14	7:29	7:44	8:00	8:14	8:45	9:14	9:44	10:44	11:44	12:44	1:44	2:44	3:14	3:44	4:14	4:41	4:52	5:09	5:20	5:37	—	—	6:05	6:19	6:35	7:05	7:44	8:44	9:44	10:44	12:43
	Redwood City	25.4	X	5:49	6:19	6:50	7:20	7:34	7:49	8:05	8:19	8:50	9:19	9:49	10:49	11:49	12:49	1:49	2:49	3:19	3:49	4:19	4:48	4:57	5:14	5:25	—	—	6:00	6:10	6:24	6:40	7:10	7:49	8:49	9:49	10:49	12:48
	Atherton	27.8	X	5:53	6:23	—	7:24	—	7:53	—	8:23	8:54	9:23	9:53	10:53	11:53	12:53	1:53	2:53	3:23	3:53	4:23	4:52	5:01	5:18	—	5:44	—	6:04	—	6:28	6:44	7:14	7:53	8:53	9:53	10:53	12:52
	Menlo Park	28.9	X	5:55	6:25	6:57	7:27	7:39	7:56	8:10	8:26	8:57	9:26	9:56	10:56	11:56	12:56	1:56	2:56	3:26	3:56	4:26	4:55	5:04	5:21	5:30	5:47	—	6:07	6:16	6:31	6:47	7:17	7:56	8:56	9:56	10:56	12:55
4	Palo Alto	30.1	X	5:58	6:28	7:00	7:30	7:42	7:59	8:13	8:29	9:00	9:29	9:59	10:59	11:59	12:59	1:59	2:59	3:29	3:59	4:29	4:58	5:07	5:24	5:33	5:50	5:58	6:10	6:19	6:34	6:50	7:20	7:59	8:59	9:59	10:59	12:58
	Stanford Stadium	30.8	X	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	California Ave.	31.8	X	6:01	6:31	7:03	7:33	7:45	8:02	8:16	8:32	9:03	9:32	10:02	11:02	12:02	1:02	2:02	3:02	3:32	4:02	4:32	5:01	5:10	—	5:36	5:53	6:01	—	6:22	6:37	6:53	7:23	8:02	9:02	10:02	11:02	1:01
	San Antonio	34.1	X	6:04	6:34	—	7:36	—	8:05	8:19	—	9:06	9:35	10:05	11:05	12:05	1:05	2:05	3:05	3:35	4:05	—	5:04	—	5:29	5:39	—	6:04	—	6:40	—	7:26	8:05	9:05	10:05	11:05	1:04	
	Castro (Rengstorff)	34.8	X	—	—	7:07	—	7:49	—	—	8:36	—	—	—	—	—	—	—	—	—	—	—	4:36	—	5:14	—	—	5:57	—	—	6:28	—	6:57	—	—	—	—	
Mountain View	36.1	X	6:08	6:38	7:10	7:40	7:52	8:09	8:23	8:39	9:10	9:39	10:09	11:09	12:09	1:09	2:09	3:09	3:39	4:09	4:39	5:08	5:17	5:33	5:43	6:00	6:09	6:18	6:29	6:44	7:00	7:30	8:09	9:09	10:09	11:09	1:08	
5	Sunnyvale	38.8	X	6:13	6:43	7:14	7:44	7:56	8:13	8:27	8:43	9:14	9:43	10:13	11:13	12:13	1:13	2:13	3:13	3:43	4:13	4:43	5:13	5:22	5:37	5:47	6:04	6:13	6:22	6:33	6:48	7:04	7:34	8:13	9:13	10:13	11:13	1:12
	Lawrence	40.8	X	6:17	6:47	7:18	7:48	8:00	8:17	8:31	8:47	9:18	9:47	10:17	11:17	12:17	1:17	2:17	3:17	3:47	4:17	4:47	5:17	5:25	5:41	5:51	—	6:17	6:26	6:37	6:52	7:08	7:38	8:17	9:17	10:17	11:17	1:16
	Santa Clara	44.3	X	6:22	6:52	7:23	7:53	8:05	8:22	8:36	8:52	9:23	9:52	10:22	11:22	12:22	1:22	2:22	3:22	3:52	4:22	4:52	5:22	5:30	5:46	5:56	6:12	6:22	6:31	6:42	6:57	7:13	7:43	8:22	9:22	10:22	11:22	1:21
6	College Park	45.7	X	—	—	7:26	7:56	8:08	8:25	—	—	—	—	—	—	—	—	—	—	—	—	4:25	4:55	5:25	—	—	—	—	—	—	—	—	—	—	—	—	—	
	San Jose Diridon	46.9	X	6:30	7:00	7:33	8:03	8:14	8:31	8:44	9:00	9:31	10:00	10:30	11:30	12:30	1:30	2:30	3:30	4:00	4:32	5:01	5:32	5:38	5:54	6:04	6:20	6:30	6:40	6:50	7:05	7:21	7:51	8:30	9:30	10:30	11:30	1:29
	Tamien	48.9	X	6:36	—	7:39	8:09	—	8:37	—	9:06	9:37	—	10:36	11:36	12:36	1:36	2:36	3:36	4:06	4:37	5:06	5:37	5:44	—	6:09	6:26	6:35	—	6:56	—	7:27	7:57	8:36	9:36	10:36	11:36	—
7	Capitol	51.3	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4:42	—	5:42	—	—	6:14	—	6:40	—	—	—	—	—	—	—	—	
	Blossom Hill	54.8	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4:47	—	5:47	—	—	6:19	—	6:45	—	—	—	—	—	—	—	—	
8	Morgan Hill	67.1	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4:59	—	5:59	—	—	6:31	—	6:57	—	—	—	—	—	—	—	—	
	San Martin	70.7	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5:04	—	6:04	—	—	6:36	—	7:02	—	—	—	—	—	—	—	—	
	Gilroy	76.8	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5:16	—	6:16	—	—	6:48	—	7:14	—	—	—	—	—	—	—	—	

• special event service only

Southbound Morning Reverse-Peak Period

Service frequencies are adequate to serve existing demand throughout this time period, except for the one-hour gap between Trains 22 and 24. Because of this, a new Train 22A (temporary designation) has been added, departing San Francisco at 5:30 AM. Since this train can “turn” for Train 45 at San Jose, no additional trainset is required.

We evaluated adding a new express-train departure from San Francisco at 7:55 AM, similar to Trains 28 and 32. Our judgement is that the historical passenger volumes in concert with the level of train service currently provided do not justify such an additional train. (If such an additional train was added, Train 31 would have to “turn” for the new departure, and Train 33 would have to “turn” for Train 36 in 17 minutes, which is marginal, unless, of course, an additional trainset was added to the weekday program.)

The historical passenger count for Train 26 was 663, including reuse/turnover of seats. Because of this, Train 26 has been programmed to operate with 5 cars instead of the current 4 cars.

Midday Off-Peak Period

A one-hour headway is currently provided. It is strictly a Caltrain policy decision whether Caltrain wants to provide a more frequent 30-minute headway during this time period. It is our judgement that midday track outages for programmed maintenance and construction activities will generally not be possible under a 30-minute headway until the new CTC bi-directional signaling is first placed into service, and then only if the interlockings are properly spaced with respect to each other.

Southbound Evening Peak Period

Service frequencies are adequate to serve demand throughout this time period.

The historical passenger counts for Trains 54 and 64 were 706 and 616 respectively, including reuse/turnover of seats. Because of this, Trains 54 and 64 have been expanded to operate with 5 cars instead of the current 4 cars.

Northbound Evening Reverse-Peak Period

Service frequencies are deemed to be good throughout this time period. However, the historical passenger counts for successive Trains 71, 73, 75, 77 and 79 are very "strong" and are 526, 619, 742, 442 and 537 respectively, including reuse/turnover of seats. Also, we noticed that there is a 45-minute gap in service between 6:15 PM and 7:00 PM departing San Jose Diridon.

Because of the above, we have improved the frequency of train service between 4:30 PM and 7:00 PM departing San Jose by adding one train and compressing the existing headways. The new Train 79A (temporary designation) has been added without any additional trainset being required.

Train Equipment Required

The above-described Service Option No. 1 modified timetable requires 16 engines and trainsets, and 72 cars. This is the same number of engines and trainsets used today, with four more cars being utilized, as demonstrated in the conceptual train-equipment cycles below.

Table 5: Conceptual Train-Equipment Cycles for Service Option No. 1

Line	Cars	Trains	Next Day	
			Line	Train
1	5	23 - 28 - X - 65 - G68	6	G33
2	4	25 - 30 - X - 77 - 82	2	25
3	5	27 - 32 - X - 75 - 80 - 87	16	26
4	4	29 - 34 - 55 - # - 56 - 79 - # - 90	4	29
5	4	31 - 36 - X - 69 - 74	5	31
6	5	G33 - 38 - X - 79A - # - 86	3	27
7	4	35 - 40 - 57 - # - 62 - X - 89	13	22
8	4	37 - # - 44 - 61 - # - 70	8	37
9	5	G39 - # - 46 - 63 - G64	9	G39
10	4	41 - 42 - 59 - # - 66 - 83	15	24
11	5	G43 - # - G58	11	G43
12	5	22A - 45 - # - 50 - 71 - 76 - 85	12	A2
13	4	22 - 47 - # - 52 - 73 - 78	7	35
14	5	G49 - # - G54	14	G49
15	4	24 - 51 - # - 60 - 81 - 84	10	41
16	5	26 - 53 - # - 48 - 67 - 72	1	23
TOTAL	72			

-- midday opportunity to service equipment at San Francisco
 X -- midday opportunity to service equipment at San Jose

Operating and Maintenance Cost Indices

The table below shows annualized operating and maintenance cost indices for Service Option No. 1. The annual number reflects the following assumptions:

- There are 255 weekdays in the year.
- Any weekend timetable developed in conjunction with this service option will maintain today's ratios of weekend to weekday revenue hours and miles.

Table 6: Annual Operating and Maintenance Cost Indices for Service Option No. 1

Revenue Train Hours	Revenue Car Miles	Revenue Locomotive Miles
38,073	5,252,847	1,201,064

7.2 Service Option No. 2: SELECTED TRAINS TURN AT MILLBRAE STATION

The primary goal of this effort was to terminate and originate (“turn”) 10 to 30 percent of the Caltrain peak service at Millbrae to and from the south. An associated goal was to reduce the required number of trainsets needed to operate the modified timetable below the 16 trainsets required today. The PCJPB CTC Master Plan includes track, station and interlocking improvements to facilitate Service Option No. 2, and these capital improvements were assumed and utilized where feasible during this effort.

Service expansion for Caltrain can mean adding new trains, adding capacity by lengthening existing trains (up to a six-car maximum), or a combination of both. Based on current ridership and service levels, Caltrain can best use the new fleet of 20 cars to expand service by adding cars to existing trains as well as by adding new trains.

The proposed train schedule for Service Option No. 2, including suggested revisions to the existing Caltrain Timetable, is presented in Exhibit 2. The running times contained in Exhibit 2 are based on the running times in the current Caltrain Timetable. Although the Train Performance Calculator analyses and actual observations suggest longer running times than those in the timetable, capital improvements now underway will make the published running times more achievable.

There are 70 revenue trains in Exhibit 2.

Service Option No. 2 Schedule Modifications

Unless otherwise stated herein, all of the Service Option No. 1 schedule modifications previously discussed have been incorporated into Service Option No. 2.

