



City of Palo Alto

City Council Staff Report

(ID # 12185)

Report Type: Action Items

Meeting Date: 4/26/2021

Council Priority: Grade Separations

Summary Title: XCAP Final Report and Recommendations

Title: Connecting Palo Alto Rail Grade Separation: Discuss Final Report and Recommendations From the Expanded Community Advisory Panel (XCAP), Removal of two Rail Grade Separation Alternatives From Further Consideration, and Review of the Draft Work Plan (Continued From March 23, 2021)

From: City Manager

Lead Department: Transportation Department

Recommended Motion

Staff recommends that the City Council:

1. Discuss the final report prepared by the Expanded Community Advisory Panel (XCAP) (Attachment A) including their findings and recommendations on the Connecting Palo Alto rail grade crossings at Churchill Avenue, Meadow Drive, and Charleston Road along the Caltrain corridor;
2. Based on the XCAP recommendations, consider eliminating the following options from further consideration:
 - a. South Palo Alto Tunnel (Passenger and Freight)
 - b. South Palo Alto Tunnel (With At-Grade Freight)
3. Review and discuss the Grade Separation Work Plan on Remaining Alternatives (as provided in the Final Report) under Council consideration for decision-making and additional direction to staff.

Background

On April 22, 2019, City Council approved the structure and membership of an Expanded Community Working Group for the evaluation of the Connecting Palo Alto railroad grade separation at crossings along the Caltrain corridor. Thus, the Expanded Community Advisory Panel (XCAP) was formed in June 2019. Later in September 2019, City Council provided additional direction and changed the responsibilities of the XCAP, including adding additional responsibilities, expectations, and members. The City Council set a deadline of April 30, 2020 for the XCAP to evaluate the seven alternatives under consideration for grade separation on three grade crossings; Churchill Avenue, Charleston Road, and Meadow Drive. At that time, the City had begun the next phase in the project's timeline: Community Conversations. This phase led to a series of community engagement opportunities ranging from in-person to online.

In an update to the City Council on January 21, 2020, the XCAP presented three (3) new community-driven ideas for consideration. These community-generated ideas were reviewed by the XCAP and volunteer retired civil engineers before coming to the City Council. The City Council directed staff to move forward with exploring two (2) of the three (3) new ideas presented by the XCAP. Staff and AECOM in coordination with XCAP Technical Working Subgroup refined these ideas and developed the conceptual plans at a similar level to the existing seven (7) alternatives.

The final nine (9) alternatives reviewed by XCAP at these grade crossings are as follows:

Churchill Avenue

- Churchill Avenue Closure with Mitigation - Option 1 & 2
- Churchill Avenue Viaduct
- Churchill Partial Underpass

Meadow Drive and Charleston Road

- Meadow Charleston Trench
- Meadow Charleston Viaduct
- Meadow Charleston Hybrid
- Meadow Charleston Underpass
- South Palo Alto Tunnel (Passenger & Freight)
- South Palo Alto Tunnel (With At-Grade Freight)

Since that time, the XCAP has completed its deliberations and prepared a final report providing their recommendations to the Council. (See links to the final report and its appendix at the end of this staff report.) This agenda item brings forward for City Council consideration, the current status of the Connecting Palo Alto railroad grade separation project and the final report and recommendations prepared by the XCAP for evaluation of grade separation alternatives.

Discussion

Since September 2019, the XCAP members met regularly to review the details and evaluate the rail grade separation alternatives at Churchill Avenue, Meadow Drive, and Charleston Road crossing. During the review process, the XCAP provided updates to the City Council on regular basis. Consultants and staff continued to support the XCAP and conducted studies, performed analysis, and provided additional technical information for the review of the alternatives.

Removal of Two Rail Grade Separation Alternatives

With the completion of the XCAP final report (links to the XCAP Final Report and Appendix provided at the end of the report) providing recommendations to the Council, the study session on March 23, 2021 was held. At this study session, Council received the final XCAP report, staff provided an overview of the alternatives in consideration and the XCAP discussed major recommendations and findings.

Considering the environmental challenges and the estimated costs for the South Palo Alto Tunnel Alternatives, the XCAP unanimously recommended to remove the tunnel alternatives from further consideration. Based on the unanimous decision of the XCAP, staff recommends that the City Council eliminate from further consideration both the South Palo Alto Tunnel Alternatives that is 1) With Passenger and Freight and 2) With Freight at Grade.

Additional details on these major recommendations and findings of the XCAP are as follows:

Churchill Avenue:

- Six of nine members voted to support the closure of Churchill Ave Crossing
 - In a follow-on motion by a vote of 7-0-2 additional mitigations and studies for the Churchill Closure alternative were recommended beyond what was proposed by the consultants.
 - In a second follow-on motion, the same seven supported Option 2 of the bike/pedestrian tunnel (tunnel in the middle of Churchill) for the Closure with Mitigations alternative with further study of improvements.

Charleston Road and Meadow Drive:

- XCAP unanimously removed from consideration the two short tunnel alternatives for South Palo Alto due to high cost and significant environmental concerns related to the potential water table and creek impacts.
- Of the remaining alternatives, XCAP unanimously voted they could not decide with the current information available.

