Corridor Crossings
STRATEGY

4-Track Analysis

Final February 2025

Caltrain

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GLOSSARY

Adopted Service Vision: The service vision adopted by the Peninsula Corridor Joint Powers Board (JPB) to guide the long-range development of Caltrain rail service and supporting plans, policies, and projects. The Adopted Service Vision outlines minimum peak hour frequencies of eight Caltrain trains and four High-Speed Rail trains per hour, per direction. The Adopted Service Vision is also referred to as the "Moderate Growth Scenario," "2040 Long Range Service Vision," or "2040 Service Vision." The Moderate Growth Scenario outlines new 4-track segments inclusive of stations at Millbrae, Hayward Park to Hillsdale, Redwood City, an option in northern Santa Clara County (Palo Alto, California Avenue, San Antonio, or Mountain View), and Blossom Hill.

California High-Speed Rail Authority (CHSRA): The California state agency established to develop and implement High-Speed Rail (HSR) service in California.

Caltrain Corridor ("corridor"): The rail alignment where Caltrain provides rail service from San Francisco to San Jose and Gilroy. The railroad is owned and operated by Caltrain from 4th and King Station Depot in San Francisco to Tamien Station in San Jose. Caltrain continues rail operations between Tamien Station in San Jose to Gilroy Station in Gilroy.

Curve Geometry: The level to which the railroad track curves, expressed in degrees.

Dwell Time: The time a vehicle, such as a train, spends at a scheduled stop without moving. This can be to allow passengers to board or deboard, allow for one train to pass another, or provide idling time to get back on schedule.

Four-Track or 4-Track: A segment of the Caltrain Corridor with four main tracks that allow faster trains to pass slower trains.

Frequency: The number of trains arriving per hour.

Headways: The amount of time between train arrivals at a stop. For example, four trains per hour entails a 15-minute headway between trains.

High Growth Scenario: The expanded "higher" service from the 2020 Caltrain Business Plan and described in the 2040 Long Range Service Vision that the Joint Powers Board (JPB) directed Caltrain staff to continue to consider and plan for potential implementation. The High Growth Scenario outlines peak hour frequencies of 12 Caltrain trains and four High-Speed Rail trains per hour, per direction. The High Growth Scenario outlines new 4-track segments inclusive of stations between South San Francisco to Millbrae, Hayward Park to Redwood, Palo Alto to San Antonio, and Blossom Hill station.

Local Service: Train service operated by Caltrain that stops at all stations on the line it operates. Local service provides maximum service coverage at the expense of end-to-end travel times.

Milepost: A marker that identifies by number a given track location, showing the number of miles from one point in a railroad division to another. Milepost zero (0.0) is at 4th and King Station Depot and increases from north to south along the railroad.

Overtake: When a faster train passes a slower train, either as a dynamic or static overtake. A dynamic (or moving) overtake occurs where both trains are traveling in the same direction on separate tracks, and one train runs faster than the other to pass the slower train. A static overtake occurs when both trains are traveling in the same direction on separate tracks, and one train is stopped and held typically at a station until the train in motion has passed with adequate space for the stopped train to depart the station.

Passing Track (aka sidings): Localized tracks allowing faster trains to pass slower or lower priority trains. Increases corridor capacity and service operation flexibility without adding a track the full length of the corridor.

Peak Hour: The period with the highest ridership during the transit service day.

Peninsula Joint Powers Board (JPB): The governing body of Caltrain. JPB consists of representatives from the three counties Caltrain serves, appointed to represent their respective transit agency or other government office.

Per Hour Per Direction (PHPD): Number of trains traveling along the corridor per hour per direction. For example, two trains per hour per direction describes two trains traveling north and two trains traveling south each hour.

Regional Express Service: Express service pattern operated by Caltrain that stops at select, high demand stations to reduce travel time between San Francisco and San Jose.

Segment: Section of track or of the corridor.

Skip-Stop Service: A service pattern which reduces travel time, or the need for additional passing tracks, by having trains skip certain stations along the corridor.

Stringline Diagram: A chart showing the time and position of train trips across a rail system. A stringline diagram can show which direction multiple trains are going, when they will stop (or dwell), slow down, or pass other trains.

Track Alignment: A series of tangents joined to circular curves and spiral transition curves to develop the horizontal direction and position measured along the center line of track.

Turnout: Track component which allows trains to divert from one track to another. A turnout is used to branch out from one track into two tracks in each direction at an overtake location.

ACRONYMS

AMP – JPB Advocacy and Major Projects Committee

BART – Bay Area Rapid Transit

BOD – Basis of Design

CalSTA – California State Transportation Agency

CCS – Caltrain Corridor Crossings Strategy

CHSRA – California High-Speed Rail Authority

EIR/EIS – Environmental Impact Report/Environmental Impact Statement

FRA – Federal Railroad Administration

JPB – Peninsula Corridor Joint Powers Board

HSR – High-Speed Rail

MPH – Miles per hour

OCS – Overhead Catenary System

PCEP – Peninsula Corridor Electrification Project

PHPD – Per hour per direction

RCE – FRA's Rail Crossing Elimination Program

RCUP – Rail Corridor Use Policy

ROW – Right-of-Way

SCRRA – Southern California Regional Rail Authority

TRICP – CalSTA's Transit and Intercity Rail Capital Program

UPRR – Union Pacific Railroad

1. EXECUTIVE SUMMARY

As a result of the Caltrain Business Plan process, the Peninsula Corridor Joint Powers Board (JPB) adopted the Moderate Growth scenario from the Business Plan (blended service pattern of eight Caltrain trains and four High-Speed Rail [HSR] trains per hour per direction [phpd]) as the 2040 Long Range Service Vision. This adoption of the Moderate Growth Scenario included policy language directing Caltrain to continue planning for potential "higher" growth service level[1] and to take specific actions to anticipate, and *where feasible and financially practicable*, facilitate such higher levels of service and connections related to a series of short, 4-track stations and overtakes (segments) at various points throughout the corridor.

The 4-Track Analysis is part of the Caltrain Crossing Corridor Strategy (CCS) and represents Caltrain's commitment to the Long Range Service Vision (see **Attachment A**) and coordinated partnership with corridor cities on grade separation projects (i.e., active crossing projects, including under and over crossing projects). Through the CCS process, corridor cities expressed a need to expedite the confirmation of the 4-track segments (identified and illustrated in the Caltrain Business Plan) to continue the advancement of grade separation projects that may be within or adjacent to the refined 4-track segment limits.

Adopted Service Vision

Through an iterative process of service operations analysis, testing of 4-track layouts based on engineering criteria, review of horizontal alignments, and workshops with Caltrain and California High-Speed Rail Authority (CHSRA), the 4-Track Analysis refined the 4-track segments at Millbrae, Hayward-Hillsdale, Redwood City, and northern Santa Clara County with length and milepost limits for the Moderate Growth Scenario (i.e., Adopted Service Vision). The technical analyses validated and confirmed the passing track locations and lengths to enable the future blended service pattern for both Caltrain and CHSRA. The refined 4-track segments are located at stations to allow for passing trains and increased operational flexibility. **Figure 1** and **Table 1** present the length and mileposts for the refined 4-track segments for the Adopted Service Vision.