After reviewing all of the available documentation, we found no strong basis for selecting a particular percentage (between 10 and 30 percent) of trains to turn at Millbrae. A value of 20 percent during peak periods was, therefore, arbitrarily decided upon. In addition, virtually all through trains passing Millbrae have been scheduled to stop at Millbrae, to permit passengers to transfer to and from BART.

Morning Commutation Period

There are 15 trains (Trains 23 through 51 inclusive) during the morning northbound peak period. We decided to turn three of these trains at Millbrae, which is exactly 20 percent, and selected Trains 25, 37 and 45. Trains 25, 37 and 45 were chosen because they do not operate south of Tamien. Train 25 was also chosen because of its low historical passenger count of 168, and because Trains 23 and 27 (immediately preceding and following Train 25) serve the stations north of Millbrae.

EXHIBIT 2

Caltrain Timetable: Service Option No. 2

Turning Trains at Millbrae

		Gilroy/San Jose to San Francisco																												Weekdays										
Station	Mile Post	Mile Out	Rule	Mile																																				
				23	25T	27	29	31	33	35	37T	39	41	43	45T	47	49	51	53	55	57	59	61	63	65T	67T	69	71T	73	75	77	79	79A	81	83	85	87	89		
8	Gilroy	76.8		—	—	—	—	—	5:23	—	—	—	6:03	—	6:28	—	—	7:10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	San Martin	70.7		—	—	—	—	—	5:32	—	—	—	6:12	—	6:37	—	—	7:19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	Morgan Hill	67.1		—	—	—	—	—	5:38	—	—	—	6:18	—	6:43	—	—	7:25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
7	Blossom Hill	54.8		—	—	—	—	—	5:50	—	—	—	6:30	—	6:55	—	—	7:37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	Capitol	51.3		—	—	—	—	—	5:56	—	—	—	6:36	—	7:01	—	—	7:43	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
6	Tamien	48.9		4:38	—	5:28	5:42	—	6:03	—	6:30	6:43	—	7:08	—	7:25	7:50	8:03	8:53	9:53	10:53	11:53	12:53	1:53	—	2:53	—	3:53	4:23	—	4:58	5:28	—	6:18	6:53	7:53	8:53	—	—	
	San Jose Diridon	46.9		4:45	5:17	5:35	5:49	6:03	6:10	6:28	6:37	6:50	7:00	7:15	7:25	7:32	7:57	8:10	9:00	10:00	11:00	12:00	1:00	2:00	2:30	3:00	3:30	4:00	4:30	4:50	5:05	5:35	6:00	6:25	7:00	8:00	9:00	10:30	—	
	College Park	45.7	X	—	—	—	—	—	—	—	—	—	—	7:18	—	—	8:00	—	—	—	—	—	—	—	—	—	3:03	3:33	4:03	4:33	—	5:08	5:38	—	—	—	—	—	—	
5	Sanja Clara	44.3	X	4:50	5:22	5:40	5:54	6:08	6:15	6:33	6:42	6:55	7:05	7:21	7:30	7:37	8:03	8:15	9:05	10:05	11:05	12:05	1:05	2:05	2:35	3:06	3:36	4:06	4:36	4:55	5:11	5:41	6:05	6:30	7:05	8:05	9:05	10:35	—	
	Lawrence	40.8		4:55	5:27	5:45	5:59	6:13	6:20	6:38	6:47	7:00	7:10	7:26	7:35	7:42	8:08	8:20	9:10	10:10	11:10	12:10	1:10	2:10	2:40	3:11	3:41	4:11	4:41	5:00	5:16	5:46	6:10	6:35	7:10	8:10	9:10	10:40	—	
	Sunnyvale	38.8	X	4:59	5:31	5:49	6:03	6:17	6:24	6:42	6:51	7:04	7:14	7:30	7:39	7:46	8:12	8:24	9:14	10:14	11:14	12:14	1:14	2:14	2:44	3:15	3:45	4:15	4:45	5:04	5:20	5:50	6:14	6:39	7:14	8:14	9:14	10:44	—	
4	Mountain View	36.1		5:03	5:35	5:53	6:07	6:22	6:28	6:46	6:55	7:08	7:18	7:34	7:43	7:50	8:16	8:28	9:18	10:18	11:18	12:18	1:18	2:18	2:48	3:19	3:49	4:19	4:49	5:08	5:24	5:54	6:18	6:43	7:18	8:18	9:18	10:48	—	
	San Antonio	34.1		5:07	5:39	5:57	6:11	—	6:32	6:50	6:59	7:12	7:22	7:38	7:47	7:54	8:20	8:32	9:22	10:22	11:22	12:22	1:22	2:22	2:52	3:23	3:53	4:23	4:53	5:12	5:28	5:58	6:22	6:47	7:22	8:22	9:22	10:52	—	
	California Avenue	31.8	X	5:10	5:42	6:00	6:14	—	6:35	6:53	7:02	7:15	7:25	7:41	7:50	7:57	8:23	8:35	9:25	10:25	11:25	12:25	1:25	2:25	2:55	3:26	3:56	4:26	4:56	5:15	5:31	6:01	6:25	6:50	7:25	8:25	9:25	10:55	—	
	Stanford Stadium	30.8	X	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	Palo Alto	30.1		5:13	5:45	6:03	6:17	6:30	6:38	6:56	7:05	7:18	7:28	7:44	7:53	8:00	8:26	8:38	9:28	10:28	11:28	12:28	1:28	2:28	2:58	3:29	3:59	4:29	4:59	5:18	5:34	6:04	6:28	6:53	7:28	8:28	9:28	10:58	—	
3	Menlo Park	28.9		5:16	5:48	6:06	6:20	6:33	6:41	6:59	—	7:21	7:31	7:47	7:56	8:03	8:29	8:41	9:31	10:31	11:31	12:31	1:31	2:31	3:01	3:32	4:02	4:32	5:02	5:21	5:37	6:07	6:31	6:56	7:31	8:31	9:31	11:01	—	
	Atherton	27.8	X	5:18	—	6:08	6:23	—	6:44	7:02	—	—	7:34	—	—	8:06	—	8:44	9:34	10:34	11:34	12:34	1:34	2:34	3:04	3:35	4:05	4:35	5:05	—	5:40	—	6:33	6:58	7:33	8:33	9:33	11:03	—	
	Redwood City	25.4		5:24	5:55	6:14	6:29	—	6:50	—	7:13	—	7:40	7:54	8:03	8:12	—	8:50	9:40	10:40	11:40	12:40	1:40	2:40	3:10	3:41	4:11	4:41	5:11	5:28	5:47	6:14	6:39	7:04	7:39	8:39	9:39	11:09	—	
	San Carlos	23.2		5:28	5:59	6:18	6:33	—	6:54	7:10	—	—	7:44	7:58	8:07	8:16	—	8:54	9:44	10:44	11:44	12:44	1:44	2:44	3:14	3:45	4:15	4:45	5:15	5:32	5:51	6:18	6:43	7:08	7:43	8:43	9:43	11:13	—	
2	Belmont	21.9		5:31	6:02	6:21	6:36	6:45	6:57	7:13	—	—	7:47	—	8:10	8:19	—	8:57	9:47	10:47	11:47	12:47	1:47	2:47	3:17	3:48	4:18	4:48	5:18	—	5:54	—	6:46	7:11	7:46	8:46	9:46	11:16	—	
	Hillsdale	20.3	X	5:34	6:05	6:24	6:39	—	7:00	7:16	—	7:34	7:50	8:03	8:13	8:22	—	9:00	9:50	10:50	11:50	12:50	1:50	2:50	3:20	3:51	4:21	4:51	5:21	5:38	5:57	—	6:49	7:14	7:49	8:49	9:49	11:19	—	
	Bay Meadows	20.0	X	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
	Hayward Park	18.9		5:37	—	6:27	—	—	7:03	—	7:23	—	7:53	—	—	8:25	—	9:03	9:53	10:53	11:53	12:53	1:53	2:53	3:23	3:54	4:24	4:54	5:24	—	6:00	—	6:52	7:17	7:52	8:52	9:52	11:22	—	
	San Mateo	17.9		5:39	6:09	6:29	—	6:51	7:06	—	7:26	—	7:56	8:07	—	8:27	8:42	9:05	9:55	10:55	11:55	12:55	1:55	2:55	3:25	3:56	4:26	4:56	5:26	5:42	6:02	6:27	6:54	7:19	7:54	8:54	9:54	11:24	—	
	Burlingame	16.3	X	5:42	6:12	6:32	—	6:54	7:09	—	7:29	—	7:59	8:10	—	8:30	—	9:08	9:58	10:58	11:58	12:58	1:58	2:58	3:28	3:59	4:29	5:00	5:29	—	6:05	—	6:57	7:22	7:57	8:57	9:57	11:27	—	
Broadway	15.2	X	5:45	—	6:35	—	6:57	7:12	—	7:32	—	8:02	—	8:20	8:32	—	9:11	10:01	11:01	12:01	1:01	2:01	3:01	3:31	4:02	4:32	5:03	5:32	—	6:08	—	7:00	7:25	8:00	9:00	10:00	11:30	—		
1	Millbrae	13.7		5:48	6:17	6:38	6:49	7:00	7:15	7:25	7:35	7:44	8:05	8:15	8:23	8:35	—	9:14	10:04	11:04	12:04	1:04	2:04	3:04	3:34	4:05	4:35	5:06	5:35	5:48	6:11	6:33	7:03	7:28	8:03	9:03	10:03	11:33	—	
	San Bruno	10.8	X	5:53	—	6:43	—	7:05	7:20	7:30	—	—	8:10	8:20	—	8:40	—	9:19	10:09	11:09	12:09	1:09	2:09	3:09	—	—	4:40	—	5:40	5:53	6:16	6:38	7:08	7:33	8:08	9:08	10:08	11:38	—	
	So. San Francisco	9.3	X	5:56	—	6:46	—	7:08	7:23	7:33	—	—	8:13	8:23	—	8:43	—	9:22	10:12	11:12	12:12	1:12	2:12	3:12	—	—	4:43	—	5:43	—	6:19	—	7:11	7:36	8:11	9:11	10:11	11:41	—	
SF	Bayshore	5.2	X	6:01	—	6:51	—	7:13	7:28	—	—	—	8:18	—	—	8:48	—	9:27	10:17	11:17	12:17	1:17	2:17	3:17	—	—	4:48	—	5:48	6:00	6:24	6:45	7:16	7:41	8:16	9:16	10:16	11:46	—	
	Paul Avenue	4.1	X	—	—	—	—	—	7:31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
	22nd Street	1.9	X	6:07	—	6:57	—	7:19	7:35	—	—	—	8:24	—	—	8:54	—	9:33	10:23	11:23	12:23	1:23	2:23	3:23	—	—	4:54	—	5:55	6:06	6:30	6:51	7:22	7:47	8:22	9:22	10:22	11:52	—	
	4th & King	0.0		6:15	—	7:05	7:11	7:27	7:43	7:49	—	—	8:03	8:32	8:39	—	9:02	9:08	9:41	10:31	11:31	12:31	1:31	2:31	3:31	—	—	5:02	—	6:03	6:14	6:39	6:59	7:30	7:55	8:30	9:30	10:30	12:00	—