For the South Palo Alto Tunnel alternatives, the railroad tracks are to be lowered in a trench south of Oregon Expressway to approximately Loma Verde Avenue. To provide for the tunnel, 34 feet twin-bore tunnel for South Palo Alto Tunnel (Passenger and Freight) alternative and 30 feet twin-bore tunnel for South Palo Alto Tunnel (With At-Grade Freight) alternative will be required. These tunnels begin near Loma Verde Avenue and extend to just south of Charleston

Road. The railroad tracks will then be raised from south of Charleston Road in trench to approximately Ferne Avenue. The new electrified southbound railroad tracks are proposed to be built at the same horizontal location as the existing railroad track. However, the northbound track will need to be moved to the east within the limits of the tunnel to accommodate the spacing required between the twin bores.

For South Palo Alto Tunnel (Passenger and Freight) Alternative, the railroad tracks will carry both passenger and freight trains as it does today. However, with the South Palo Alto Tunnel (With At-Grade Freight) Alternative, the tunnel will carry only passenger trains and the freight trains will remain at grade.

The estimated costs associated with these alternatives well exceed one billion dollars. Also, the lowering of the tracks will require the diversion of Adobe and Matadero creeks, resulting in the need for lift stations/siphons and numerous regulatory agencies' permits/approvals. Negotiations with the regulatory agencies will be lengthy and difficult since there are other "least impacting" alternatives that could be considered. In addition, pump stations will also be needed for dewatering since the tunnel will be below the groundwater level. The pump stations, lift stations, and/or siphons will have increased long-term ongoing maintenance costs and risk of flooding. These alternatives will also require major utility relocations to construct the lowered railroad.

Grade Separation Work Plan on Remaining Alternatives

Staff has developed the following draft work plan for an in-depth review of the remaining alternatives under consideration for further City Council action.

City Council Consideration in Summer:

- Charleston/Meadow detailed review of alternatives in consideration
- Charleston/Meadow direction on additional studies/next phase of the project

City Council Consideration in Fall:

- Churchill detailed review of alternatives in consideration
- Churchill direction on additional studies/next phase of the project

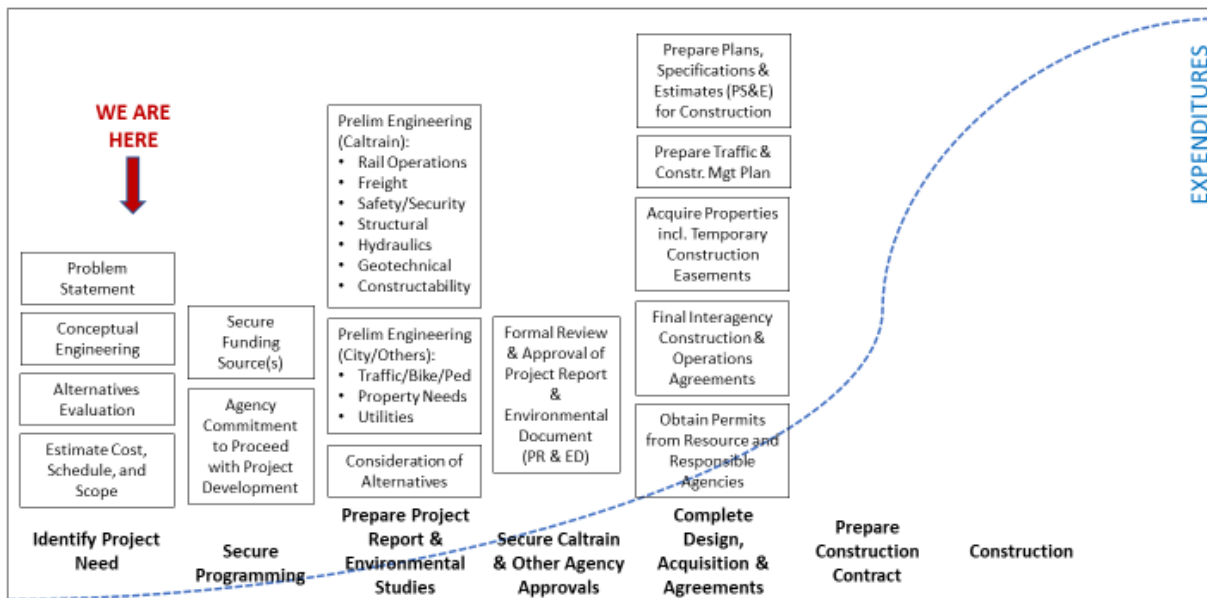
City Council Reconvene the Rail Committee in Fall/Winter:

- Discuss financial considerations

The following graphic illustrates where we are in the project development process, and some of the critical phases/steps remaining leading to actual construction. Key considerations as the City Council deliberates on the next steps are that: (a) the costs involved in further engineering analyses increase significantly going forward; (b) further studying multiple alternatives in greater detail will involve significantly greater expenses; and, (c) formal approval from responsible agencies (including Caltrain, VTA, and potentially Valley Water, the County of Santa

Clara, and others) will occur much later in the development process and after additional expense.