[1] 12 Caltrain Trains (8 Express/4 Local) and 4 HSR Trains phpd

Figure 1: Caltrain Crossing Corridor Strategy Refined 4-Track Segments for the Adopted Service Vision

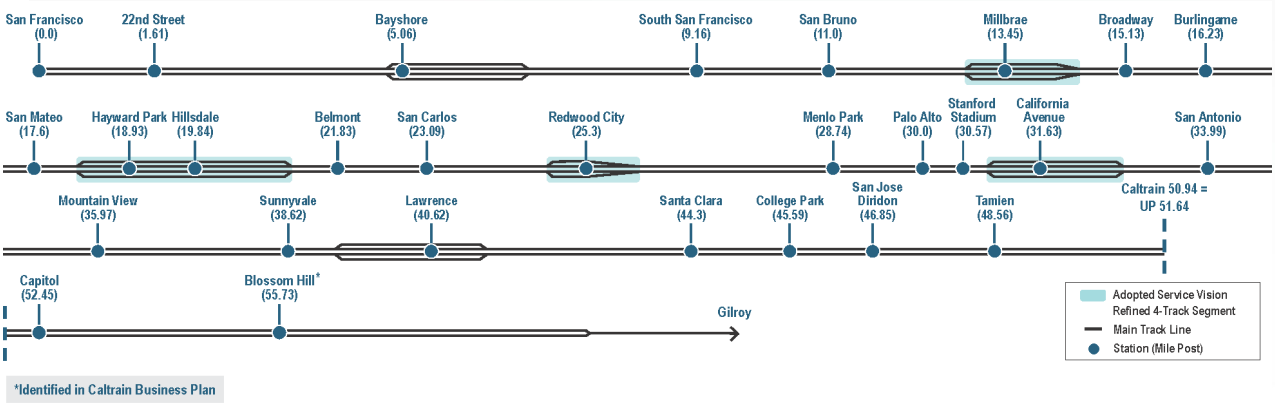


Table 1: Caltrain Crossing Corridor Strategy Refined 4-Track Segments for the Adopted Service Vision

Segment(1)	Length(2) (miles)	North Milepost	South Milepost
Millbrae	1.6	12.9	14.5
Hayward Park-Hillsdale	3	18.2	21.2
Redwood City(3)	1.3	24.75	26.05
California Avenue	1.9	30.9	32.85

Notes: (1) Segment inclusive of station. (2) Length includes transition from 2-track to 4-track. (3) Per Redwood City Grade Separation Study project summary report. Not further evaluated as part of the CCS 4-Track Analysis.

Flexibility in service operations, impacts to existing community assets and infrastructure, available right-of-way (ROW), and engineering criteria were reviewed to evaluate each option in northern Santa Clara County. As a result of the analysis, California Avenue is the optimal northern Santa Clara County 4-track segment to support the Adopted Service Vision. California Avenue presents an opportunity to expand to 4-tracks largely in the Caltrain ROW (with minor public ROW adjustments) while also supporting the Adopted Service Vision's rail service. The 4-Track Analysis process considered ways to optimize the length of the confirmed 4-track segment at California Avenue while minimizing infrastructure impacts.

High Growth Scenario

The 4-Track Analysis evaluated the feasibility and financial practicability of the High Growth Scenario 4-track segments (identified in the High Growth Scenario of the Caltrain Business Plan). The evaluation included conceptual layouts, operational analysis, and trade-offs between service parameters, engineering criteria, and available Caltrain ROW.

For the purpose of this evaluation, *feasibility* is defined as the possibility that a 4-track segment can be accommodated on the corridor given the engineering criteria, width of Caltrain ROW, adjacent land use type and intensity of activity, location and age of existing structures, and proposed infrastructure projects

of corridor cities. *Financial practicability* is defined as the capability of the corridor to fund the implementation of future 4-track segments by considering the number of parcels that would be impacted and the number and type of infrastructure that would need to be reconstructed.

Based on the analysis, the High Growth Scenario 4-track segments developed is estimated to affect:

- More than 150 acres of land beyond Caltrain's existing ROW
- More than 400 parcels adjacent to the Caltrain ROW
- 35 overpasses and underpasses along the Caltrain corridor
- 15 local roads and three interchanges in proximity to the Caltrain corridor

The evaluation found that 4-track segments for High Growth Scenario are infeasible and financially impracticable at this time due to the constraints presented by existing and planned infrastructure, surrounding land uses, and existing Caltrain ROW.

Next Steps

The opportunity to implement the refined 4-track segments for the Adopted Service Vision will continue to be monitored through the Rail Corridor Use Policy (RCUP). The RCUP provides a process to review and approve proposed uses of Caltrain property. One of the first steps in the RCUP review process is for Caltrain staff to determine if the proposed use is compatible with Caltrain's current and future needs.

The RCUP maps will be updated to include an overlay of the refined 4-track segments for the Adopted Service Vision. The RCUP and future service agreements will include the following guidance regarding grade separations and 4-track segments for the Adopted Service Vision:

- If a project is located within the Adopted Service Vision's 4-track limits, the project must be designed to accommodate four tracks, although only two tracks may need to be constructed in the interim.
- If the project is not within the Adopted Service Vision refined 4-track segments, the project does not need to accommodate for expansion or transition to four tracks.

The findings of the 4-Track Analysis can inform future re-evaluation of Caltrain's Long Range Service Visions — specifically additional corridor-wide analysis to identify 4-track segments outside of the High Growth Scenario segments to support "higher" levels of service.

2. 4-TRACK ANALYSIS BACKGROUND AND PURPOSE

Caltrain's 2040 Long Range Service Vision identified the need for 4-track infrastructure to facilitate higher speed trains passing local (slower) train service (see **Attachment A**). Caltrain, along with partner agencies and corridor communities, recognized a need to define the limits of the 4-track infrastructure called for in the Long Range Service Vision and conceptually identified in the Caltrain Business Plan.

The 4-Track Analysis is a focused technical and planning level effort to:

- Continue Caltrain's commitment to a future blended service developed in partnership with CHSRA,
- Continue the planning efforts called for in the 2040 Long Range Service Vision,
- Validate and refine the location and milepost limits of the identified 4-track segments from the Adopted Service Vision, and
- Better understand the feasibility of the 4-track segments for the High Growth Scenario.

This memo provides a summary of processes and findings of the 4-Track Analysis, including:

- The needs and constraints for the 4-track segments identified in the Business Plan for both the Adopted Service Vision and High Growth Scenario,
- The confirmed 4-track segments needed to enable the Adopted Service Vision,
- The findings of the 4-track segments for the High Growth Scenario, and
- Utilzing the Adopted Service Vision confirmed 4-track segments to guide grade separation projects.

2.1 LONG RANGE SERVICE VISION

The Long Range Service Vision directs Caltrain to plan for an expanded rail service that will address the local and regional mobility needs of the corridor while supporting local economic development activities. Caltrain adopted a Long Range Service Vision to:

- Realize specified service levels per the Adopted Service Vision within the Caltrain Business Plan, and
- Continue planning for a potential "higher" growth level of service (High Growth Scenario).

Delivery of these expanded services will occur through the development of infrastructure including a series of 4-track stations, and the completion of key regional and state partner projects, including grade separations along the corridor as well as safety upgrades to at-grade crossings.

2.2 CALTRAIN BUSINESS PLAN

The Caltrain Business Plan was a planning effort by Caltrain (between 2017 and 2020) that culminated in the adoption of the Long Range Service Vision: it is a foundational document that provides a service-

focused blueprint for how Caltrain can grow to meet the needs of customers and the larger public while integrating with the larger regional and state transit network.

The Caltrain Business Plan included a process to develop, select, and define key characteristics of the 2040 Service Vision for Caltrain. The plan developed illustrative service concepts for three growth scenarios: Baseline Growth, Moderate Growth, and High Growth. Each growth scenario represented a different level of service that Caltrain could provide in 2040 based on varying levels of supporting investment. The Caltrain Board of Directors selected the Moderate Growth Scenario as the service vision.

> The Service Vision is an illustrative plan which includes the style, stopping patterns, and frequencies of Caltrain service. The Service Vision is also a set of organizational directions and actions that Caltrain will advance in partnership with other agencies to realize the service levels specified in a coordinated and proactive manner.

The Caltrain Business Plan illustrated 4-track segments (inclusive of stations) to enable the Adopted Service Vision and High Growth Scenario. The Adopted Service Vision identified the following five locations to facilitate faster trains to overtake (i.e., pass) slower trains. To facilitate these overtakes, the following 4-track segments and stations were identified:

- Millbrae Station
- Hayward Park and Hillsdale Stations
- Redwood City Station
- Northern Santa Clara County (either Palo Alto, California Avenue, San Antonio or Mountain View Stations)
- Blossom Hill Station[2]

For the High Growth Scenario, the Caltrain Business Plan includes approximately 15 miles of 4-track segments to support higher levels of service along the corridor. The Caltrain Business Plan illustrated 4-track segments (inclusive of stations) between:

- South San Francisco to Millbrae Stations
- Hayward Park to Redwood City Stations
- Palo Alto to San Antonio Stations
- Blossom Hill Station[2]

Figure 2 and **Figure 3** show the illustrated 4-track segments between San Jose and San Francisco per Caltrain Business Plan for the Adopted Service Vision and High Growth Scenario.