• special event service only

Caltrain Timetable: Service Option No. 2

Turning Trains at Millbrae

		San Francisco to San Jose/Gilroy																												Weekdays										
Station	Mile Post	Hold- Out Rule	22	22A	24	26T	28	30	32	34T	36	38T	40	42	44	46	48	50	52	54	56T	58	60T	62	64	66	68	70T	72	74	76	78	80	82	84	86	90			
			SF	4th & King	0.0	5:00	5:30	6:00	—	6:55	7:00	7:25	—	8:00	—	9:00	10:00	11:00	12:00	1:00	2:00	2:30	3:00	—	3:55	—	4:25	4:49	4:53	5:20	—	5:30	5:35	6:00	6:20	7:00	8:00	9:00	10:00	11:59
	22nd Street	1.9	X	5:05	5:35	6:05	—	7:00	7:05	7:30	—	8:05	—	9:05	10:05	11:05	12:05	1:05	2:05	2:35	3:05	—	4:00	—	4:30	—	4:58	—	—	5:40	—	6:25	7:05	8:05	9:05	10:05	—			
	Paul Avenue	4.1	X	—	—	6:08	—	—	—	—	—	8:08	—	—	—	—	—	—	—	—	—	—	4:02	—	—	—	—	—	—	—	6:27	—	—	—	—	—	—			
	Bayshore	5.2	X	5:10	5:40	6:11	—	7:05	7:10	7:35	—	8:11	—	9:10	10:10	11:10	12:10	1:10	2:10	2:40	3:10	—	4:06	—	4:35	—	5:03	—	—	5:45	—	6:31	7:10	8:10	9:10	10:10	12:09			
1	So. San Francisco	9.3	X	5:16	5:46	6:17	—	7:16	—	—	8:17	—	9:16	10:16	11:16	12:16	1:16	2:16	2:46	3:16	—	4:12	—	4:41	5:03	5:09	—	—	5:51	—	6:37	7:16	8:16	9:16	10:16	12:15				
	San Bruno	10.8	X	5:19	5:49	6:20	—	7:11	7:19	7:41	—	8:20	—	9:19	10:19	11:19	12:19	1:19	2:19	2:49	3:19	—	4:15	—	4:44	—	5:12	—	—	5:45	5:54	—	6:40	7:19	8:19	9:19	10:19	12:18		
	Millbrae	13.7	X	5:24	5:54	6:25	6:53	7:16	7:24	7:46	7:53	8:25	8:53	9:24	10:24	11:24	12:24	1:24	2:24	2:54	3:24	3:53	4:20	4:37	4:49	5:09	5:17	—	5:43	5:50	5:59	6:19	6:45	7:24	8:24	9:24	10:24	12:23		
2	Broadway	15.2	X	5:27	5:57	6:28	6:57	—	7:27	—	7:57	8:28	8:57	9:27	10:27	11:27	12:27	1:27	2:27	2:57	3:27	3:57	4:23	—	4:52	—	5:20	—	—	6:02	—	6:48	7:27	8:27	9:27	10:27	12:26			
	Burlingame	16.3	X	5:29	5:59	6:30	6:59	—	7:29	—	7:59	8:30	8:59	9:29	10:29	11:29	12:29	1:29	2:29	2:59	3:29	3:59	4:26	—	4:54	—	5:22	—	—	5:54	6:04	—	6:50	7:29	8:29	9:29	10:29	12:28		
	San Mateo	17.9	X	5:32	6:02	6:33	7:02	7:23	7:32	7:52	8:02	8:33	9:02	9:32	10:32	11:32	12:32	1:32	2:32	3:02	3:32	4:02	4:29	—	4:57	—	5:25	—	—	5:57	6:07	6:25	6:53	7:32	8:32	9:32	10:32	12:31		
	Hayward Park	18.9	X	5:35	6:05	6:36	7:05	—	7:35	—	8:05	8:36	9:05	9:35	10:35	11:35	12:35	1:35	2:35	3:05	3:35	4:05	4:32	—	5:00	—	5:28	—	—	6:10	—	6:56	7:35	8:35	9:35	10:35	12:34			
	Bay Meadows	20.0	X	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
	Hillsdale	20.3	X	5:38	6:08	6:39	7:08	—	7:38	7:56	8:08	8:39	9:08	9:38	10:38	11:38	12:38	1:38	2:38	3:08	3:38	4:08	4:35	4:46	5:03	5:17	5:31	—	5:52	6:01	6:13	6:29	6:59	7:38	8:38	9:38	10:38	12:37		
Belmont	21.9	X	5:41	6:11	6:42	7:11	—	7:41	—	8:11	8:42	9:11	9:41	10:41	11:41	12:41	1:41	2:41	3:11	3:41	4:11	4:38	4:49	5:06	—	5:34	—	5:55	6:04	6:16	6:32	7:02	7:41	8:41	9:41	10:41	12:40			
3	San Carlos	23.2	X	5:44	6:14	6:45	7:14	7:31	7:44	8:02	8:14	8:45	9:14	9:44	10:44	11:44	12:44	1:44	2:44	3:14	3:44	4:14	4:41	4:52	5:09	5:22	5:37	—	—	6:07	6:19	6:35	7:05	7:44	8:44	9:44	10:44	12:43		
	Redwood City	25.4	X	5:49	6:19	6:50	7:20	7:36	7:49	8:07	8:19	8:50	9:19	9:49	10:49	11:49	12:49	1:49	2:49	3:19	3:49	4:19	4:48	4:57	5:14	5:27	—	—	6:02	6:12	6:24	6:40	7:10	7:49	8:49	9:49	10:49	12:48		
	Alherton	27.8	X	5:53	6:23	—	7:24	—	7:53	—	8:23	8:54	9:23	9:53	10:53	11:53	12:53	1:53	2:53	3:23	3:53	4:23	4:52	5:01	5:18	—	5:44	—	6:06	—	6:28	6:44	7:14	7:53	8:53	9:53	10:53	12:52		
	Menlo Park	28.9	X	5:55	6:25	6:57	7:27	7:41	7:56	8:12	8:26	8:57	9:26	9:56	10:56	11:56	12:56	1:56	2:56	3:26	3:56	4:26	4:55	5:04	5:21	5:32	5:47	—	6:09	6:18	6:31	6:47	7:17	7:56	8:56	9:56	10:56	12:55		
4	Palo Alto	30.1	X	5:58	6:28	7:00	7:30	7:44	7:59	8:15	8:29	9:00	9:29	9:59	10:59	11:59	12:59	1:59	2:59	3:29	3:59	4:29	4:58	5:07	5:24	5:35	5:50	5:58	6:12	6:21	6:34	6:50	7:20	7:59	8:59	9:59	10:59	12:58		
	Stanford Stadium	30.8	X	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	
	California Ave.	31.8	X	6:01	6:31	7:03	7:33	7:47	8:02	8:18	8:32	9:03	9:32	10:02	11:02	12:02	1:02	2:02	3:02	3:32	4:02	4:32	5:01	5:10	—	5:38	5:53	6:01	—	6:24	6:37	6:53	7:23	8:02	9:02	10:02	11:02	1:01		
	San Antonio	34.1	X	6:04	6:34	7:06	7:36	7:50	8:05	8:21	8:35	9:06	9:35	10:05	11:05	12:05	1:05	2:05	3:05	3:35	4:05	4:35	5:04	5:13	5:29	5:41	5:56	6:04	—	6:27	6:40	6:56	7:26	8:05	9:05	10:05	11:05	1:04		
	Mountain View	36.1	X	6:08	6:38	7:10	7:40	7:54	8:09	8:25	8:39	9:10	9:39	10:09	11:09	12:09	1:09	2:09	3:09	3:39	4:09	4:39	5:08	5:17	5:33	5:45	6:00	6:09	6:20	6:31	6:44	7:00	7:30	8:09	9:09	10:09	11:09	1:08		
5	Sunnyvale	38.8	X	6:13	6:43	7:14	7:44	7:58	8:13	8:29	8:43	9:14	9:43	10:13	11:13	12:13	1:13	2:13	3:13	3:43	4:13	4:43	5:13	5:22	5:37	5:49	6:04	6:13	6:24	6:35	6:48	7:04	7:34	8:13	9:13	10:13	11:13	1:12		
	Lawrence	40.8	X	6:17	6:47	7:18	7:48	8:02	8:17	8:33	8:47	9:18	9:47	10:17	11:17	12:17	1:17	2:17	3:17	3:47	4:17	4:47	5:17	5:25	5:41	5:53	—	6:17	6:28	6:39	6:52	7:08	7:38	8:17	9:17	10:17	11:17	1:16		
	Santa Clara	44.3	X	6:22	6:52	7:23	7:53	8:07	8:22	8:38	8:52	9:23	9:52	10:22	11:22	12:22	1:22	2:22	3:22	3:52	4:22	4:52	5:22	5:30	5:46	5:58	6:12	6:22	6:33	6:44	6:57	7:13	7:43	8:22	9:22	10:22	11:22	1:21		
6	College Park	45.7	X	—	—	7:26	7:56	8:10	8:25	—	—	—	—	—	—	—	—	—	—	—	—	—	4:25	4:55	5:25	—	—	—	—	—	—	—	—	—	—	—	—			
	San Jose Diridon	46.9	X	6:30	7:00	7:33	8:03	8:16	8:31	8:46	9:00	9:31	10:00	10:30	11:30	12:30	1:30	2:30	3:30	4:00	4:32	5:01	5:32	5:38	5:54	6:06	6:20	6:30	6:42	6:52	7:05	7:21	7:51	8:30	9:30	10:30	11:30	1:29		
7	Tamien	48.9	X	6:36	—	7:39	8:09	—	8:37	—	9:06	9:37	—	10:36	11:36	12:36	1:36	2:36	3:36	4:06	4:37	5:06	5:37	5:44	—	6:11	6:26	6:35	—	6:58	—	7:27	7:57	8:36	9:36	10:36	11:36	—		
	Capitol	51.3	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4:42	—	5:42	—	—	6:16	—	—	—	—	—	—	—	—	—	—		
8	Blossom Hill	54.8	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4:47	—	5:47	—	—	6:21	—	—	—	—	—	—	—	—	—	—		
	Morgan Hill	67.1	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4:59	—	5:59	—	—	6:33	—	—	—	—	—	—	—	—	—	—		
	San Martin	70.7	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5:04	—	6:04	—	—	6:38	—	—	—	—	—	—	—	—	—	—	—	
9	Gilroy	78.8	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5:16	—	6:16	—	—	6:50	—	—	—	—	—	—	—	—	—	—		

◆ special event service only

Train 37 was also chosen because of its relatively low historical passenger count of 369 (relatively low when compared to the other northbound trains currently operating in that time period), and because Train 37 does not currently serve any intermediate station north of Millbrae.

Train 45 was also chosen because of its relatively low historical passenger count of 277 (relatively low when compared to the other northbound trains currently operating in that time period), and because Train 45 currently serves only one intermediate station (San Bruno) north of Millbrae.

Trains 25, 37 and 45 were turned for Trains 26, 34 and 38 respectively. These southbound trains were chosen because they allow the turning trainsets to be reused as soon as possible, which is considered necessary if a trainset is to be "saved".

The historical passenger count of Train 26 is a rather robust 663, including reuse/turnover of seats.

While we did not add station stops to Trains 28 and 32 at South San Francisco, this can be easily done so as to avoid reducing southbound service at that station.