Rail Grade Separation Design and Approval Process



Upon the Council's review and direction at the subsequent discussions and action items through the work plan, staff will develop alternatives for further review and selection of preferred alternatives at each of the crossings and prepare the City's final project report. The development of alternatives, additional studies, and support during the work plan will require professional consultant support and therefore will require amendment(s) for the additional scope to perform this work. Based on direction from the City Council, staff will return for Council adoption of amendments to the existing consultant contracts and expanded scope of work needed to accomplish additional work. As noted in previous reports, the full funding for the entire project including design and construction is yet to be fully established.

Potential Next Steps

Following the City Council's review of alternatives and consideration of the XCAP recommendations and the final report, staff is seeking feedback on proposed next steps in moving the project forward, including the work plan noted above. While these are options for Council to consider, it is important to note that some of these next steps may have cost implications, either financially due to costs associated with additional studies or costs as a result of carrying forward multiple options before decision making.

Potential Options for further input could include:

- Review and select a final alternative at each of the crossing locations based on the significant work completed to date.

- Invite regional partners like Caltrain and Valley Transportation Agency (VTA) to discuss City Council's concerns and questions.
- Further narrow the number of alternatives under consideration and seek additional studies based on Council direction.
- Perform additional studies of selected alternatives as directed at each of the locations and bring back additional information for Council consideration.
- Direct staff to prepare the initial Project Study Report (PSR) that provides the summary of actions and demonstrates the purpose, need, and provides the scope of the project which is necessary to complete studies and the work needed for project approval and environmental design.

The selection of preferred alternatives will therefore lead to the development of preliminary engineering and preparation of environmental documents including associated Environmental Impact Report (EIR). The completion of Environmental documents will better position the City to seek grant funding from Federal and State programs for such projects. Depending upon the timing and funding availability, after the approval of EIR, the project will move towards completion of final design documents and then followed by construction of project improvements.

As demonstrated in the rail grade separation design and approval process figure above, the project is in the initial stages of defining project scope as we are working towards the selection of preferred alternatives at the subject crossings. Any additional studies that provide support to select the preferred alternative will help develop the draft PSR. The purpose of using the PSR document is to gain approval for the project studies to move into the Project Approval and Environmental Document (PA&ED) phase. The refined concept project plans through preliminary engineering are also developed concurrently. The development of concept plans, environmental documents, and draft PSR helps in developing project estimates, program the capital outlay support cost needed for various phases of the project, identify and secure funding needed for the project. These documents further assist in gaining approvals from various regulatory agencies and develop cooperative agreements for the final design including preparation of final Plans, Specifications and Cost Estimates (PS&E). With the approval of final PS&E, the project moves toward construction of improvements.

Resource Impact

The recommendations in this report to discuss the XCAP final report, eliminate South Palo Alto Tunnel options from consideration, and review and discuss the draft grade separation work plan do not result in direct resource impact. Funding for currently planned work on grade separation alternatives evaluation is programmed in the FY 2021 Adopted Capital Budget in project PL-17001, Railroad Grade Separation. Funding for future years is subject to City Council approval through the annual budget process. Direction from the City Council regarding further work on the grade separation projects may lead to future resource impacts. As City Council direction is provided, corresponding budget adjustments will be brought forward for approval

as appropriate. This project is historically funded by the General Capital Improvement Fund through funding sources such as SB1 and Measure B funding in certain instances when available, or through General Fund support.

Environmental Review

The proposed action is part of a planning study for a possible future action, which has not been approved, adopted, or funded and is therefore exempt from the California Environmental Quality Act (CEQA) in accordance with CEQA Guidelines Section 15262. The future decision to approve construction of any one of the identified potential alternatives would be subject to CEQA and require preparation of an environmental analysis. Environmental review and design for the grade separation project will be performed in the subsequent steps of the project development.

Documents

All of the XCAP Final Report documents are posted on the project webpage here:

<https://connectingpaloalto.com/presentations-and-reports/>.

Here are direct links furthered for Council consideration and public information as part of this staff report:

[XCAP Final Report](#)

XCAP Final Report Appendix - Appendix A contains Fact Sheets, Matrix, Renderings and Plans (created by AECOM). Appendix B contains general information. Appendix C contains XCAP materials. Due to file size limitations, the Appendix is broken into six parts:

Part 1: [Appendix A-1 thru A-2-1](#)

Part 2: [Appendix A-2-2 \(01-04\)](#)

Part 3: [Appendix A-2-2 \(05-08\)](#)

Part 4: [Appendix A-2-3 thru A-6](#)

Part 5: [Appendix B](#)

Part 6: [Appendix C](#)

Attachments:

- Attachment A: XCAP Final Report

Report of the Expanded Community Advisory Panel (XCAP) on Grade Separations for Palo Alto

Completed on

March 4, 2021

Presented at

Palo Alto City Council Meeting

March 23, 2021

By

Nadia Naik (Chair)

Larry Klein (Vice Chair)

Gregory Brail

Phil Burton

Tony Carrasco

Inyoung Cho

David Shen

Keith Reckdahl

Cari Templeton

Letter of Transmittal

Dear Mayor DuBois, Vice-Mayor Burt, and Members of the City Council:

We are pleased to present to you our report on potential grade separations for the train crossings at Churchill, Meadow, and Charleston. Our committee held 47 meetings from June 2019 through February 2021 for a total of approximately 1500 volunteer hours. In addition, we individually spent many hours outside the meetings on matters such as reviewing consultant reports, meeting with volunteer professional advisors, and preparing this report. We recognize that grade separations are a multi-year project and have prepared our report in a manner so that we hope it will be useful to you in 2021 and also for decision-makers many years in the future.