[2] Blossom Hill Station is a 3-track segment per the Caltrain Business Plan

Figure 2: Illustrative Service Plan for Adopted Service Vision

Adopted Service Vision

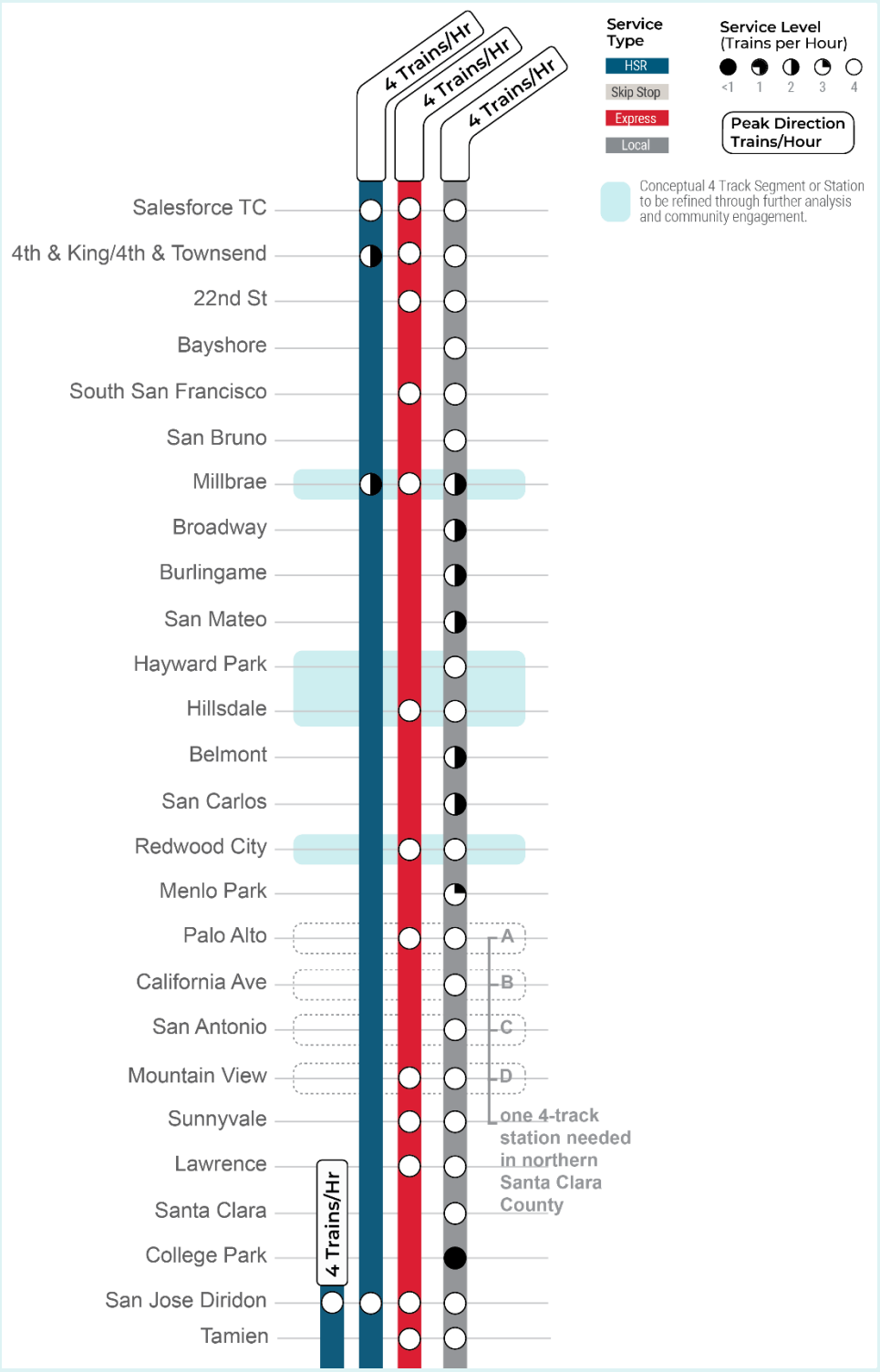
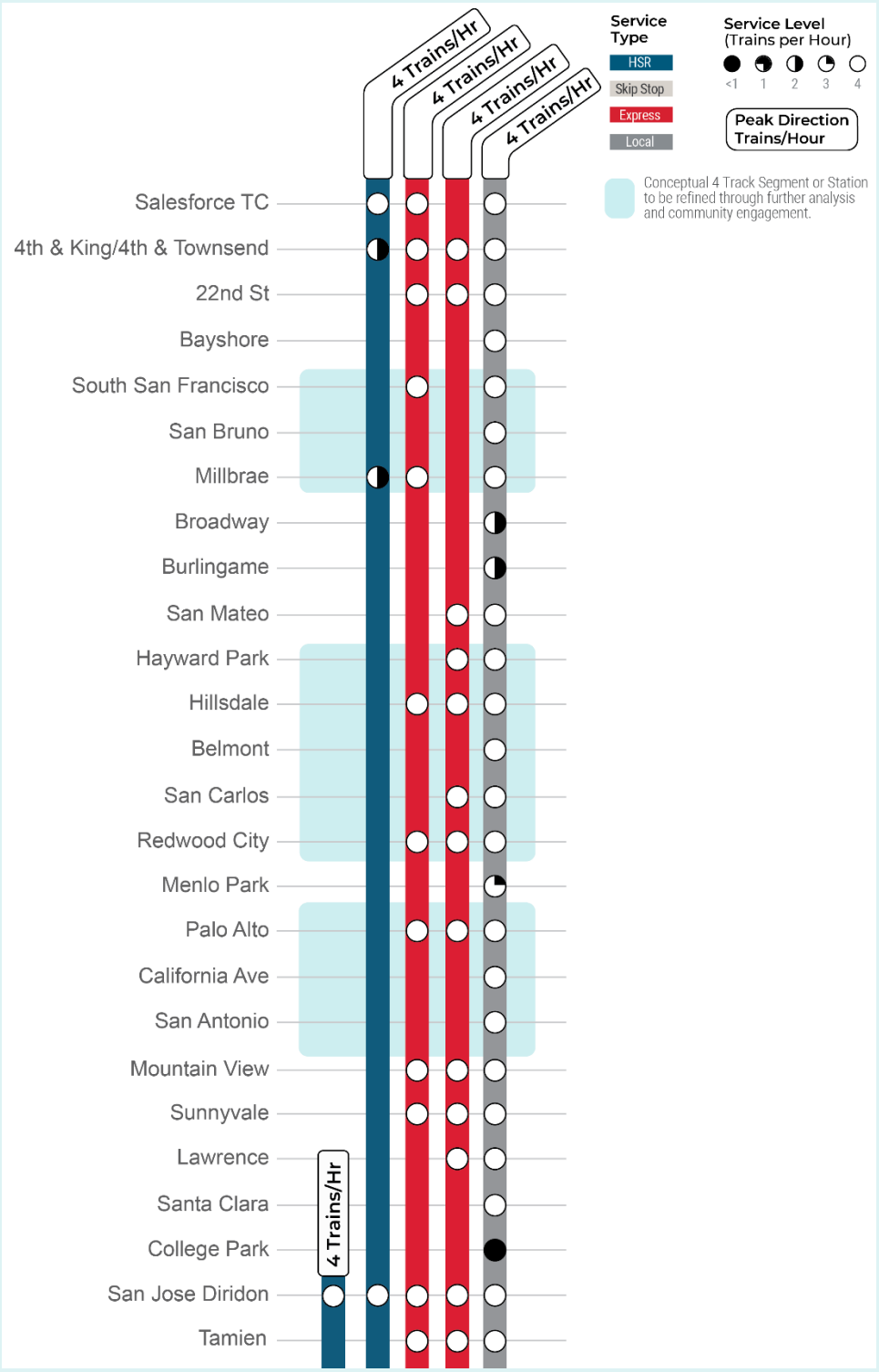