Evening Commutation Period

There are 14 trains (Trains 54 through 80, inclusive) during the evening southbound peak period. We decided to originate three of these trains at Millbrae, which is approximately 21 percent, and selected Trains 56, 60 and 70.

Trains 56, 60 and 70 were chosen because they do not operate south of Tamien.

Train 56 was also chosen because of its relatively low historical passenger count of 435 (relatively low when compared to the other southbound trains currently operating in that time period), and because Trains 54 and 58 (immediately preceding and following Train 56) serve the stations north of Millbrae.

Train 60 was also chosen because of its relatively low historical passenger count of 319 (relatively low when compared to the other southbound trains currently operating in that time period), and because Train 60 currently serves only one intermediate station (South San Francisco) north of Millbrae.

Train 70 was also chosen because of its relatively low historical passenger count of 414 (relatively low when compared to the other southbound trains currently operating in that time period), and because Train 70 currently does not serve any intermediate station north of Millbrae.

Trains 56, 60 and 70 were turned from Trains 65, 67 and 71, respectively. These northbound trains were chosen because they allow the turning trainsets to be reused as soon as possible, which is considered necessary if a trainset is to be "saved".

The historical passenger count of Train 71 is a rather robust 526, including reuse/turnover of seats.

Turning successive Trains 65 and 67 both at Millbrae significantly reduces the northbound service provided at the stations north of Millbrae during this time period.

Train Equipment Required

The Service Option No. 2 modified timetable requires 16 engines and trainsets, and 72 cars. This is the same number of engines and trainsets used today, with four more cars being utilized, as shown in the conceptual train-equipment cycles. The running time savings between Fourth and King and Millbrae are not sufficient to enable a single train set to make two round trips between Millbrae and San Jose.

Table 7: Conceptual Train-Equipment Cycles for Service Option No. 2

Line	Cars	Trains	Next Day	
			Line	Train
1	4	22 - 47 - # - 50 - 71 - 70	11	35
2	4	22A - 45 - 38 - X - 77 - 82	12	37
3	5	24 - 51 - 44 - X - 79A - 84	5	23
4	5	25 - 26 - 53 - # - 52 - 73 - 78	4	25
5	5	23 - 28 - X - 75 - 80 - 87	3	24
6	5	27 - 32 - X - 65 - 56 - 79 - # - 90	6	27
7	4	30 - X - 61 - 72 - 85	7	30
8	4	29 - # - 46 - 63 - 74	8	29
9	5	31 - 36 - X - 69 - 76	9	31
10	4	G33 - # - 48 - 67 - 60 - 81	1	22
11	4	35 - 42 - 59 - # - G68	10	G33
12	4	37 - 34 - 55 - # - 62 - X - 89	2	A2
13	5	G39 - # - G54	16	G49
14	4	41 - 40 - 57 - # - 66 - 83 - 86	14	41
15	5	G43 - # - G58	15	G43
16	5	G49 - # - G64	13	G39
TOTAL	72			

-- midday opportunity to service equipment at San Francisco

X -- midday opportunity to service equipment at San Jose

Operating and Maintenance Cost Indices

The table below shows annualized operating and maintenance cost indices for Service Option No. 2. The annual number reflects the following assumptions:

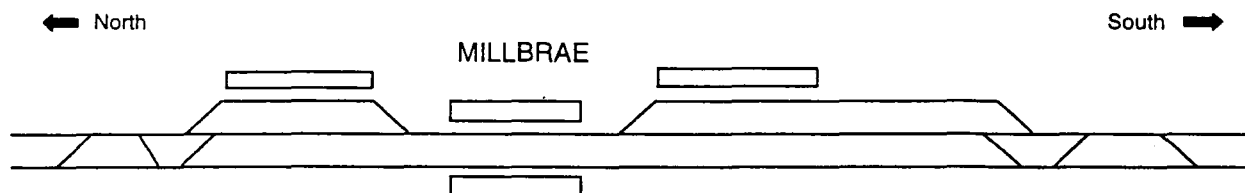
- There are 255 weekdays in the year.
- Any weekend timetable developed in conjunction with this service option will maintain today's ratios of weekend to weekday revenue hours and miles.

Table 8: Annual Operating and Maintenance Cost Indices for Service Option No. 2

Revenue Train Hours	Revenue Car Miles	Revenue Locomotive Miles
36,633	5,023,595	1,151,584

Millbrae Track Configuration and Operations

The planned Millbrae track layout as presented in the JPB CTC Master Plan is presented below.



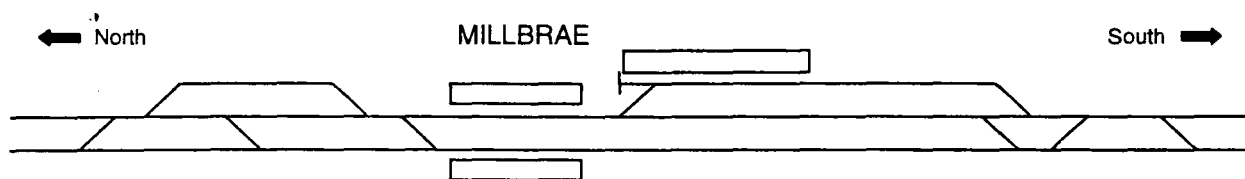
In Service Option No. 2, all of the trains “turning” at Millbrae were able to use the platform on the south siding. We recommend that certain configuration changes as described below be considered for incorporation into the planned improvements for Millbrae. We suggest that the turnout on the northbound track south of the main station platforms be converted to a crossover with very short tail track, and that the proposed platform be extended to the north. This will allow terminating and originating trains using the south siding and associated station platform to be positioned approximately 200 feet closer to the main Caltrain station area and the BART station.

We recommend that an additional main-to-main crossover be provided immediately north of the main station platforms so that the north siding can directly access both of the Millbrae mainline station platform tracks.

We have been unable to establish a justification for providing parallel routes at the north end of the north siding, and recommend that one proposed crossover be eliminated and the remaining proposed turnouts be reconfigured.

Lastly, we do not think that it is necessary to provide a station platform on and for the north siding.

The modified track layout that we recommend be considered for Millbrae is presented below.



After undertaking this assignment, we have come to the opinion that it may be best for Caltrain to not implement any major timetable changes coincident with the opening of the new BART station, other than scheduling most Caltrain trains to stop at Millbrae and preparing for some increases in ridership south of Millbrae. Caltrain would then be in a position to monitor the change-in-ridership trends because of the new BART station and transfer opportunity, and would be better able to decide what timetable changes are justified because of the actual changes in ridership.

In addition, turning trains at Millbrae may not be desirable if at least one trainset cannot be "saved". We say this because for every train that is turned at Millbrae, there will be a number of existing passengers that will be inconvenienced by the reduction in service north of Millbrae, and because Caltrain will have less flexibility in the servicing and switching-out of the train equipment.

7.3 Service Option No. 3: PALO ALTO-GILROY ADDITIONAL TRAIN SERVICE

The primary goal of this effort was to determine how new train service could be provided so that passengers are able to travel southbound (reverse-peak) during the morning peak period from Palo Alto to Gilroy, and northbound (reverse-peak) during the evening peak period from Gilroy to Palo Alto. A secondary goal was to determine how the existing Gilroy train service could be cost-effectively enhanced above the four peak direction trains that are currently operated during each of the two commutation periods.

The proposed train schedule for Service Option No. 3, including suggested revisions to the existing Caltrain Timetable, is presented in Exhibit 3. The running times contained in Exhibit 3 are based on the running times in the current Caltrain Timetable. Although the Train Performance Calculator analyses and actual observations suggest longer running times than those in the timetable, capital improvements now underway will make the published running times more achievable.

Note that as in Service Option No. 2, we recommend that Caltrain expand service with a mixture of new trains and longer trains.

There are 70 revenue trains in Exhibit 3.

Shuttles versus Through Trains

The initial concept for Option No. 3 was to schedule new "shuttle" trains, one in the morning from Palo Alto to Gilroy and one in the evening from Gilroy to Palo Alto. After evaluating this type of shuttle service, we are recommending against operating shuttles between Palo Alto and Gilroy. Alternatively, we recommend operating additional Gilroy - San Francisco through trains by extending some of the trains that are currently operated between San Francisco and San Jose.

There are several reasons for this recommendation. The key reasons are as follows:

- 1) Considering the existing double-track configuration at Palo Alto, it is not operationally feasible to turn trains from the south at Palo Alto. Use of the crossover south of Menlo Park would delay other trains and does not provide a layover location if needed. Any such shuttles from Gilroy will have to continue north to the proposed controlled siding at Redwood Junction.
- 2) Based on existing ridership patterns, it is likely that some passengers from north of Palo Alto will want to use these new trains to travel to and from stations south of Tamien. A through, seamless service would be preferable for such passengers than changing trains and waiting at an intermediate station.

- 3) Operating shuttles will require more trainsets than are required by extending the through trains.
- 4) Operating shuttles will incur more congestion and train delays than would be incurred by extending the through trains.

Service Option No. 3 Schedule Modifications

Unless otherwise stated herein, all of the Service Option No. 1 schedule modifications previously discussed have been incorporated into Service Option No. 3.

Train 28 has been extended to an 8:58 AM arrival time at Gilroy, and turns for Train 59, departing Gilroy at 11:13 AM. (Train 28 was not turned for Train 57 in order to avoid a conflict with Amtrak's southbound Coast Starlight, which is scheduled to depart San Jose at 10:31 AM.)

Train 46 has been extended to a 2:15 PM arrival time at Gilroy, and turns for Train 79 departing Gilroy at 4:46 PM. Train 79 meets Train 54 at the Morgan Hill CTC siding that is located between Morgan Hill and San Martin.

Train 79 then has an approximately five-minute opposing-train clearance interval with Train 58 at CP Michael. Train 79 is scheduled to skip Tamien because we do not believe that it is feasible to schedule Trains 58 and 79 to both stop at Tamien given the station configuration and scheduling constraints.

Train 68 has been scheduled to turn for Train 87 departing Gilroy at 8:13 PM, and as a complement, Train 82 has been extended to a 10:15 PM arrival time at Gilroy. Train 82 turns for Train 33, departing Gilroy at 5:23 AM.

Incidental changes have also been made to the schedules of Trains 60, 62, 79 and 79A, primarily to limit unacceptable train congestion in the vicinity of Tamien Station.

Train Equipment Required

The Service Option No. 3 modified timetable requires 16 engines and trainsets, and 72 cars. This is the same number of engines and trainsets used today, with four more cars being utilized, as demonstrated in the following conceptual train-equipment cycles:

Table 9: Conceptual Train-Equipment Cycles for Service Option No. 3

Line	Cars	Trains	Next Day	
			Line	Train
1	5	23 - G28 - G59 - # - 70	1	23
2	5	25 - 30 - X - 63 - 60 - X - 89	16	26
3	5	27 - 32 - X - 75 - 80	3	27
4	4	29 - 34 - 55 - # - 56 - 79A - # - 90	4	29
5	4	31 - 36 - X - 65 - 66 - 83 - 86	5	31
6	4	G33 - 38 - X - 69 - 74	10	41
7	4	35 - 40 - 57 - # - 62 - 81	13	22
8	4	37 - # - 44 - 61 - G68 - G87	12	A2
9	5	G39 - # - G64	9	G39
10	4	41 - 42 - X - 77 - G82	6	33
11	5	G43 - # - G58	11	G43
12	4	22A - 45 - # - G46 - G79 - 84	8	37
13	4	22 - 47 - # - 48 - 67 - 72	7	35
14	5	G49 - # - G54	14	G49
15	5	24 - 51 - # - 50 - 71 - 76 - 85	15	24
16	5	26 - 53 - # - 52 - 73 - 78	2	25
TOTAL		72		

-- midday opportunity to service equipment at San Francisco
 X -- midday opportunity to service equipment at San Jose

Operating and Maintenance Cost Indices

The table below shows annualized operating and maintenance cost indices for Service Option No. 3. The annual number reflects the following assumptions:

- There are 255 weekdays in the year.
- Any weekend timetable developed in conjunction with this service option will maintain today's ratios of weekend to weekday revenue hours and miles.