Sincerely,

Expanded Community Advisory Panel:

Nadia Naik, Chair
Larry Klein, Vice-Chair
Gregory Brail
Phil Burton
Tony Carrasco
Inyoung Cho
Keith Reckdahl
David Shen
Cari Templeton

Acknowledgments

The Expanded Community Advisory Panel (XCAP) wishes to thank and acknowledge the many people who have assisted us in our work.

A special thanks to the following members who departed before the report was completed, but whose support was greatly appreciated.

Adina Levin
Judy Kleinberg
Megan Kanne
Patricia Lau
Barbara Best
William (Billy) Riggs

City Staff:

XCAP work would have been impossible without the help of the Office of Transportation team that provided invaluable technical information and support. We'd like to give a special thanks to the Staff that provided critical support of our process:

Ed Shikada
Chantal Cotton-Gaines
Philip Kamhi
Sarah Wilson
Ripon Bhatia

Consultants:

XCAP would also like to thank the extensive team of consultants that provided critical technical information, plans, renderings, and overall patience and support.

Etty Mercurio, PE - Vice President / Senior Project Manager, AECOM
Millette Litzinger, PE - Associate Vice President /Senior Project Manager, AECOM
Peter DeStefano, PE - Project Manager, AECOM
Elliot Wong, Civil Engineer - Project Manager (Deputy) and ProjectWise Administrator, AECOM
Paul Burge, INCE Bd. Cert. - Principal Engineer, AECOM
John Maher, PE - Associate Vice President, AECOM
Gary Black, AICP - President, Hexagon Transportation Consultants
Eileen Goodwin - President, Apex Strategies

Volunteer Technical Advisory Group:

We were fortunate to have a group of resident civil engineering experts who volunteered their time to be part of our Volunteer Technical Advisory Group.

Ron Owes
Sreedhar Rao
Joe Terisi
Edgar Ugarte

Land Use Attorney:

XCAP would like to thank Norm Matteoni of Matteoni, O'Laughlin & Hechtman, for accepting our invitation and speaking to XCAP and the public about eminent domain.

Community Content Creators:

A special thanks to the following people for providing new concepts and alternatives and spent countless hours working to improve design alternatives:

Elizabeth Alexis
Michael Chacon
Roland LeBrun
Michael Price

Editor:

Thanks to our editor, who made sense of nine voices trying to explain technical concepts to fellow Palo Altans.

Suanne Starner

Finally, a heartfelt thank you to the members of the public who participated throughout this process, who sat through meetings (live and, eventually, virtually), waded through pages of technical reports, sent pages of emails, pictures, and articles, asked tough questions, navigated live and virtual Town Halls, provided ideas and feedback, and supported XCAP's attempts to tackle this difficult topic. Your participation produced better outcomes and promoted community cohesion by working together for a better Palo Alto. Thanks for doing your part and staying engaged - even in a pandemic.

XCAP Executive Summary

Background

The Need

Palo Alto at-grade crossings have become increasingly congested and dangerous and the planned increases in trains following completion of Caltrain's electrification project will make grade separations essential to prevent near-gridlock at those crossings and adjacent intersections. High-Speed Rail (HSR) continues to plan to eventually make it to the Peninsula as part of a "blended system" with Caltrain which would result in even more trains on the rail corridor, further exacerbating the need for separations.

Initial Steps

In 2017, the City of Palo Alto initiated a grade-separation planning process that was led by Staff and consultants, with public input coming through Community Meetings. In 2018, City Council concerns led the former City Manager to change consultants and create a Citizen Advisory Panel (CAP). The role of the CAP was limited to advising staff and consultants on improving community outreach and communications. It had no role in analyzing or advising grade separation alternatives.

XCAP

In order to have stronger stakeholder and community involvement, the City Council in June 2019, created the Expanded Community Advisory Panel (XCAP) and in October 2019, authorized XCAP to set its agendas, elect a Chair and Vice Chair and recommend grade separation design alternatives to the City Council. There were initially fourteen XCAP members: eight community representatives carried over from the CAP, along with six additional representatives. The six additional members included a former Mayor with experience in high-speed rail policy issues, the President of the Palo Alto Chamber of Commerce, a representative from Friends of Caltrain, an employee designated by Palo Alto Unified School District (PAUSD), a member of the Planning and Transportation Commission, and a resident from the Charleston/Meadows neighborhood. During the XCAP process PAUSD and the Chamber of Commerce decided that it was not appropriate to have their representatives participate. In addition, the Friends of Caltrain representative and two of the community members, for personal reasons, also resigned. This report reflects the recommendations of the nine remaining members.

XCAP proceeded rapidly to define its processes, identify and fill information gaps, invite proposals from the public, explore a broader set of alternatives, and narrow options. XCAP established a goal of making unanimous recommendations and required a two-thirds vote to make a recommendation to the City Council. The final recommendations in this report are not unanimous, but there is unanimity on the removal of some alternatives from further consideration and on further work that needs to be done.