Figure 3: Illustrative Service Plan for High Growth Scenario

High Growth Scenario



3. 4-TRACK ANALYSIS PROCESS

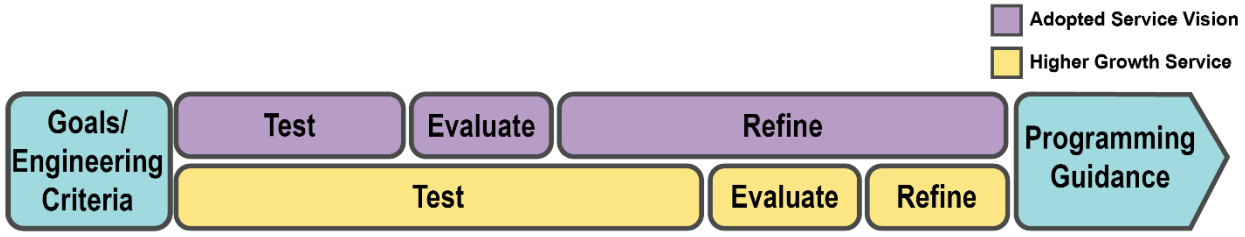
The 4-Track Analysis process consisted of:

1) Reviewing the CCS goals and Caltrain engineering criteria,
2) Testing, evaluating, and refining via operational analysis of service parameters and engineering analysis of the 4-track segments (as identified in the Caltrain Business Plan for the Adopted Service Vision and High Growth Scenario),
3) Developing an approach to utilize 4-track segments for the Adopted Service Vision to guide grade separation projects, and
4) Engaging partner agencies on the 4-Track Analysis.

The 4-Track Analysis evaluated requirements among service operations, engineering design parameters, and ROW availability to consider where the opportunity for future 4-track infrastructure must be preserved.

The 4-Track Analysis process, shown below in **Figure 4**, was implemented through a series of workshops with Caltrain staff and discussions with corridor stakeholders (1) to confirm the 4-track segments needed to enable the Adopted Service Vision and (2) to understand the constraints (i.e., physical requirements) for High Growth Scenario.

Figure 4: 4-Track Analysis Process



For confirming 4-track segments, the following aspects were considered.

- Which location and what length of 4-track segments are necessary to meet the service levels of the Adopted Service Vision?
- Is it possible to reduce the 4-track segment lengths and still support the service levels of the Adopted Service Plan?
- Can existing corridor crossings be avoided?
- Is it possible to accommodate 4-tracks within a specified segment based on the engineering criteria and the available Caltrain ROW?
- What existing and planned land uses (i.e., existing and future development) will be impacted by 4-track segments?

As part of the 4-Track Analysis, engagement with partner agencies was conducted to continue Caltrain's commitment to coordinated partnership across the corridor. The 4-Track Analysis held discussions on the

approach, parameters, and findings with partner agencies throughout the evaluation process to ensure partner agency challenges, ambitions, and needs were identified for consideration. The following stakeholders were engaged as part of the 4-Track Analysis.

- JPB Advocacy and Major Projects Committee (AMP) – JPB Subcommittee
- CHSRA
- City of Palo Alto
- City of Palo Alto Stakeholders
- City of Mountain View

Additional information on the partner agency engagement done throughout the 4-Track Analysis in **Attachment F**.

3.1 4-TRACK SEGMENTS NOT EVALUATED

Prior to the 4-Track Analysis, the 4-track segment identified at the Mountain View Station was removed from further consideration because it's located too far south to meet the needs of the Adopted Service Vision. In addition, the 4-Track Analysis did not define the limits and length for the 3-track segment at Blossom Hill for the Adopted Service Vision and High Growth Scenario.

Mountain View Segment

The Mountain View Transit Center was identified as a potential 4-track segment for the Adopted Service Vision. However, the 4-Track Analysis excluded this segment due to the ongoing Mountain View Transit Center Grade Separation project and additional considerations discussed below.

The Adopted Service Vision and High Growth Scenario are based on structured, repeating service patterns. These service patterns were designed to provide maximum opportunities for seamless, coordinated connections for various service types and with other transit services on the corridor. Through development of the Caltrain Business Plan and Service Vision, a guiding principle was to focus train "overtakes" (i.e., a train passing another train in the same direction) to consolidate the 4-track segments needed for both the Adopted Service Vision and High Growth Scenario.

For the Adopted Service Vision, the Mountain View Station is not preferable for a 4-track segment because it would not effectively support the service patterns and it's located too far south to meet the needs of the Adopted Service Vision. Adding 4-track capacity further north at either the Palo Alto, California Avenue, or San Antonio stations better supports the service patterns for both the Adopted Service Vision and High Growth Scenario.

Blossom Hill Segment

Blossom Hill was identified as a potential 3-track segment for the Adopted Service Vision. However, the analysis did not include this segment for the following reasons:

- The Blossom Hill 3-track segment is not for train overtakes—this expanded segment was identified to allow for train turnarounds from southbound to northbound (to serve two trains phpd),
- The location is in the Union Pacific Railroad (UPRR)-owned ROW, requiring UPRR approval of concepts and improvements, and
- The segment is anticipated to require electrification specific infrastructure improvements.

4. SERVICE ASSUMPTIONS

The 4-Track Analysis utilized the service scenarios from the Caltrain Business Plan that serve as the foundation for the Long Range Service Vision. This section describes the service plan for the Adopted Service Vision and High Growth Scenario. The service plans of each scenario determine the need for the 4-track infrastructure required for faster trains to overtake slower trains and facilitate expanded rail service in the corridor.

4.1 HIGH-SPEED RAIL SERVICE

For both service scenarios, four HSR trains phpd operate between San José and San Francisco, with two trains stopping at the Millbrae and 4th and Townsend Stations, and two trains operating non-stop from San Jose to Salesforce Transit Center. Both service plans operate on 15-minute intervals for HSR, with regularly spaced trains throughout the hour to avoid trains catching up to each other and bunching.

4.2 ADOPTED SERVICE VISION

The service concept for the Adopted Service Vision is characterized by two Caltrain services (Local and Regional Express), along with HSR, each operating at 15-minute headways (or four times per hour per direction) during the peak period. Under this service concept, Local and Regional Express trains each operate at 15-minute frequencies with timed cross-platform transfers at the Redwood City Station.

4.3 HIGH GROWTH SCENARIO

The High Growth Scenario expands the service offered in the Adopted Service Vision by adding four Regional Express trains phpd. In this service scenario, the Local and Express A trains operate at 15-minute frequencies with timed cross-platform transfers at the Redwood City Station. Express B trains operate every 15 minutes between the 4th and King and Tamien Stations. Additional 4-track infrastructure is needed to facilitate four local trains phpd serving nearly all stops while also providing passing tracks for faster rail service (i.e., Express and HSR services).

Table 2 shows a summary of the service plans identified in the Caltrain Business Plan for the Adopted Service Vision and High Growth Scenario.

Table 2: Service Plans identified in Caltrain Business Plan for Adopted Service Vision and High Growth Scenario

Service Plan Element	Adopted Service Vision	High Growth Scenario
Trains (phpd)	8 Caltrain + 4 HSR *Peak* 6 Caltrain + 3 HSR *Off-Peak*	12 Caltrain + 4 HSR *Peak* 6 Caltrain + 3 HSR *Off-Peak*
Passing Tracks	Millbrae Hayward Park-Hillsdale Redwood City One 4-track segment (inclusive of station) needed in northern Santa Clara County: • Palo Alto (Option A) • California Avenue (Option B) • San Antonio (Option C) • Mountain View (Option D) Blossom Hill	South San Francisco-Millbrae Hayward Park-Redwood City Northern Santa Clara County (Palo Alto Station to San Antonio Station) Blossom Hill

5. BASIS OF DESIGN FOR 4-TRACK ANALYSIS - SUMMARY AND APPLICATION

The 4-Track Analysis included a Basis of Design (BOD) to establish preferred and minimum parameters to conceptually layout 4-track sections within the Caltrain corridor (see **Attachment B**).