Table 10: Annual Operating and Maintenance Cost Indices for Service Option No. 3

Revenue Train Hours	Revenue Car Miles	Revenue Locomotive Miles
39,269	5,447,264	1,258,781

7.4 Service Option No. 4: MEDIUM-TERM SCHEDULE OPTIMIZATION

Service Option No. 4 incorporates the "Near-Term Schedule Optimization" train-service improvements included in Service Option No. 1 and builds on Option No. 2.

Service Option No. 4 has also been developed to reflect various planned changes and improvements to the existing railroad (see Table 3) and BART being operational, including:

- additional Caltrain equipment,
- the BART/Caltrain transfer opportunity at Millbrae,
- three main tracks between Mileages 14.2 and 16.8,
- centralized traffic control (CTC) for mainline trackage and new interlockings between San Francisco and San Jose,
- station improvements allowing elimination of the "hold-out" rule procedures at many stations,
- Paul Avenue Station closed and replaced by Oakdale/Palou,
- Bayshore Station relocated south to be immediately north of CP 54, and a
- new Bailey Avenue Station, located north of Morgan Hill.

Passenger-count information from February 1998 and 1999 was used to determine patronage by train and time period. The proposed train schedules for Service Option No. 4, including suggested revisions to the current Caltrain Timetable, are presented in Exhibit 4. The running times contained in Exhibit 4 are based on the running times in the current Caltrain Timetable. Although the Train Performance Calculator analyses and actual observations suggest longer running times than those in the timetable, capital improvements now underway will make the published running times more achievable.

There are 86 revenue trains in Exhibit 4.

General

Minor schedule changes are proposed in Exhibit 4 to account for the new Bailey Avenue and Oakdale/Palou Stations, the relocation of the Bayshore Station, and the closure of the Paul Avenue Station.

To optimize the transfer opportunity at Millbrae between Caltrain and BART, all Caltrain trains have been scheduled to stop at Millbrae, except for one peak-direction express train during each of the two commutation periods (Trains 49 and 68). This has resulted in additional minor schedule changes to many trains.

Northbound Morning Peak Period

Service frequencies are adequate to serve demand throughout this time period.

Because of the low passenger volume on Train 25, stops have been added on this train at Hillsdale, Burlingame and San Bruno to increase service at those stations.

In a February 1999 count, Train 39 had a total of 855 boardings over the length of its run, and a peak load of 503, which is the highest northbound peak load of a single train during the morning commutation period. Because of the strong northbound passenger volumes during this time period, we added an additional train to supplement the existing service - Train 39A in Exhibit 4.

The usual approach (when adding a train to supplement a "crowded" train) would be to eliminate a few stops from Gilroy Train 39 to both speed it up and to deflect some of the patronage to new Train 39A. However, the existing density of traffic and train schedule patterns taken together do NOT allow this. (Referring to Exhibit 4, Train 39 is scheduled only five minutes behind Train 37 arriving San Francisco, Train 37 is scheduled only five minutes behind Train 35 in the vicinity of Hayward Park, Train 35 is scheduled only five minutes behind Train 33 arriving San Francisco, and Train 33 is scheduled only six minutes behind Train 31 at Mountain View. The headway specification for the new signal system is five minutes.) In short, Train 39 cannot be scheduled to operate any faster over the territory without speeding up the local trains and/or reducing the frequency of all-stop local service.

Train 51 has been moved five minutes earlier to be compatible with the improved midday 30-minute off-peak headway that will be discussed later in this document.

Southbound Morning Reverse-Peak Period

Service frequencies are adequate to serve demand throughout this time period, except for the one-hour gap between Trains 22 and 24. Because of this, a new Train 22A has been added, departing San Francisco at 5:30 AM.

Again, we evaluated adding a new express-train departure from San Francisco at 7:55 AM, similar to Trains 28 and 32. Our judgement continues to be that the historical passenger volumes in concert with the level of train service currently provided do not justify such an additional train.

Midday Off-Peak Period

To reduce the midday off-peak headway from one hour to 30 minutes, new Trains 51A, 53A, 55A, 57A, 59A, 61A, 40A, 42A, 44A, 46A and 48A have been added. Most of these trains have been scheduled to "turn" at Millbrae.

A 30-minute headway between same-direction trains during the midday off-peak period will make it more difficult to operate local "way freights" and to take track segments out of service for maintenance and/or construction activities during this time period.

Southbound Evening Peak Period

Service frequencies are adequate to serve demand throughout this time period.

In a February 1999 count, Train 76 had a total of 616 boardings over the length of its run, and a peak load of 519, which is the highest southbound peak load of a single train during the evening commutation period. Because of the strong southbound passenger volumes during this time period, we added an additional train to supplement the existing service - Train 76A in Exhibit 4.

Two stops have been eliminated from the schedule for Train 76 (San Mateo and Atherton), which stops will be served by Train 76A.

Train 80 has been moved five minutes earlier to reduce the 40-minute headway behind Train 78.

Trains 80A and 82A have been added to provide a 30-minute headway until 9:00 PM departing San Francisco.

Northbound Evening Reverse-Peak Period

In a February 1999 count, Train 75 had a total of 717 boardings over the length of its run, and a peak load of 561, which is the highest northbound reverse-peak load of a single train during the evening commutation period. Because of the strong northbound passenger volumes during this time period, we compressed the service headways during this time period by moving Trains 75, 77, and 79 all 10 minutes earlier. In addition, Train 79A has been added and Train 81 has been "moved" 10 minutes later, both for the purpose of increasing the frequency of service during this time period.

Train 83A has been added to provide an approximately 30-minute headway until 8:00 PM departing San Jose.

Train Equipment Required

The above-described Service Option No. 4 modified timetable requires 18 engines and trainsets, and 79 to 80 cars, as demonstrated in the conceptual train-equipment cycles below.

Table 11: Conceptual Train-Equipment Cycles for Service Option No. 4

Line	Cars	Trains	Next Day	
			Line	Train
1	5	23 - 28 - 53 - # - G68	6	G33
2	4	25 - 30 - X - 59A - 48A - 69 - 78 - 87	15	24
3	5	27 - 32 - 53A - 42A - X - 75 - 80	3	27
4	4	29 - 34 - 55 - # - 62	4	29
5	4	31 - 36 - X - 61A - # - 76A	5	31
6	5	G33 - 38 - 55A - 44A - X - 77 - 80A	1	23
7	4	35 - # - 44 - 61 - # - 74	7	35
8	4	37 - # - 46 - 63 - 72	8	37
9	5	G39 - 40 - 57 - # - G58	9	G39
10	5	41 - # - 50 - 71 - 76 - 85 - 90	10	41
11	4	G43 - 42 - 59 - # - G64	11	G43
12	5	G49 - # - G54	12	G49
13	5	22 - 47 - # - 56 - 79	13	22
14	5	22A - 45 - # - 52 - 73 - 82 - 89	14	22A
15	4	24 - 51 - # - 60 - 81 - 86	2	25
16	4	26 - 51A - 40A - 57A - 46A - 65 - 66 - 83	16	26
17	4	39A - # - 48 - 67 - 70 - 83A - 82A	17	39A
18	3-4	X - 79A - 84	18	79A
TOTAL		79-80		

-- midday opportunity to service equipment at San Francisco

X -- midday opportunity to service equipment at San Jose

A trainset was generally assigned five cars if the February 1999 reported average peak load for one of the trains in the cycle equalled or exceeded 60 percent of the number of seats on a 4-car train (60 percent of 553), which equals 332.

Except for Line/Cycle No. 18, all of the other trainsets were assigned 4 cars. This is because of the fact that for each of these trainsets, there is at least one train in the cycle that has a February 1999 reported average peak load equal to or greater than 60 percent of the number of seats on a 3-car train (60 percent of 415), which equals 249.

The maximum peak load of the two trains in Line/Cycle No. 18 is low enough to justify providing only 3 cars for this one trainset. Caltrain may want to assign the standard 4 cars to this trainset to facilitate the "swapping" of trainsets without having to cut or add a car.

Operating and Maintenance Cost Indices

The table below shows annualized operating and maintenance cost indices for Service Option No. 4. The annual number reflects the following assumptions:

- There are 255 weekdays in the year.
- Any weekend timetable developed in conjunction with this service option will maintain today's ratios of weekend to weekday revenue hours and miles.

Table 12: Annual Operating and Maintenance Cost Indices for Service Option No. 4

Revenue Train Hours	Revenue Car Miles	Revenue Locomotive Miles
44,475	6,071,264	1,396,790

Triple-Track Section Between Mileages 14.2 and 16.8

We determined that it is not practical to schedule an express train to pass a local train within this short 2.6 mile distance encompassing two stations, because the length of the triple-track section in concert with the number of stations therein will not allow an overtake to be scheduled without delaying the local train by approximately six minutes (see pages 57 - 60 for additional information).

The primary purpose of a triple-track section, in addition to operational flexibility, is to allow express trains to pass local trains. A very-related and equally important purpose is to increase the capacity of the rail line to accommodate/operate a mixture of express and local trains having different average speeds. Without the ability for an express train to pass a local train, the trip time and average speed of the local train is the primary constraint that limits the number and performance of express trains. This is why it has been proposed in some options to assign a second locomotive to certain local trains.

The values used in the sample calculation are our best estimates for each of the pertinent parameters. Based on the proposed formula and the suggested values, and also based on the assumption that the local trains are not to be routinely delayed by what is called "built-in (to the timetable schedules) signal delay", the length of the proposed triple-track section will have to be extended to encompass a total of six stations. Since it is assumed that most if not all express trains will stop at Millbrae because of the BART transfer opportunity, the triple-track section will have to be extended so as to encompass Broadway, Burlingame, San Mateo, Hayward Park, Hillsdale and Belmont Stations.

Since the proposed timetable maximum speed for most of this area is 70 mph, there is the possibility of increasing the maximum speed up to 79 mph, which is the legal limit without having some form of train control. However, the achievable time savings are approximately 35 to 40 seconds if 45-mph diverging routes are used. Other possibilities include the use of equilateral turnouts as discussed in Section 8.2 (Page 57). In any triple-track design, the stations must be configured so that Caltrain Rule 6.30 (the so-called "hold-out" rule) does not apply.

7.5 Service Option No. 5: MEDIUM-TERM SCHEDULE OPTIMIZATION, GILROY SERVICE EXTENSION

Service Option No. 5 incorporates the Near-Term and Medium-Term Schedule Optimization train-service improvements included in Service Option Nos. 1 and 4, except that no trains turn at Millbrae. This option continues to assume that the various planned changes and improvements to the existing railroad and BART are operational, as were listed under Service Option No. 4 (see Table 3).