Impacts of the COVID Emergency

The global pandemic has impacted the XCAP process. It caused a hiatus in meetings scheduled for March. Under the City's new Zoom protocols, however, XCAP has met nearly weekly since April 2020, to the conclusion of XCAP's work in January 2021.

Due to fully online meetings, XCAP members reported difficulty having important communication with neighborhood groups, residents, or even XCAP meeting attendees who, after a live XCAP meeting, would typically linger with XCAP members and Staff to better understand and discuss the issues. The crisis also made it difficult to get the community's attention on this important issue as people have been, understandably, focusing on health, safety and living through the pandemic restrictions. In addition, the sudden collapse of City revenue caused by the pandemic meant that any further contract amendments for the consultants or additional costs were unlikely, impacting XCAP's ability to do any further iterations on the newest, community generated concepts which some XCAP members thought desirable.

Engagement with key stakeholder groups has also suffered. The Palo Alto Unified School District had to focus on providing critical educational adjustments rather than on this and other non-emergency issues. Similarly, coordination with the bicycle community, the business community and other stakeholder groups suffered as a result of the pandemic.

The pandemic has also impacted the ability for the City to conduct traditional Town Hall meetings, although the staff and consultants were eventually able to move online to a Virtual Town Hall. It was held over the summer for four weeks (Aug 19 - Sept 14) and engaged a higher number of residents than is typical for an in-person Town Hall (over 1000 unique users), allowing a wider audience flexibility to review the materials and information at their convenience. However, it is difficult to determine whether this platform was an effective way to clearly communicate and have discourse about the trade-offs of the various alternatives.

The dramatic drop in ridership of public transit, the fiscal crisis across multiple transit and government agencies due to the pandemic and the unknowns resulting from the Presidential election and now the change in administrations has resulted in a high level of uncertainty, leading to further difficulty in making firm decisions. XCAP remains convinced that while the timeframe for the need for grade separations will likely be pushed out by a few years, the importance of these projects necessitates continuous work and focus so Palo Alto can be ready to complete these projects as funding becomes available.

Findings Overview

Constraints

XCAP was tasked with recommending grade separations for Churchill Avenue, Meadow Drive, and Charleston Road. The Council's decision to remove Palo Alto Avenue from XCAP's purview and instead include it as part of an eventual Downtown Coordinated Area Plan led to a disjointed analysis of North Palo Alto. With only seven places citywide for vehicles to cross the tracks (Palo Alto Avenue, University Avenue, Embarcadero Road, Churchill Avenue, Oregon Expressway/

Page Mill Road, Meadow Drive and Charleston Road), traffic analysis shows that modifications at one crossing will likely impact the other crossings.

In 2012, Caltrain and High-Speed Rail signed a Memorandum of Understanding (MOU) that indicated the need for two additional “passing” tracks somewhere within northern Santa Clara County so HSR trains can pass Caltrain trains. The need for passing tracks is currently in dispute between Caltrain and HSR and is being partially addressed through HSR’s Environmental Impact Report for San Francisco to San Jose. Additional technical studies between Caltrain and HSR are needed to determine the location of the passing tracks. Caltrain can operate at their maximum projected capacity under their most recent business plan without needing any additional tracks if HSR does not share the corridor. There is uncertainty if HSR will get to the Peninsula but passing tracks must be kept in mind.

Initially, Caltrain had indicated HSR passing tracks would likely be located somewhere between South Palo Alto (south of Oregon Expressway) and northern Mountain View. During the XCAP process, and in the absence of a resolution of this issue with HSR, the Caltrain Joint Powers Board adopted a very conservative Rail Corridor Use Policy essentially preserving the possibility of needing two additional tracks the entire length of the City of Palo Alto. Caltrain has indicated that if Palo Alto wants to move forward with designs prior to an HSR/Caltrain decision on the passing track location, the City will need to show that designs do not preclude the possibility of a future four track system.

Notably, all of the designs XCAP reviewed assume a two-track system and the impacts of a four-track system on designs were not addressed since Caltrain’s policy decision was not shared with XCAP until April 2020. **If four tracks are needed, a significant revised XCAP-type study would have to be undertaken.**

Decisions and Recommendations

Churchill Avenue

At Churchill Avenue, XCAP started with two alternatives: A **Viaduct** or a **Churchill closure with mitigations** suggested by the traffic consultants including two options for a bike/pedestrian tunnel at Churchill. A third, community generated alternative, known as the **Partial Underpass**, would depress Churchill on the west side of the tracks, allowing cars to turn north/south onto Alma but they could no longer cross Alma. From the east side of Alma, traffic traveling westbound towards Alma could only turn right to head north on Alma.

Ultimately, six of nine members voted to support the closure of Churchill. The remaining three said they could not support the recommendation without further study.

In a follow-on motion by a vote of 7-0-2 additional mitigations and studies for the Churchill Closure alternative were recommended beyond what was proposed by the consultants.

In a second follow-on motion, the same seven supported Option 2 of the bike/pedestrian tunnel (tunnel in the middle of Churchill) for the Closure with Mitigations alternative with further study of improvements, while the other two members abstained.