The design parameters were informed by applicable design criteria and standards from the following documents:

- Caltrain 2020 Design Criteria[3];
- Caltrain Design Criteria, Volume 2 (October 27, 2022 – 90% Submittal)
- Caltrain Standard Drawings (2020)
- UPRR Engineering Standards (2020)
- Metrolink Southern California Regional Rail Authority (SCRRA) Design Criteria Manual (2021)
- Metrolink SCRRA Engineering Standard Drawings (2021)
- CHSRA Technical Memorandums[4]

During the 4-Track Analysis, parameters such as platform configuration and length, and site-specific typical sections were developed to consider tradeoffs among operations, ROW, engineering criteria, and other factors. In developing the horizontal layouts, a maximum design speed of 110 miles per hour (mph)[5] was assumed "where practicable." Although curves were optimized for high speed, existing track alignment was maintained in areas where existing features or community resources were potentially impacted by higher speed track alignment.

Shown below are the two turnout transition scenarios that were developed and evaluated. The two concepts were evaluated for center station platforms:

- **Figure 5**: trains not stopping at the station access the outermost tracks by reducing speed (60 mph) along the diverging (righthand) side of the turnout; trains stopping at the station would utilize the through side of the turnout and proceed to the center platform.
- **Figure 6**: widens the spacing between the 2-track section and introduces a lefthand turnout at the transition to the 4-track segment. A train passing the station on the outermost tracks would maintain maximum allowable speed utilizing the through movement of the turnout. Trains stopping at the station would utilize the diverging (lefthand) side of the turnout (no faster than 60 mph) and proceed to the center platform.

[3] The 4-Track Analysis used the 2020 edition of the Caltrain Design Criteria. At the time of the analysis, the 2024 edition of the Caltrain Design Criteria and Standards were not finalized or published.
[4] Technical memorandums do not represent adopted design criteria or standards.
[5] At locations where a horizontal design layout could not achieve speed of 110 mph, the design maximized speed to the greatest extent possible without impacting existing features along or adjacent to the corridor that should be protected in place.

Figure 5: Center Platform Configuration – Righthand Turnout Layout

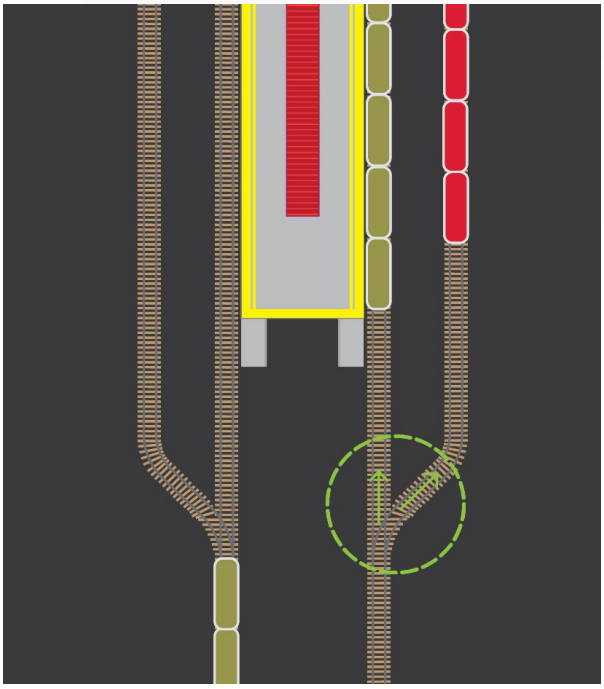
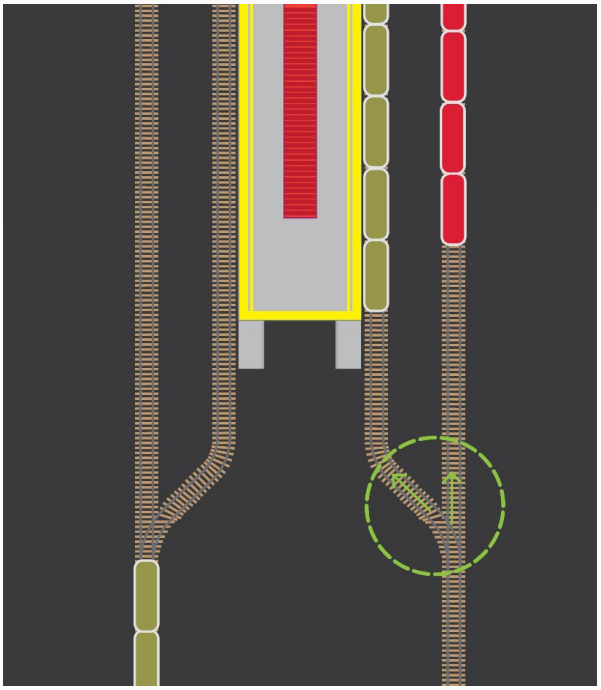


Figure 6: Center Platform Configuration – Lefthand Turnout Layout



Four-track segments for the Redwood City and Millbrae Stations are based on concepts developed as part of prior efforts by partner agencies:

- **Redwood City Station** - Redwood City Grade Separation Study completed October 2022, and
- **Millbrae Station** - CHSRA conceptual plans for Volume III, Book C of CHSRA Final EIR/EIS San Francisco to San Jose Project Section.

6. OPERATIONAL ANALYSIS

The purpose of the Operational Analysis was to confirm the beginning and end mileposts of the 4-track limits for the Adopted Service Vision, and facilitate faster train overtakes (i.e., passing) of slower trains for the future blended service plans.

Existing sections of the corridor that have 4-track (i.e., 2-mainline with 2-adjacent sidings) were included in the operational analysis to inform operations and maintenance. Two different types of overtakes (described below) were evaluated and utilized within these 4-track segments.

1) Dynamic (or Moving) Overtake: Both trains are traveling in the same direction on separate tracks. One train is running faster than the other allowing the faster train to pass the slower train.
2) Static Overtake: Both trains are traveling in the same direction on separate tracks. One train is stopped and held at a station until the train in motion has passed and adequate space has been achieved so the stopped train may depart the station.

A memo was developed to describe the approach and operating parameters for the Adopted Service Vision and High Growth Scenario (see **Attachment C**). The memo also details where each overtake occurs and train dwell time for overtakes. The Redwood City Station was identified as a key transfer point between Caltrain Express and Local trains for the service concepts.

Operating models and resulting stringline diagrams were developed to determine where overtakes would occur for the Adopted Service Vision and High Growth Scenario Plans. Additional analysis was needed to maintain a minimum separation of 2-minutes between trains traveling in the same direction and on the same track. Overtakes that require a 4-track segment are:

- Caltrain Express overtaking Caltrain Local (Dynamic and Static)
- Caltrain Express static overaking Caltrain Local after transfer between trains
- High Speed Rail overtaking Caltrain Local (Dynamic and Static)
- High Speed Rail overtaking Caltrain Express (Dynamic and Static)

Through the operational analysis, the ideal overtake location for northern Santa Clara County is as far north as feasible in the City Palo Alto—to provide service/schedule resiliency for higher speed trains. Based on the Caltrain ROW and surrounding community/infrastructure context, the California Avenue Station was identified as the most practicable 4-track segment for a static overtake.

7. CONFIRMED 4-TRACK SEGMENTS

The BOD and operational analysis informed the location and limits of 4-track infrastructure required to support the Adopted Service Vision and to plan for higher levels of service. This section summarizes the findings of the technical analysis and identifies the confirmed 4-track segments for Caltrain to support the expanded rail service identified for the Adopted Service Vision and High Growth Scenario.

7.1 ADOPTED SERVICE VISION REFINED 4-TRACK SEGMENTS

Through an iterative process of service operation analysis, testing of 4-track layouts based on engineering criteria, review of horizontal alignments, and workshops with Caltrain and CHSRA, the 4-Track Analysis refined the 4-track segments at Millbrae, Hayward-Hillsdale, Redwood City, and northern Santa Clara County with length and milepost limits. **Figure 7** and **Table 3** present a schematic, length and milepost limits for the Adopted Service Vision refined 4-track segments.