In addition, Service Option No. 5 also reflects and assumes that the trackage from Tamien to Gilroy will be entirely double-tracked, and that the trackage surrounding Palo Alto will support the turning of trains to and from the south at Palo Alto. Also, the stations between Capitol and San Martin inclusive will be configured with side platforms, inter-track fencing, etc., so that the "hold out" rule will not apply at these locations. Station and track configurations at Tamien and Gilroy are discussed later in this report.

This option assumes that the number of additional trains to be operated to and from Gilroy was to be increased above the level of service provided in Service Option No. 3. Specifically, under Service Option No. 5, a total of four reverse-peak direction trains are to be provided to and from Gilroy during each of the two commutation periods.

Passenger-count information from February 1998 and 1999 was used to determine patronage by train and time period. The proposed train schedules for Service Option No. 5, including suggested revisions to the current Caltrain Timetable, are presented in Exhibit 5. The running times contained in Exhibit 5 are based on the running times in the current Caltrain Timetable. Although the Train Performance Calculator analyses and actual observations suggest longer running times than those in the timetable, capital improvements now underway will make the published running times more achievable.

There are revenue 87 trains (plus one deadhead), including service to and from employment centers at Blossom Hill and Morgan Hill, in Exhibit 5.

Shuttles versus Through Trains

Caltrain's initial concept was to schedule new "shuttle" trains between Palo Alto and Gilroy. After again having evaluated this type of shuttle service, we are recommending against operating shuttles between Palo Alto and Gilroy, except when it is not practical to extend the schedule of an existing train operating to or from San Francisco. Instead, we recommend generally operating through trains to and from San Francisco by extending the schedules of some of the trains that are currently operated between San Francisco and San Jose.

There are several reasons for this recommendation. The key reasons are as follows:

- 1) Providing capital improvements to turn trains at Palo Alto are not cost effective because it is generally deemed to be not operationally desirable to turn trains at Palo Alto. (To avoid the need for these capital improvements, the one train that we turned was turned in the proposed controlled siding at Redwood Junction.)
- 2) There will always be passengers from north of Palo Alto who will want to use these new trains to travel to and from stations south of Tamien. We suggest providing a through, seamless service rather than requiring these passengers to change trains and wait at an intermediate station.
- 3) Operating shuttles will require more trainsets than are required by extending the through trains.
- 4) Operating shuttles will incur more congestion and train delays than would be incurred by extending the through trains.

Service Option No. 5 Schedule Modifications

Unless otherwise stated herein, all of the Service Option No. 4 schedule modifications (with the exception of Millbrae turns) previously discussed have been incorporated into Service Option No. 5.

The schedules of southbound Trains 22, 24, 28, 44, and 82 have been extended to Gilroy. In addition, a new Train 20 has been added, which originates at Atherton (the first station south of the Redwood Junction controlled siding) The train is a Palo Alto turn, providing early morning service from Palo Alto, intermediate stations, and to Gilroy. The train also stops at Palo Alto and Menlo Park because the train turns in the Redwood Junction control siding and must therefore pass these stations.

The schedules of northbound Trains 57, 71, 75, 79A, 83 and 87 have been "extended" to originate at Gilroy.

Except for the extension of double track to Gilroy, the suggested schedule improvements do not require any changes to the Gilroy yard or station trackage.

Our analysis of the suggested schedule improvements is that some improvements to the Tamien Station configuration may be desirable. Opposing through trains such as Trains 54 and 75 are scheduled to stop at Tamien within six minutes of each other, while the stub-ended platform track is occupied.

Train Equipment Required

The conceptual train-equipment cycles below for the Service Option No. 5 modified timetable demonstrate that 19 engines/trainsets and 81 cars are required. These train-equipment cycles will need to be further refined before implementation. For instance, Line 18 is a "closed" train-equipment cycle whose equipment is stored overnight at Gilroy, and which has insufficient layover times during the day at San Francisco or San Jose to facilitate locomotive servicing. Our analysis has established that these train-equipment cycles can be modified without increasing the number of engines, trainsets or cars to ensure that all trainsets being stored overnight at Gilroy can be serviced at either San Francisco and/or San Jose.

Table 13: Conceptual Train-Equipment Cycles for Service Option No. 5

Line	Cars	Trains	Next Day	
			Line	Train
1	4	G22 - 57 - # - 60 - 85	1	G22
2	4	22A - 45 - # - 46 - 67 - 74 - 83A - 86	13	31
3	4	G24 - G71 - 76	10	51
4	5	26 - 51A - # - G54 - G83 - 84	6	27
5	5	23 - G28 - G75 - 80A	5	23
6	5	27 - 32 - 53A - # - G58 - 87	4	26
7	4	29 - 34 - 55 - 50 - 77 - 80	7	29
8	4	37 - 40A - 57A - # - 62	8	37
9	4	47 - # - 46A - 65 - 72	9	47
10	4	51 - # - 48A - 69 - 76A - X - 89	3	G24
11	5	21 - G20 - G49 - # - 48 - 73 - 78	11	21
12	4	25 - 30 - 53 - # - 52 - 79 - 82A	12	25
13	4	31 - 36 - 59 - # - G64	17	G33
14	4	35 - 40 - 61 - # - 70	14	35
15	4	39A - 42A - 59A - # - 66	15	39A
16	4	41 - G44 - G79A - # - 90	16	41
17	4	G33 - 38 - 55A - # - 56 - 81	2	22A
18	5	G39 - 42 - 63 - G68	18	G39
19	4	G43 - # - 44A - 61A - # - G82	19	G43
TOTAL	81			

-- midday opportunity to service equipment at San Francisco
 X -- midday opportunity to service equipment at San Jose

Also, some trains have been provided with excessively long turn times at Tamien, which will require some unnecessary deadhead movements between Tamien and Diridon to avoid congestion at Tamien. These turn times should be shortened to be in line with current Caltrain practice. In summary, our work has clearly established that the Service Option No. 5 modified timetable only requires 19 engines/trainsets and 81 cars.

A trainset was generally assigned 5 cars if the February 1999 reported average peak load for one of the trains in the cycle equaled or exceeded 60 percent of the number of the number of seats on a 4-car train (60 percent of 553), which equals 332. All of the other trainsets were assigned 4 cars.

Operating and Maintenance Cost Indices

The table below shows annualized operating and maintenance cost indices for Service Option No. 2. The annual number reflects the following assumptions:

- There are 255 weekdays in the year.
- Any weekend timetable developed in conjunction with this service option will maintain today's ratios of weekend to weekday revenue hours and miles.

Table 14: Annual Operating and Maintenance Cost Indices for Service Option No. 5

Revenue Train Hours	Revenue Car Miles	Revenue Locomotive Miles
49,386	6,484,218	1,555,052

Triple-Track Section Between Mileages 14.2 and 16.8

We determined that it is not practical to schedule an express train to pass a local train within this short 2.6 mile distance encompassing two stations, because the length of the triple-track section in concert with the number of stations therein will not allow an overtake to be scheduled without delaying the local train by approximately six minutes (see pages 57 - 60 for additional information).

The primary purpose of a triple-track section, in addition to operational flexibility, is to allow express trains to pass local trains. A very-related and equally important purpose is to increase the capacity of the rail line to accommodate/operate a mixture of express and local trains having different average speeds. Without the ability for an express train to pass a local train, the trip time and average speed of the local train is the primary constraint that limits the number and performance of express trains. This is why it has been proposed in some options to assign a second locomotive to certain local trains.

The values used in the "sample calculation" are our best estimates for each of the pertinent parameters. Based on the proposed formula and the suggested values, and also based on the assumption that the local trains are not to be routinely delayed by what is called "built-in (to the timetable schedules) signal delay", the length of the proposed triple-track section will have to be extended to encompass a total of six stations. Since it is assumed that most if not all express trains will stop at Millbrae because of the BART transfer opportunity, the triple-track section will have to be

extended so as to encompass Broadway, Burlingame, San Mateo, Hayward Park, Hillsdale and Belmont Stations.

Since the proposed timetable maximum speed for most of this area is 70 mph, there is the possibility of increasing the maximum speed up to 79 mph, which is the legal limit without having some form of train control. However, the achievable time savings are approximately 35 to 40 seconds if 45-mph diverging routes are used. Other possibilities include the use of equilateral turnouts as discussed in Section 8.2 (Page 57). In any triple-track design, the stations must be configured so that Caltrain Rule 6.30 (the so-called "hold-out" rule) does not apply.

7.6 Service Option No. 6: MEDIUM-TERM COMPLETELY NEW SCHEDULE, REPETITIVE ZONE PATTERNS

Service Option No. 6 was prepared in response to Caltrain's request that we develop a third proposed schedule for the medium term. Service Option No. 6 was to include increased train service using cyclical patterns of zone and express trains on a 30-minute cycle.

As was the case with Service Option No. 4, Service Option No. 6 has been developed to reflect various planned changes and improvements being operational to the existing railroad and BART (see Table 3), including:

- additional Caltrain train equipment,
- the BART/Caltrain transfer opportunity at Millbrae,
- three main tracks between Mileages 14.2 and 16.8,
- centralized traffic control (CTC) for the trackage and new interlockings between San Francisco and San Jose,
- station improvements allowing elimination of the "hold-out" rule procedures at many stations,
- Paul Avenue Station closed and replaced by Oakdale/Palou,
- Bayshore Station relocated, and a
- new Bailey Avenue Station, located north of Morgan Hill.

Passenger-count information from February 1998 and 1999 was used to determine patronage by train and time period. The proposed train schedules for Service Option No. 6, including suggested revisions to the current Caltrain Timetable, are presented in Exhibit 6. The running times contained in Exhibit 6 are based on the running times in the current Caltrain Timetable. Although the Train Performance Calculator analyses and actual observations suggest longer running times than those in the timetable, capital improvements now underway will make the published running times more achievable.

There are 100 revenue trains in Exhibit 6.

General

Minor schedule changes are proposed in Exhibit 6 to account for the new Bailey Avenue and Oakdale/Palou Stations, the relocation of the Bayshore Station, and the closure of the Paul Avenue Station.

To optimize the transfer opportunity at Millbrae between Caltrain and BART, all Caltrain trains have been scheduled to stop at Millbrae, except for two southbound trains (Trains 68 and 76) during the evening peak period. This has resulted in additional minor schedule changes to many trains.

Northbound Morning Peak Period

A total of 17 northbound trains have been scheduled to arrive San Francisco prior to 9:30 AM, versus 14 today. The primary train-service pattern proposed by Caltrain involves three trains every 30 minutes, one of which is an all-stop local. The other two trains every half-hour are limited-stop express/zone trains. The primary thrust of this conceptual service pattern is to increase the frequency of all-stop local service (which today has a 49-minute gap between Trains 33 and 41), while continuing to provide faster express/zone trains for the major stations and longer-haul commuters.

Locomotive Assignments

The scheduled running times for all-stop local Trains 31, 37, 41 and 47 are based on two engines hauling the train, and are five minutes faster than if only one engine was assigned. Assigning two engines to each of these four local trains has "freed up" 20 minutes of capacity (five minutes per local train with two engines) for the faster express/zone trains.

For instance, if Train 41 was only assigned one engine, its schedule would need five to six minutes of additional running time. This would require preceding Train 39A to be moved earlier and/or following Train 43 to be moved later, which reduces the density of train service that could be provided. Alternatively, instead of providing the all-stop local trains with two engines, the express/zone trains could be slowed down by adding additional and otherwise unnecessary running time (built-in signal delay), and/or by adding up to three station stops per non-local train.