For both follow-on motions, one member abstaining did not support the Closure and therefore did not vote on the follow-on motions and the other abstaining member thought all bike designs needed to be re-conceptualized because both designs were unacceptable as they force bikes/pedestrians into tunnels.

Meadow Drive and Charleston Road

For Meadow Drive and Charleston Road, XCAP originally considered a **viaduct**, a **hybrid** (raised berm), a **trench**, a short **tunnel with freight** and a short **tunnel with freight at the surface**. In addition, an **underpass** alternative was developed by a community member and refined by the City's consultant which would leave the tracks at their current elevation and have bikes and pedestrians in dedicated tunnels that separate them from both the train and Alma.

XCAP unanimously removed from consideration the two short tunnel alternatives for South Palo Alto due to high cost and significant environmental concerns related to potential water table and creek impacts.

Of the remaining alternatives, XCAP unanimously voted they could not decide with the current information available. No alternative received the support of more than three members. The pros and cons of each alternative are described in the body of this report. However, several broad themes emerged in the deliberations:

1. Every alternative has negatives, there was no clear winner, and there was no enthusiasm for any particular one.
2. While neighborhood opposition to the above ground solutions --the hybrid and the viaduct-- was vociferous and near unanimous, there was also recognition that the trench, tunnel, and underpass have serious challenges.
3. Resolution of the four-track issue is essential.

The time delays occasioned by the pandemic may be fruitfully utilized by the City in further studies and the implementation of small projects such as bike/pedestrian crossings that would mitigate or even enhance whatever grade separation is ultimately chosen. The report has more detailed findings, suggested future areas of study and additional recommendations within the report and provides a summary with additional Lessons Learned in Chapter 7. Among the things the City needs to work on in the near term include:

1. Groundwater analysis and geotechnical studies.
2. Prioritize participation in the Caltrain Corridor-wide Grade Separation Study.
3. Development of a formal structure to work with PAUSD and Bicycle advocacy groups on soliciting detailed feedback.

4. Bike/Pedestrian-specific review of the impact of grade separations on bike/pedestrian circulation.
5. Study bike/pedestrian crossings at Seale/Alma and vicinity of Loma Verde/Alma/Matadero Creek.
6. Negotiate with Caltrain and High-Speed Rail regarding the possibility of passing tracks in Palo Alto and their implications on design, cost, and timeline.
7. Create a framework for soliciting feedback from key stakeholders post-pandemic including businesses and Stanford.

XCAP was asked not to focus on how to finance these projects and has not, but the panel did occasionally receive information of how projects have historically been funded and what new funding sources may emerge.

The completion of grade separations in Palo Alto is arguably the most expensive, complex, and important transportation infrastructure investment the City will make in the next half century. The work XCAP has completed to date has significantly improved the understanding of the City's needs. The City has been able to capitalize on new technology throughout this process to better understand the transportation network, the relationship of key roads in the network to the existing grade crossings and to each other. In addition, technology has helped improve outreach efforts and XCAP's deliberations have broadened the community's understanding of the need for grade separations and the challenges with the different alternatives. The ongoing flow of additional information will enable improved designs as the City moves to the next phase. And while the pandemic has pushed out the timeframe, the City can make productive use of the additional time by preparing for these transformative changes in the City.

Note for the Reader: Colloquially, Palo Altans refer to Caltrain as traveling North/South. Similarly, Alma Street is considered to run North/South where Old Palo Alto and Professorville are considered East of Alma and Palo Alto High School, Southgate and Evergreen Park are considered West of Alma. When looking at a map, however, Caltrain and Alma generally run from Northwest to Southeast. All references to North, South, East and West in this report refer to the colloquial direction, and all images created by the consultants have an arrow in the lower right corner showing true North.

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Glossary

At-grade Crossing (also known as Level Crossing) - is an intersection where a railway line crosses a road at the same level, as opposed to the railway line crossing over or under a road using an overpass or tunnel.

Berm - Like an embankment, it is a long artificial mound of earth and stone built to support a road or railway.

Blended System - Plan developed by Caltrain and California High-Speed Rail Authority to share the existing train tracks between San Francisco and San Jose to support operations of High-Speed Rail on existing Caltrain tracks, with some passing tracks where needed, to maintain operation of both services.

California High-Speed Rail (CAHSR or HSR) - a project to bring high speed train service from San Francisco to Los Angeles using the Caltrain corridor between San Jose and San Francisco.

California Public Utilities Committee (CPUC) - State agency that regulates passenger and freight rail operations in California. Also regulates electric, natural gas, telecommunications, water, rail transit, and passenger transportation companies.

Caltrain - Operating agency that provides train service along a 77-mile route to 32 stations between San Francisco and Gilroy.

Caltrain Business Plan (Long Range Service Vision) - A plan by Caltrain to define and assess its service vision after completion of the electrification of its line and how that service vision can be implemented and funded.

Catenary Wires - A system of overhead wires used to deliver electric power to electrified transit vehicles or locomotives (also known as Overhead Contact System (OCS)).

Crossover - Switches and track connections which allow trains to cross from one track to another or a level crossing between two rail lines without connections.

dBA - Refers to noise levels measured in decibels using an “A-weighted” sound level (expressed in units of dBA) The A-weighting network approximates the frequency response of the average young ear when listening to most ordinary sounds. For more information, see pg. 7 of Appendix B-4-1 Noise and Vibration Comparative Analysis Report.