Figure 7: Adopted Service Vision 4-Track Segments

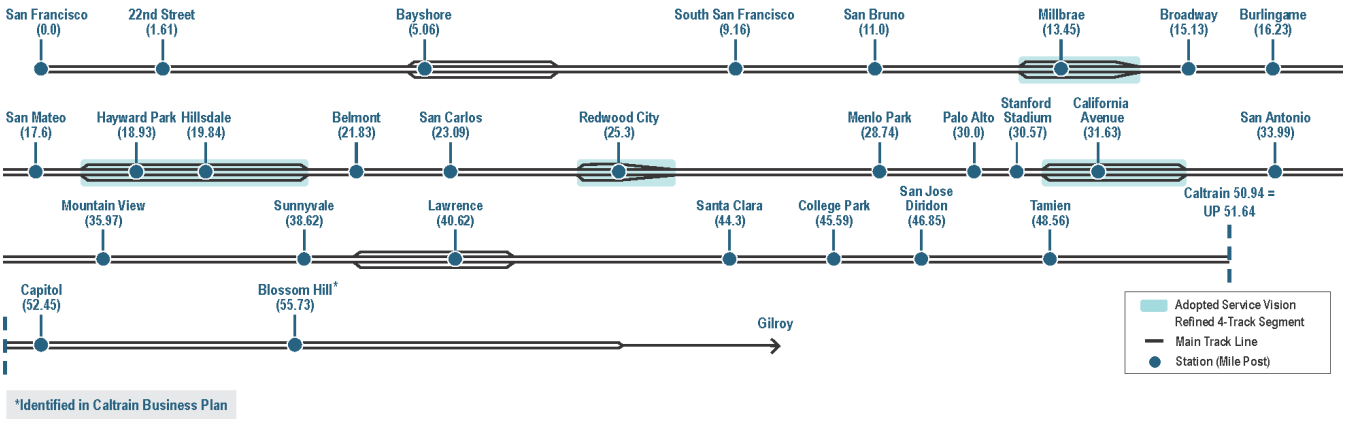


Table 3: Adopted Service Vision 4-Track Segment Length and Mileposts

Segment(1)	Length(2) (miles)	North Milepost	South Milepost
Millbrae	1.6	12.9	14.5
Hayward Park-Hillsdale	3	18.2	21.2
Redwood City(3)	1.3	24.75	26.05
California Avenue	1.9	30.9	32.85

Notes: (1) Segment inclusive of station. (2) Length includes transition from 2-track to 4-track. (3) Per Redwood City Grade Separation Study project summary report. Not further evaluated as a part of the CCS 4-Track Analysis.

Flexibility in service operations, impacts to existing community assets and infrastructure, available ROW, and engineering criteria were reviewed to evaluate each option in northern Santa Clara County. As a result of the analysis, California Avenue is the optimal northern Santa Clara County 4-track segment to support the Adopted Service Vision.

The technical analyses validated and confirmed the passing track locations and lengths to enable the future blended service pattern for both Caltrain and CHSRA. The refined 4-track segments are located at stations to allow for passing trains and increased operational flexibility.

7.2 HIGH GROWTH SCENARIO 4-TRACK SEGMENTS

Based on the engineering criteria outlined in the BOD and developed to fully support the service plan for the High Growth Scenario, 4-track segments totaling approximately 18.6 miles are required at the locations presented in **Table 4** below. Note, the Hayward Park-Hillsdale and Redwood City segments merge into one longer consolidated 4-track segment.

Table 4: High Growth Scenario 4-Track Segments Length and Mileposts

Segment(1)	Length(2) (miles)	North Milepost	South Milepost
South San Francisco to Millbrae	5.8	8.4	14.2
Hayward Park to Redwood City	7.9	18.2	26.1
Palo Alto to San Antonio	4.9	29.7	34.6

Notes: (1) Segment inclusive of stations. (2) Length Includes transition from 2-track to 4-track.

The High Growth Scenario 4-track segments from South San Francisco to Millbrae, Hayward Park to Redwood City, and Palo Alto to San Antonio are considered infeasible and financially impracticable due to multiple constraints related to costs, impacts to existing and planned infrastructure, lack of available ROW, and community impacts. Within the limits of these High Growth Scenario 4-track segments, there are rail corridor crossings with nine overpasses and 26 underpasses which will need to be modified to accommodate 4-tracks sections. Approximately, 15 local roads (adjacent to or crossing Caltrain ROW) and three interchanges would be substantively impacted or need to be relocated/reconstructed. Approximately, 155 acres of ROW acquisition would be required, affecting about 420 parcels along the segments.

8. SUMMARY OF ACTIVE PROJECTS

Active grade separation projects along the corridor were identified and overlaid upon the Adopted Service Vision refined 4-track segments. Overlapping grade separation projects that have already initiated the final design phase will not need to accommodate the 4-track infrastructure. This decision was made to not delay active grade separation projects that have been environmentally cleared as of May 2024. Specifically, it was determined that 4-track segments were not needed on the corridor at or near Broadway and Castro Street as these are locations with active grade separation projects in final design. Current planning and future design projects within or adjacent to the segments for the Adopted Service Vision will likely need to accommodate and design for 4-track infrastructure as long as the projects are consistent with RCUP — additional information regarding guidance is in a subsequent section.

8.1 ACTIVE PROJECTS IN ADOPTED SERVICE VISION REFINED 4-TRACK SEGMENTS

Table 5 shows the active projects located in or adjacent to the Adopted Service Vision refined 4-track segments. Future crossing projects located within the Adopted Service Vision's 4-track limits must be designed to accommodate four tracks and/or the transition from 2-track to 4-tracks, although only two tracks may need to be constructed in the interim.

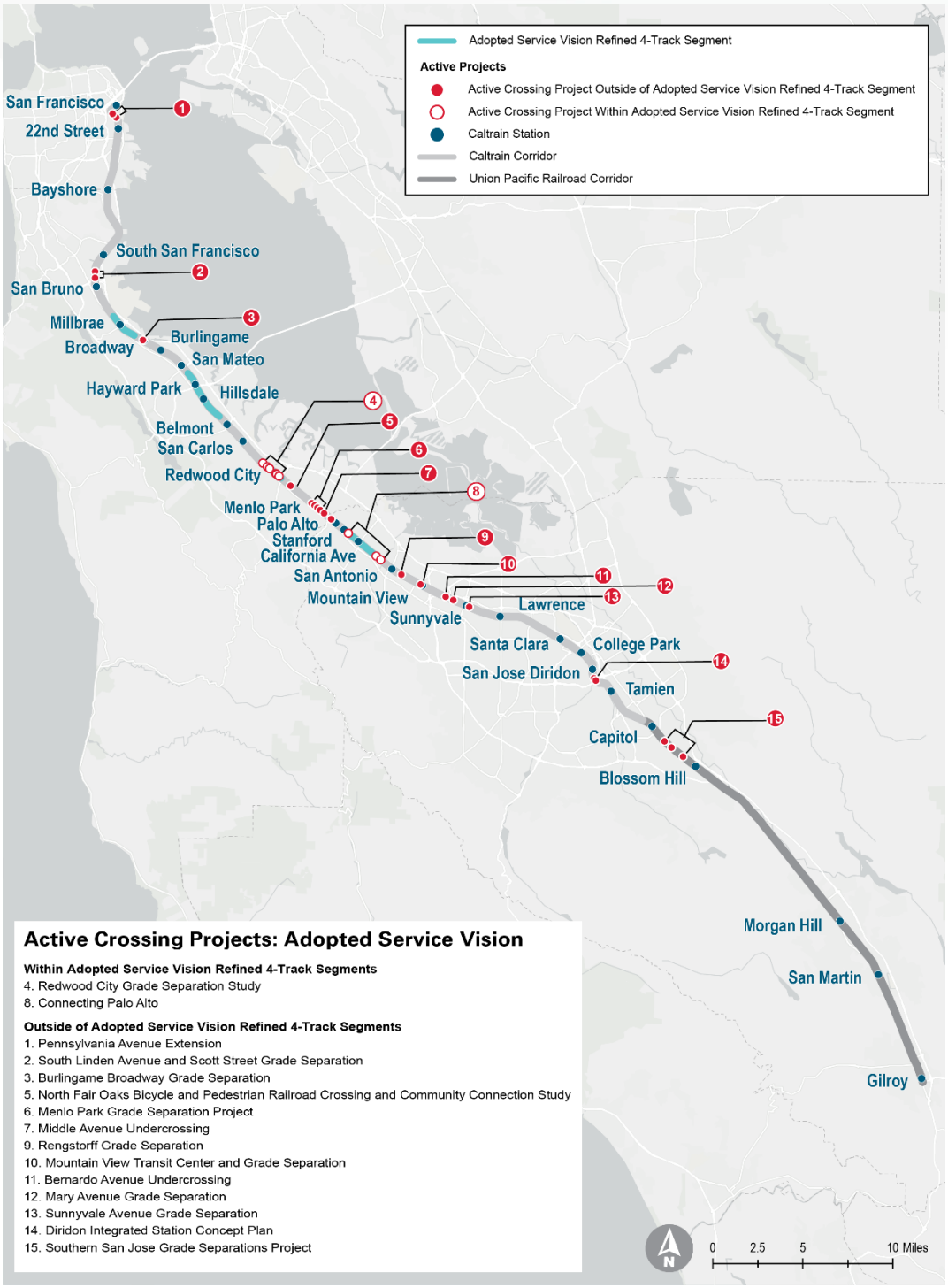
Table 5: Active Crossing Projects Located In or Adjacent to Adopted Service Vision Refined 4-Track Segments