Southbound Morning Peak Period

A total of 15 southbound trains have been scheduled to depart San Francisco prior to 9:30 AM, versus 10 today. The primary train-service pattern involves three trains every 30 minutes, one of which is an all-stop local. The other two trains every half-hour are limited-stop express/zone trains. The primary thrust of this conceptual service pattern is to maintain the 30-minute frequency of all-stop local service, while providing additional faster express/zone trains for the major stations and longer-haul commuters.

Locomotive Assignments

The scheduled running times for all-stop local Trains 26 and 30 are based on two engines hauling the train, and are five minutes faster than if only one engine was assigned. Assigning two engines to each of these two local trains has "freed up" 10 minutes of capacity (five minutes per local train with two engines) for the faster express/zone trains.

For instance, if Train 30 was only assigned one engine, its schedule would need five to six minutes of additional running time. This would require preceding Train 28 to be moved earlier and/or following Train 30A to be moved later, which reduces the density of train service that could be provided. Alternatively, instead of providing the all-stop local trains with two engines, the express/zone trains could be slowed down by adding additional and otherwise unnecessary running time (built-in signal delay), and/or by adding up to three station stops per non-local train.

Midday Off-Peak Period

To reduce the midday off-peak headway from one hour to 30 minutes, new Trains 51A, 53A, 55A, 57A, 59A, 61A, 40A, 42A, 44A, 46A and 48A have been added. Most of these trains have been scheduled to turn at Millbrae.

A 30-minute headway between same-direction trains during the midday off-peak period will make it more difficult to operate local "way freights" and to take track segments out of service for maintenance and/or construction activities during this time period.

Northbound Evening Peak Period

A total of 14 northbound trains have been scheduled to depart San Jose between 3:00 PM and 7:00 PM, versus nine today. The primary train-service pattern involves two trains every 30 minutes, one of which is an all-stop local. The other train every half-hour is a limited-stop express train. The primary thrust of this conceptual service pattern is to provide a 30-minute frequency for all-stop local service, while also providing interspersed faster express trains for the major stations and longer-haul commuters.

Southbound Evening Peak Period

A total of 18 southbound trains have been scheduled to depart San Francisco between 3:00 PM and 7:00 PM, versus 14 today. The primary train-service pattern generally remains unchanged from that in the current timetable. Three express/zone trains have been added to supplement the existing train service, and one local train was added to reduce the service headway at the end of the evening peak period.

We determined that it is not possible to reduce the current 42-minute gap in all-stop local service between Trains 66 and 74 to less than 40 minutes without unacceptably impacting/degrading the current level of express/zone service provided within that time period. The primary thrust of this conceptual service pattern is to maintain the existing frequency of all-stop local service, while providing a few extra express/zone trains for the major stations and longer-haul commuters.

The scheduled running times for all-stop local Trains 54, 58 and 74 are based on two engines hauling the train, and are five minutes faster than if only one engine was assigned. These extra engines are available because of the proposed morning timetable.

Assigning two engines to Trains 54 and 58 allow the existing San Francisco departure times to be retained, while the following Gilroy ("split") trains can be scheduled to depart San Jose Diridon and Tamien essentially per the existing timetable. Train 74 has been assigned two engines to maintain separation from following express/zone Train 76.

Train Equipment Required

The above-described Service Option No. 6 modified timetable requires 22 trainsets, 28 locomotives and 88 cars, as demonstrated in the conceptual train-equipment cycles on the next page.

Table 15: Conceptual Train-Equipment Cycles for Service Option No. 6

Line	Engines	Cars	Trains	Next Day	
				Line	Train
1	1	4	22 - 43 - # - 50 - 71 - 76A	9	25
2	1	4	22A - 49 - 42 - 59 - # - 66 - 83 - 86	17	39
3	1	4	24 - 51 - 44 - X - 79A	3	24
4	1	4	24A - 51A - 40A - X - 75 - 80B - 89	4	24A
5	2	4	26 - X - 61 - # - 74 - 85A - 90	16	37
6	1	4	26A - X - 57A - 46A - 65 - G64	18	G39A
7	1	4	28 - 53 - # - G58A	22	G49A
8	2	4	23 - 30 - X - 69 - 72	8	23
9	1	4	25 - 30A - X - 59A - 48A - 69A - 76 - 85	1	22
10	1	4	27 - 32 - 53A - 42A - X - 77 - 82	10	27
11	1	4	29 - 34 - 55 - # - 60 - 81	2	22A
12	1	4	29A - 34A - X - 61A - # - 80	12	29A
13	2	4	31 - 36 - X - 71A - 78	13	31
14	1	4	G33 - # - 46 - 63 - G68	14	G33
15	1	4	35 - # - 48 - 67 - 70	15	35
16	2	4	37 - # - 52 - 73 - 80A - 87	5	26
17	1	4	39 - 38 - 55A - 44A - X - 77A	6	26A
18	1	4	G39A - 40 - 57 - # - 62	11	29
19	2	4	41 - # - 54 - 79B - 84	19	41
20	1	4	G45 - # - G54A	20	G45
21	2	4	47 - # - 58 - 83A - 82A	21	47
22	1	4	G49A - # - 56 - 79	7	28
TOTAL	28	88			

-- midday opportunity to service equipment at San Francisco
 X -- midday opportunity to service equipment at San Jose

Because of the increased level of service, no train was assigned 5 cars; every train was assigned 4 cars.

Operating and Maintenance Cost Indices

The table below shows annualized operating and maintenance cost indices for Service Option No.6. The annual number reflects the following assumptions:

- There are 255 weekdays in the year.
- Any weekend timetable developed in conjunction with this service option will maintain today's ratios of weekend to weekday revenue hours and miles.

Table 16: Annual Operating and Maintenance Cost Indices for Service Option No. 6

Revenue Train Hours	Revenue Car Miles	Revenue Locomotive Miles
50,345	6,302,599	2,024,120

Service Pattern Observations

Operating both express/zone and local trains on the same track at different average speeds consumes much more capacity than operating all locals, expresses, or skip stops. Because so much of Caltrain's patronage involves intermediate ridership, we believe that providing a peak-period 30-minute headway between all-stop local trains is very important. However, the longer that it takes the local train to transit the line, the less capacity is left for intervening express/zone trains. That is why selected local trains have been assigned two engines. Caltrain should also explore speeding up the all-stop local trains by combining and/or closing low-volume stations.

7.7 Key Recommendations

While there exist many opportunities to improve Caltrain service, there are also constraints which inhibit the transition to providing more service. In today's environment, limited track capacity and the hold-out rule make expanded service difficult to implement. The hold-out rule prohibits two trains from entering a station at the same time due to safety concerns, while third tracking is necessary for trains to overtake each other to provide faster, more express service.

The implementation of Caltrain capital projects over the next few years should ease the service restrictions imposed by these two factors. The exhibits in this study show that the current 24 stations that are governed by the hold-out rule will decrease to only 5 stations in the next four to five years due to station capital improvements like platform relocation and center-line fencing. In addition, the potential construction of triple track segments will also enable the expansion of train service.

This study also examined the feasibility of providing "turnback" service between Palo Alto and Gilroy in order to provide specialized service to Santa Clara County residents who travel mostly within the county. Our conclusion is that Caltrain's high intermediate ridership undermines the service goals of turnback service. Based on existing ridership patterns, it is likely that some passengers from north of Palo Alto will want to travel to and from station south of Tamien. We recommend operating additional Gilroy-San Francisco through trains by extending some of the trains that are currently operated between San Francisco and San Jose.

However, if turnback service were implemented, Redwood City would be a preferable location to Palo Alto for the construction of the actual turnback. Due to the existing double-track configuration at Palo Alto, it is not operationally feasible to turn trains from south of Palo Alto. Use of the crossover south of Menlo Park would delay other trains and does not provide a layover location if needed. Any such shuttles from Gilroy would have to continue north to the proposed controlled siding at Redwood Junction.

For the most part, current Caltrain service is well optimized, with limited methods for improvement available due to the above-mentioned constraints. As mentioned above, one measure that Caltrain can take in order to expand service and operate more efficiently is to reduce hold out stations. This will enable Caltrain to operate more trains by allowing two trains to occupy a station at the same time. Reducing the number of station stops can also improve service by offering riders faster trips. Eliminating low patronage stations, as was recently done with the Castro station, can also significantly improve run times.

Another area of improvement is the impending delivery of new equipment. With the new equipment Caltrain can lengthen consists to up to six cars in order to meet growing demand. Adding cars, however, will make trains run slower, and Caltrain should also

consider running trains with two locomotives instead of just one. This study also evaluated the operation of three-car trains in order to reassign equipment to make other trains longer, but concluded that there was little opportunity to use them.

Caltrain can also re-evaluate different ways to operate the railroad in order to make it run more efficiently. There are three primary types of service patterns which to consider: local, zone express, and skip stop. Caltrain currently provides a combination of local and zone express service. While local service (stopping at all stations) takes the longest time to traverse the railroad, it also provides for all origination and destination combinations. This is particularly important since nearly 50 percent of Caltrain ridership is intermediate.

Zone express and skip stop service can improve average speed and save run time, but they may also adversely impact certain riders. Zone express is usually provided during peak periods and serves end-to-end markets. This type of service typically stops at several stations and then runs express to the final destination -- usually the Central Business District. Skip stop patterns bypass various stations, running faster but providing less origin and destination options to the passenger.

Caltrain can also expand service in key travel markets: reverse peak, midday and evenings. Reverse peak ridership shows great potential, as demonstrated by the 25 percent growth in reverse peak ridership between 1990 and 1996. Hourly off-peak service should be turned into half-hourly service at a minimum, which we have determined is feasible in the near term. Expanded evening service should also be readily achievable.

In order to meet the growing demands of customers, we recommend an incremental expansion of service: adding 2 new trains this year, 12 new trains in 2000 or 2001 (half hourly midday service), and another 2 new trains in 2002, 2003 and 2004, as illustrated in Table 17 (Service Improvement Plan). Based on our study, we conclude that Caltrain's goal of 86 trains, as stated in its 1999 Interim Short-Range Transit Plan, is achievable within the next four years.

Table 17: Actions to Increase the Number of Weekday Trains

Year	Action	Resulting No. of Trains	Service Option
2000	Add 22A and 79A	70	No. 1
2000 - 2001	40A, 42A, 44A, 46A, 48A, 51A, 53A, 55A, 57A, 59A	80	No. 4
2002	Add 76A, 61A	82	No. 4
2003	80A, 83A	84	No. 4
2004	Add 82A, 39A	86	No. 4

8. Related Service Planning Issues

8.1 Yard and Terminal Capacity

In 1998, Caltrain evaluated the capacity of its existing terminals to accommodate the fleet expansion that was then underway.⁸ The weekday night storage requirements associated with Service Option Nos.1-6 were compared to the future scenario analyzed in the terminal capacity study to identify implications for yard and terminal capacity. The table below compares the storage requirements for San Francisco, Gilroy and San Jose.