Electric Multiple Unit (EMU) - self-propelled electric rail cars coupled together into one train and controlled by one engineer. EMUs do not require a locomotive.

Electrification - The installation of an overhead wire (catenary) system to enable trains to run on electric power. Caltrain is in the process of electrifying their right of way between San Francisco and San Jose, to allow retirement of their passenger diesel locomotives. Another form of electrification, not used by Caltrain, is third rail.

Embankment - An embankment (also known as a berm) is a long artificial mound of earth and stone, built to support a road or railway.

Federal Railroad Administration (FRA) - a division of the US Department of Transportation, it sets standards used by railroads operating in the United States.

Gate Downtime - the period of time that a crossing gate at a grade crossing is in the down position when it stops traffic to allow trains to cross a roadway or a pedestrian crossing.

Grade - refers to the rate of change in the rise or fall in elevation of a railroad track. A rise of one foot in elevation in 100 feet of track is a 1% ascending grade. Similarly, a decrease of one foot in elevation in 100 feet of track is a descending grade of 1%. Also see Vertical Curve.

Grade Crossing - see At-grade Crossing.

Grade Separation - The process of separating a rail line from a road, or another rail line, to eliminate delays or disruptions to the flow of traffic on both rail and road. Separation is achieved by building bridges over or tunnels under the crossing site and/or by raising or lowering the rail line tracks, allowing roads and or railways and canals to pass another without interrupting the flow of traffic.

Types of grade separation:

- *Viaducts* are elevated grade separations, where the train is completely elevated above the roadway on a long bridge or series of bridges, usually supported by a series of arches or on spans between tall towers.
- *Hybrids* are where the train is partially elevated on an earthen berm that forms a wall and the road is sunken down in a shallow trench.
- *Tunnels* are where the train is completely submerged underground and not visible.
- *Trenches* are where the train is in an open ditch while cars travel flat across the ditch, are below grade separations.

Hybrid - A type of grade separation where the train is partially elevated on an earthen berm that forms a wall and the road is sunken down in a shallow trench.

HSR (or CAHSR) – High-Speed Rail

Level of Service (LOS) - Level of Service (LOS) is a quantitative standard used to determine how well an intersection (signalized or unsignalized) or street segment (between signalized intersections) is operating from a traveler's perspective. Typically, six levels of service are defined,

and each is assigned a letter designation from A to F, with LOS A representing the best operating conditions, and LOS F the worst. LOS refers to the ratio of the volume of motor vehicle demand to the capacity of the motor vehicle system during a specific increment of time.

Locomotive - Diesel - A locomotive that is powered from an onboard diesel engine.

Locomotive - Electric-Powered - A locomotive having one or more electric motors that obtain power either from a third rail or from catenary wire suspended above the track (overhead contact system). Contact with the overhead wire is made by a pantograph mounted at the top of the locomotive. EMU cars also use a pantograph to make contact with an overhead power wire.

Means Restriction - Reducing a suicidal person's accessibility to mechanisms that cause injuries and fatalities, such as access to a train that is considered a lethal means for intentional harm.

Noise Parapet - A low protective wall, roughly six feet high, designed to redirect noise away from structures along the rail right of way.

Overhead Contact System (OCS) - A system of overhead wires used to deliver electric power to electrified transit vehicles or locomotives (also known as Catenary Wires).

Peak Period - The heaviest ridership periods which, for the Caltrain Corridor, is defined as 6-10 AM in the morning and 3-7 PM in the evening. It can also refer to the heaviest traffic period, as in the peak periods reported in the traffic study.

Peninsula Corridor Joint Power Board (PCJBP or JPB) - The government entity which manages the Caltrain commuter rail line. The PCJBB consists of three representatives from each of the three counties in which the Caltrain line provides service: San Francisco, San Mateo and Santa Clara.

Positive Train Control (PTC) - A form of collision avoidance that integrates command, control, communication, and information systems for controlling train movements with safety, security, precision, and efficiency.

Right-of-Way (ROW) - Any strip or area of land, including surface, overhead, or underground, granted by a deed or easement, for construction or maintenance according to designated use. Caltrain owns its own right-of-way from San Francisco to the Tamien Station in San Jose. A right-of-way can also be a roadway, public footpath, as well as electrical transmission lines and sewer lines.

Safe Routes to School (SRTS) - The Palo Alto Safe Routes to School program is a partnership between the City, the Palo Alto Unified School District, and the Parent Teacher Association (PTA) to reduce risk to students en route to and from school and to encourage more families to choose healthy, active, sustainable alternatives to driving solo.

Shoofly - A temporary track built to bypass an obstruction or construction site. Caltrain shoofly tracks will need to be electrified for Caltrain to maintain passenger train service during grade separation construction.

Sound Wall - A **noise barrier** (also called a **sound wall**, **noise wall**, **sound berm**, **sound barrier**, **noise parapet** or **acoustical barrier**) exterior structure designed to protect from noise pollution.