Adopted Service Vision Refined 4-Track Segment	Project Name	Crossing Street
Redwood City	Redwood City Grade Separation Study	Whipple Avenue(1) Brewster Avenue Broadway Maple Street Main Street Chestnut Street
California Avenue	Connecting Palo Alto	Churchill Avenue East Meadow Drive Charleston Road

Notes: (1) Immediately adjacent to Adopted Service Vision refined 4-track segment.

Overlap of 4-track segments with active projects are shown in **Figure 8**. Details about the crossings in the active grade separation projects can be found in **Attachment D**.

Figure 8: Map of Active Crossing Projects Located In or Adjacent to Adopted Service Vision 4-Track Segments



8.1.1 REDWOOD CITY GRADE SEPARATION STUDY

Redwood City is advancing a grade separation study which encompasses six at-grade Caltrain corridor crossings with Whipple Avenue, Brewster Avenue, Broadway, Maple Street, Main Street, and Chestnut Street. The Redwood City study evaluated the opportunity to grade separate these crossings as part of a single project which elevates the Caltrain corridor. The Redwood City study considered the requirement to accommodate 4-tracks at the Redwood City Caltrain Station.

The 4-Track Analysis applied the alternatives developed by Redwood City rather than developing a new concept for this 4-track segment. The Redwood City grade separation project is still in early phases and a locally preferred alternative has not been selected. Caltrain is coordinating with Redwood City to confirm the grade separations in this segment can support the future 4-track infrastructure.

8.1.2 CONNECTING PALO ALTO

The California Avenue 4-track segment overlaps with the City of Palo Alto's "Connecting Palo Alto" project. The Connecting Palo Alto project is considering grade separating the Caltrain corridor crossings with Churchill Avenue, East Meadow Drive, and Charleston Road. The Connecting Palo Alto project is in the planning phase as of June 2024, and there is not a locally preferred alternative selected.

The City of Palo Alto recently received funding for these three crossings through the Federal Railroad Administration's (FRA's) Rail Crossing Elimination (RCE) Program and for Churchill Avenue through California State Transportation Agency's (CalSTA's) Transit and Intercity Rail Capital Program (TIRCP). This funding will facilitate advancing the "Connecting Palo Alto" project. The crossings at Churchill Avenue and East Meadow Drive are adjacent to the California Avenue 4-track segment and will likely require minor modifications to planning concepts to accommodate transitions between 2-tracks and 4-tracks. Caltrain is actively coordinating this effort.

8.2 ACTIVE PROJECTS IN HIGH GROWTH SCENARIO REFINED 4-TRACK SEGMENTS

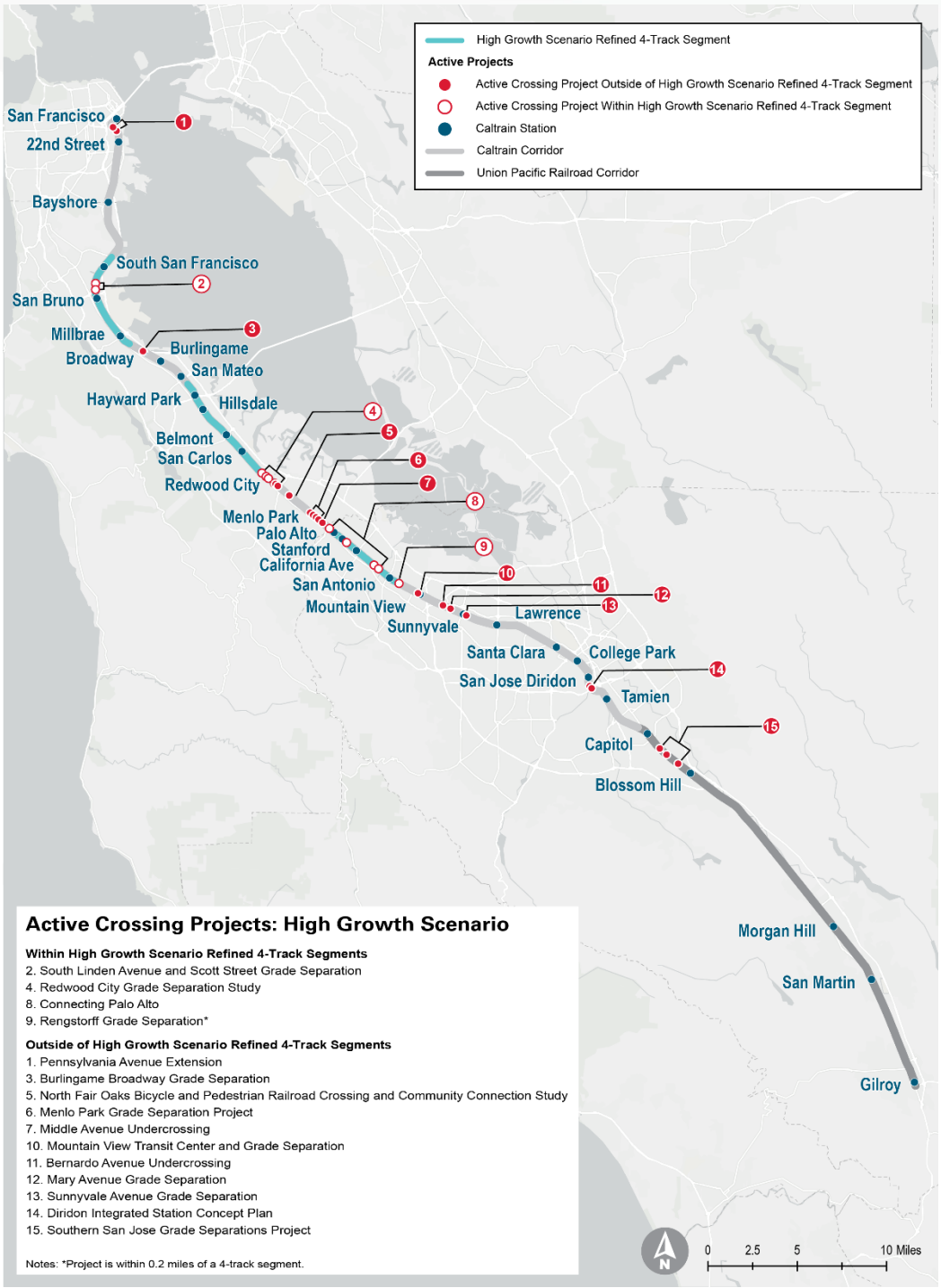
The evaluation of 4-track segments anticipated to support the High Growth Scenario expands the limits of 4-track segments defined to support the Adopted Service Vision. Accordingly, the potential 4-track segments required for the High Growth Scenario encompass additional active grade separation projects beyond those identified within the Adopted Service Vision's 4-track segment limits. Active grade separation projects within the boundaries of potential 4-track segments for the High Growth Scenario are presented in **Table 6** and **Figure 9**. Details about the crossings in the active grade separation projects can be found in **Attachment D**.