Table 18: Number of Consists to be Stored Overnight

Terminal	Capacity		Short-Term Service and Fleet Study Service Option					
	Current	Study	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Gilroy	4	4	4	4	4	4	3	4
San Jose	9+1 (Amtrak)	12	8	8	8	10	12	11
San Fran.	3+1 (in Yard)	6	4	4	4	4	4	7
Total	18	22	16	16	16	18	19	22

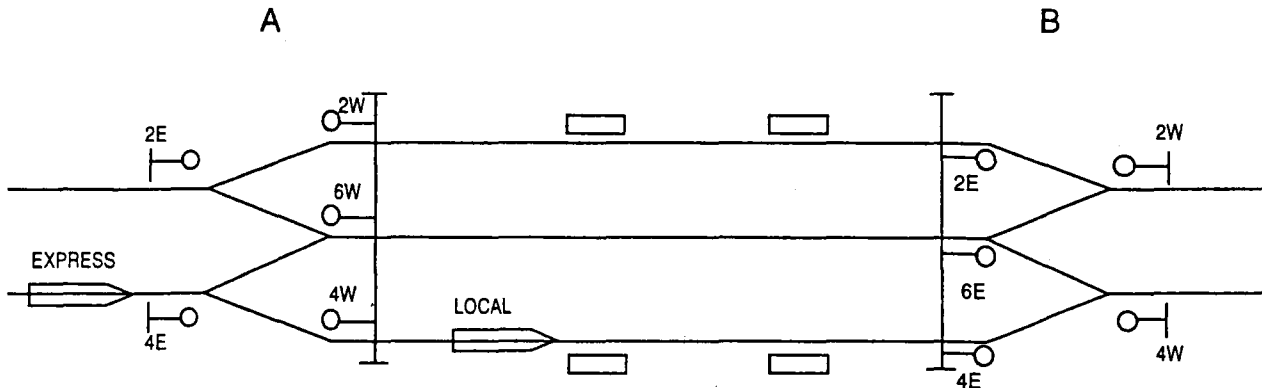
Comparison of Requirements

The terminal capacity study stated that four trainsets can be stored at Gilroy. Therefore, none of the service options has an impact at Gilroy. The terminal capacity study cited capacity for twelve trains at Cahill Yard in San Jose including yard and station tracks. The storage requirements for all of the service options are less than or equal to twelve trainsets; therefore, there is no impact to San Jose. The terminal capacity study stated that storage of six trains at San Francisco posed no problem. Therefore, the storage requirements of Service Options No. 1-5 can be readily accommodated. Storage of the seven trainsets required for Service Option No. 6 can also be accommodated at San Francisco where both yard and station tracks are used for storage. In conclusion, the service options are all compatible with available and expected storage capacity.

The terminal capacity study noted that several operational changes would be necessary at existing maintenance facilities in order to provide for daily servicing and inspection. That study also recommended that Caltrain consider moving toward a 90-day cycle (versus 92-day) for coach repairs. The equipment manipulations suggested in this study for each service option should be analyzed in the context of current practices and plans for the future in order to determine their implications for maintenance facilities and operations.

⁸ Caltrain Terminal Operations and Capacity Study, Technical Memorandum, January, 1998.

8.2 Third Track Utilization and Capital Requirements



In order for an express train that follows a local train on the same track to Interlocking A (the beginning of the triple-track section) to overtake and pass the local train within the triple-track section, the progress of the local train must be slowed down and delayed within the triple-track section. This is necessary to allow the express train (that follows the local train to Interlocking A) to overtake/pass the local train and reach the end of the triple-track section (Interlocking B) sufficiently ahead of the local train, so that the express train can be merged ahead of the local train onto the same track exiting Interlocking B.

The suggested formula that will be presented later is based on several assumptions, as discussed below:

- One important assumption is that under ideal/normal conditions when both trains are expected to be on-time, neither train is to receive signal delay that actually delays the train. The express train that follows the local train to Interlocking A is not to receive any signal delay prior to or approaching Interlocking A because of the preceding local train. This requires Green (Clear) signal aspects for the express train. In addition, the local train that follows the express train from Interlocking B is not to receive any signal delay approaching, passing or beyond Interlocking B because of the preceding express train. This requires Flashing Yellow (Advance Approach) signal aspects for the local train.
- Another assumption is that the maximum authorized speed is the same for all three tracks within the triple-track section. Also, it is assumed that the design of all stations within the triple-track section will allow express trains to operate at the authorized maximum speed totally independent of local trains, and that the stations designs will preclude applicability of Caltrain Rule 6.30 (the so-called "hold-out" rule) within the triple-track section.

- The last assumption relates to the interlocking configurations at Interlockings A and B. It is assumed that the straight non-diverging interlocking routes are to and from the outside/local tracks within the triple-track section, and not to and from the inside/middle/express/third track. Of course, equilateral turnouts could be used. These would speed up the diverging movements of the express trains. Depending on the size and speed of the equilateral turnouts and the proximity to nearby stations, the trip time of local trains may be slightly increased. Also, equilateral turnouts generally require increased maintenance since every train diverges and imparts increased lateral forces (as opposed to the impacts of straight non-diverging movements) to the "special work."

The above assumptions imply that the local train can only be slowed down and delayed (to allow the overtake/pass) by being scheduled to make station stops within the triple-track section. The formula below is a way of calculating how many stops have to be made.

The Formula

$$\text{NSSWTTS} = \frac{(\text{SSHWA} + \text{SSHWB} + 2\text{SSHWPAD} + \text{TLXOVERA} + \text{TLXOVERB})}{\text{TLPERSS}}, \text{ where:}$$

NSSWTTS is the number of station stops (that the local train will have to make) within the triple-track section,

SSHWA is the signal-system headway prior to and approaching Interlocking A,

SSHWB is the signal-system headway approaching, passing and beyond Interlocking B,

SSHWPAD is the extra/additional signal-system headway margin/"pad" necessary between two trains to promote timetable/schedule reliability,

TLXOVERA is the time lost by the express train because of the diverge at Interlocking A,

TLXOVERB is the time lost by the express train because of the diverge at Interlocking B, and

TLPERSS is the time lost (by the local train) when making each station stop.

Formula Explanation and Values

The value NSSWTTS (the number of station stops that will be required within the triple-track section) calculated using the formula could include a fraction of a station stop. Rounding up to an integer number of stations will be required. Of course, a lesser number of station stops than calculated using the formula can always be provided, in which case the local train being overtaken/passed will have to routinely incur signal delay approaching and in the vicinity of Interlocking B.

We recommend predicating SSHWA on Green (Clear) signal aspects since such aspects are deemed necessary for the express train to not be delayed. Also, this value must be large enough to account for the always-encountered Interlocking Delay (ID) plus the sometimes-encountered Traffic-Direction Delay (TDD) that are incurred after the local train clears Interlocking A before Signal 4E at Interlocking A can clear for the diverging route to the middle/express/third track.

We recommend predicating SSHWB on Flashing Yellow (Advance Approach) signal aspects since such aspects are deemed necessary for the local train to not be delayed.

The values SSHWA and SSHWB must both also include the propagation delay due to electronic track circuits for successive signal aspects to upgrade.

Based on our experience, we recommend setting the SSHWPAD to be at least 90 seconds. Thus, on an ideal/on-time day, no signal would upgrade to a Green aspect less than 90 seconds before it is passed by the express train, and no signal would upgrade to a Flashing Yellow aspect less than 90 seconds before it is passed by the local train.

The time lost by the express train because of the diverges at Interlockings A and B (TLXOVERA and TLXOVERB) depends on the configuration of the interlockings, the speed of the turnouts, the wording of the signal rules, etc. Based on our experience, we recommend using 75 seconds for 30-mph diverging routes, 45 seconds for 45-mph diverging routes and 15 seconds for 60-mph diverging routes. (Caltrain does not have any proposed signal aspects for 60 mph diverging routes.)

The time lost (by the local train) when making each station stop (TLPERSS) varies from station to station due to the dwell time, the surrounding operating speeds and speed restrictions, etc. Our TPC simulations of local and express trains operating between Gilroy and San Francisco established that for 30-second station-dwell times, each station stop on average causes an increased trip time or delay of 2.025 minutes. We recommend setting the value of TLPERSS to 2.0 minutes.

A Sample Calculation and Comment

For SSHWA being 4.0 minutes, SSHWB being 3.0 minutes, SSHWPAD being 1.5 minutes, TLXOVERA and TLXOVERB each being 0.75 minutes (for 45-mph turnouts), and TLPERS being 2.0 minutes, NSSWTTS would equal 5.75, which we would round up to 6 required station stops within the triple-track section. Scheduling overtakes/passes between same-direction trains is similar to scheduling meets between opposing trains within single-track territories. One late train approaching an overtake/pass usually results in both trains being late departing the overtake/pass. Such scheduling of trains increases the compounding of train delays, especially if the value for SSHWPAD is not set large enough.

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10. Appendix

Table 19: Northbound Speed Table

Reflects future passenger-train operating speeds under new CTC signal system.

7-15-1999 GILROY-SAN FRANCISCO (NO STOPS)

FROM MILEPOST	TO MILEPOST	SPEED LIMIT	REASON FOR SPEED RESTRICTION
77.259	76.933	10.	TO/STA
76.933	76.200	35.	M78.4-76.2
76.200	70.500	79.	MAS
70.500	70.200	55.	MP 70.2-.5
70.200	60.222	79.	MAS
60.222	52.022	60.	M59.9-49.7
52.022	51.869	35.	TO-LICK
51.869	49.775	60.	M59.9-49.7
49.775	49.469	15.	TO-LICK
49.469	47.936	35.	M59.9-49.7
47.936	47.200	15.	XO-MICHAEL
47.200	47.100	20.	M47.2-47.1
47.100	46.300	50.	M47.1-46.3
46.300	39.300	79.	M46.3-39.3
39.300	24.700	70.	MP 39.3-24
24.700	21.400	79.	MP 24.7-21
21.400	11.000	70.	MP 21.4-11
11.000	1.800	60.	MP11.0-1.8
1.800	1.300	40.	MP 1.8-1.3
1.300	0.600	25.	MP 1.3-.6
0.600	0.530	20.	MP.6-.53
0.514	0.156	10.	MP.53-BLOK

Table 20: Southbound Speed Table

Reflects future passenger-train operating speeds under new CTC signal system.

7-15-1999 SAN FRANCISCO-GILROY (NO STOPS)

FROM MILEPOST	TO MILEPOST	SPEED LIMIT	REASON FOR SPEED RESTRICTION
0.247	0.514	10.	TO MP .53
0.514	0.600	20.	TO MP 0.6
0.600	1.300	25.	MP 0.6-1.3
1.300	1.800	40.	MP 1.3-1.8
1.800	11.000	60.	MP 1.8-11.0
11.000	21.400	70.	MP 11.0-21.4
21.400	24.700	79.	MP 21.4-24
24.700	39.300	70.	MP 24.7-39
39.300	46.300	79.	M39.3-46.3
46.300	47.050	50.	M46.3-47.1
47.050	47.936	15.	XO'S-STA
47.936	49.469	35.	M47.9-49.5
49.469	49.775	15.	XO CP-MIKE
49.775	51.869	60.	M49.8-59.9
51.869	52.022	35.	TO-LICK
52.022	59.900	60.	M49.7-59.9
59.900	70.200	79.	MAS
70.200	70.500	55.	M70.2-70.5
70.500	74.575	79.	MAS
74.575	76.200	40.	ADV.APP.
76.200	76.933	35.	M76.2-78.4
76.933	77.250	10.	RESTRICTNG