Table 6: Active Crossing Projects Located In or Adjacent to High Growth Scenario 4-Track Segments

Adopted Service Vision Refined 4-Track Segment	Project Name	Crossing Street
South San Francisco to Millbrae	South Linden Avenue and Scott Street Grade Separations	S Linden Avenue Scott Street
Hayward Park to Redwood City	Redwood City Grade Separation Study	Whipple Avenue Brewster Avenue Broadway Maple Street Main Street Chestnut Street
Palo Alto to San Antonio	Connecting Palo Alto	Palo Alto Avenue Churchill Avenue East Meadow Drive Charleston Road
	Rengstorff Grade Separation	Rengstorff Avenue(1)

Notes: (1) Immediately adjacent to High Growth Scenario 4-track segment.

Figure 9: Map of Active Crossing Projects In or Adjacent to High Growth Scenario 4-Track Segments



Active Crossing Projects: High Growth Scenario

Within High Growth Scenario Refined 4-Track Segments
2. South Linden Avenue and Scott Street Grade Separation
4. Redwood City Grade Separation Study
8. Connecting Palo Alto
9. Rengstorff Grade Separation*

Outside of High Growth Scenario Refined 4-Track Segments
1. Pennsylvania Avenue Extension
3. Burlingame Broadway Grade Separation
5. North Fair Oaks Bicycle and Pedestrian Railroad Crossing and Community Connection Study
6. Menlo Park Grade Separation Project
7. Middle Avenue Undercrossing
10. Mountain View Transit Center and Grade Separation
11. Bernardo Avenue Undercrossing
12. Mary Avenue Grade Separation
13. Sunnyvale Avenue Grade Separation
14. Diridon Integrated Station Concept Plan
15. Southern San Jose Grade Separations Project

Notes: *Project is within 0.2 miles of a 4-track segment.

8.2.1 SOUTH LINDEN AVENUE AND SCOTT STREET GRADE SEPARATION

The 4-track segment for the High Growth Scenario spanning the Millbrae Station at the northern end of the corridor overlaps with the Linden Avenue and Scott Street grade separation project—which is being advanced jointly by the Cities of South San Francisco and San Bruno. This grade separation project has a locally preferred alternative that elevates the Caltrain corridor above Linden Avenue and Scott Street The crossing at Scott Street will no longer accommodate vehicles but will be open for cyclists and pedestrians. This project is in preliminary design and final design is anticipated to begin in 2024. The opportunity to support expansion of the Caltrain corridor to 4-tracks may be challenging, since this grade separation's locally preferred alternative did not anticipate accommodating 4-tracks.

8.2.2 REDWOOD CITY GRADE SEPARATION STUDY

The Hayward Park/Hillsdale and Redwood City 4-track segments from the Adopted Service Vision are extended and combined into an approximately 7.9 mile 4-track segment. The six at-grade crossings in Redwood City (Whipple Avenue, Brewster Avenue, Broadway, Maple Street, Main Street, and Chestnut Street) identified as overlapping with the Adopted Service Vision's 4-track segment also overlap with the High Growth Scenario 4-track segment.

8.2.3 CONNECTING PALO ALTO

The High Growth Scenario includes a 4-track segment in northern Santa Clara County from north of the Palo Alto Station to south of the San Antonio station. The City of Palo Alto's "Connecting Palo Alto" grade separation project overlaps with this segment. Connecting Palo Alto includes the Churchill Avenue., East Meadow Drive, and Charleston Road crossings that were identified as overlapping with the Adopted Service Vision's 4-track segment. Although not part of the "Connecting Palo Alto" project, the City of Palo Alto is also evaluating a grade separation at Palo Alto Avenue within the limits of the High Growth Scenario 4-track limits.

8.2.4 RENGSTORFF GRADE SEPARATION

In the City of Mountain View in northern Santa Clara County, there is an active grade separation project at Rengstorff Avenue that is adjacent to the northern Santa Clara County 4-track segment required for the High Growth Scenario. Final design for the Rengstorff Avenue project began in late 2022 and is projected to finish construction in 2028. According to City of Mountain View staff, the grade separation is being designed for 2-tracks, but in a manner not to preclude the future expansion to 4-tracks.

9. PROGRAMMING 4-TRACK SEGMENTS AND FINDINGS

This section:

- Describes an approach to program the 4-Track Analysis findings; specifically, the refined Adopted Service Vision 4-track segments at the Millbrae, Hayward Park-Hillsdale, Redwood City, and California Avenue Stations,
- Summarizes the preliminary findings of the service operations and engineering analysis performed for the High Growth Scenario 4-track segments, as identified in the Caltrain Business Plan, and
- Provides a preliminary approach for providing guidance regarding implementing the 4-track segments and grade separation projects in the corridor.

9.1 PROGRAMMING ADOPTED SERVICE VISION REFINED 4-TRACK SEGMENTS

The opportunity to implement the refined 4-track segments for the Adopted Service Vision can be monitored in the RCUP. The RCUP provides a process to review and approve proposed uses of Caltrain property (see **Attachment E**). One of the first steps in the RCUP review process is for Caltrain staff to determine if the proposed use is compatible with Caltrain's current and future needs. The RCUP maps will be updated to include an overlay of the 4-track segments for the Adopted Service Vision and the following guidance regarding grade separations and 4-track segments for the Adopted Service Vision:

- If a project is located within the Adopted Service Vision's 4-track limits, the project must be designed to accommodate four tracks and/or the transition from 2-tracks to 4-tracks, although only two tracks may need to be constructed in the interim.
- If the project is not within the Adopted Service Vision's 4-track limits, the project does not need to accommodate for expansion or transition to four tracks.

9.2 FINDINGS FOR HIGH GROWTH SCENARIO 4-TRACK SEGMENTS

Based on the technical analysis of service operations, engineering criteria, and corridor constraints, the High Growth Scenario 4-track segments identified in the Caltrain Business Plan may be infeasible and financially impracticable.

For this evaluation, *feasibility* is defined as the possibility that a 4-track segment can be accommodated on the corridor given the engineering criteria, width of Caltrain ROW, adjacent land use type and intensity of activity, location and age of existing structures, and proposed infrastructure projects of corridor cities. Financial practicability is defined as the capability of the corridor to fund the implementation of future 4-track segments by considering the number of parcels that would be impacted and the number and type of infrastructure that would need to be reconstructed.

The 4-track segments required for High Growth Scenario would impact private property, community resources, and existing infrastructure. Specifically, the 4-track segments for the High Growth Scenario would affect:

- More than 150 acres of land needed beyond Caltrain's existing ROW
- More than 400 parcels adjacent to the Caltrain ROW
- 35 overpasses and underpasses along the Caltrain corridor
- 15 local roads and three interchanges in proximity to the Caltrain corridor

9.3 ADDITIONAL CONSIDERATION

Policy language from the Long Range Service Vision directs: Caltrain "to periodically reaffirm the Vision to ensure that it continues to provide relevant and useful guidance to the railroad at regular intervals of no less than 5 years and in response to significant changes to JPB or partner projects that materially influence the substance of the Long Range Service Vision."

The findings of the 4-Track Analysis can inform future re-evaluation of Caltrain's Long Range Service Visions—specifically additional corridor-wide analysis to identify new 4-track segments outside of the High Growth Scenario 4-track segments.

ATTACHMENT A: CALTRAIN 2040 LONG RANGE SERVICE VISION

The Caltrain 2040 Long Range Service vision can be accessed on Caltrain's website using the following link: https://www.caltrain.com/projects/business-plan/caltrain-2040/long-range-service-vision

Corridor Crossings
STRATEGY

ATTACHMENT B: BASIS OF DESIGN MEMO

Corridor Crossings
STRATEGY

ATTACHMENT C: OPERATIONS ANALYSIS MEMO

Corridor Crossings
STRATEGY

ATTACHMENT D: LIST OF ACTIVE CROSSING PROJECTS IN THE REFINED 4-TRACK SEGMENTS

ATTACHMENT E: RAIL CORRIDOR USE POLICY

The Rail Corridor Use Policy can be accessed on Caltrain's website using the following link:
https://www.caltrain.com/projects/rail-corridor-use-policy-rcup

Corridor Crossings
STRATEGY

ATTACHMENT F: PARTNER AGENCY ENGAGEMENT