Superelevation - The banking of railroad track on curves which allows the forces produced by the weight of the train to counteract the outward forces of the speed of the train on the outside rail, thus allowing higher speeds with greater safety margins.

Trackage Rights Agreement (TRA) - an arrangement where the company that owns the line retains all rights but allows another company to operate over certain sections of its track. The agreement may specify whether the latter company can serve customers on the line. The JPB has a TRA with the Union Pacific railroad, which uses its right-of-way.

Train Preemption - (or signal preemption) Interruption of normal traffic flows on a road at a level grade crossing to give priority to the safe passage of a train.

Trench - A type of grade separation where the train is in a below ground open concrete box with a road above it remaining at its current level, crossing the trench on bridges.

Tunnel - A type of grade separation where the train is in an underground concrete tube deep enough to pass under traffic bearing roads.

Unclearable Queues – when cars back up at a traffic light due to multiple interruptions of the signal (usually from train preemption), leading to traffic. Also see Appendix A 4 Queue Lengths at Churchill 10-16-19.

Union Pacific Railroad (UP or UPRR) - an operating subsidiary of the Union Pacific Corporation. Under a trackage rights agreement with Caltrain, UP operates freight trains on the Caltrain corridor, serving ports and other industries along the Peninsula and in San Francisco.

Vertical Curve - Section of track that provides a smooth transition between different track grades to allow a train to negotiate the elevation rate change at a gradual rate rather than a sharp cut.

Viaduct - A type of grade separation where the train is completely elevated above a roadway on a long bridge or series of bridges, usually supported by a series of arches or on spans between tall towers.

Viewscape - A visual connection that occurs between a person and the spatial arrangement of urban and landscape features.

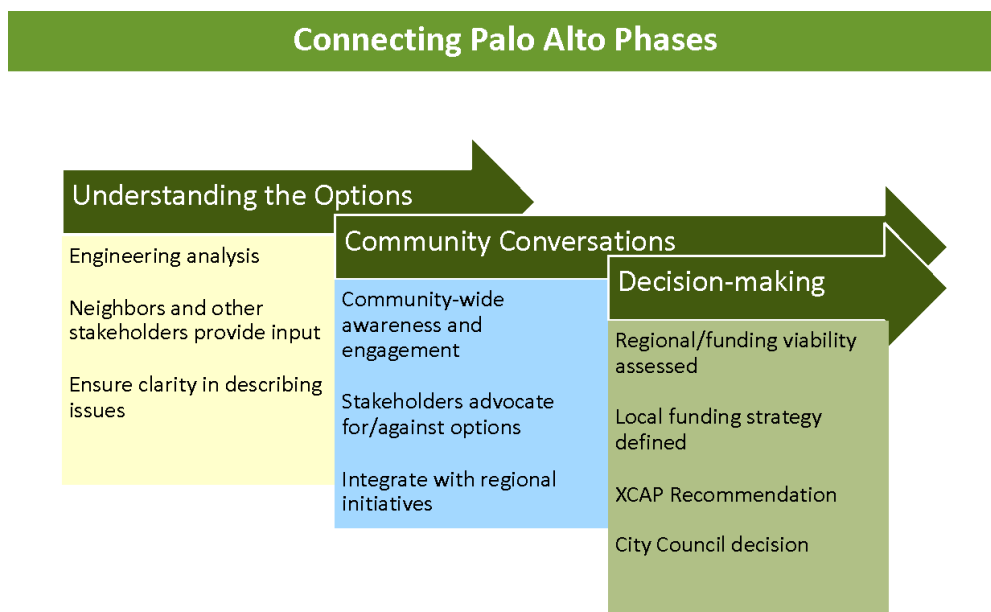
XCAP - Expanded Community Advisory Panel created June 2019 by the City of Palo Alto to study and make recommendations to the City Council regarding grade separations along the Caltrain corridor in Palo Alto.

1. Introduction

1.1. Connecting Palo Alto

Connecting Palo Alto (formerly the Palo Alto Rail Program) is a community-based process to address the increased traffic congestion expected when Caltrain completes the electrification of its tracks and runs more trains through the corridor. The increased train traffic will lead to congestion at intersections where cars wait for trains to pass. If High-Speed Rail comes to the corridor, the increased traffic issues will be further compounded by even more trains. Community feedback and collaboration are a vital part of this decision-making process that will affect future generations to come. The work presented in this report is part of the Connecting Palo Alto process.

In addition, the City has maintained a lengthy public community engagement process for this project and has made a concerted effort to engage community members from the start. The City has held numerous workshops, roundtables, community meetings, a Community Advisory Panel (CAP) which evolved into the Expanded Community Advisory Panel (XCAP), and City Council Rail Committee meetings; built a database of interested stakeholders; sent out a questionnaire that received 800 responses; produced a Connecting Palo Alto e-newsletter; posted extensively on social media; and contacted local media about workshops, roundtables and the XCAP's process. And, during the pandemic, a Virtual Town Hall was created to try to get the word out.



More information about Connecting Palo Alto can be found on the Connecting Palo Alto website at <http://www.cityofpaloalto.org/connectingpaloalto>.

More information about the Virtual Town Hall is available in Appendix A-4-7 Draft Virtual Town Hall Information 10-7-20.

1.2. What is XCAP?

The City of Palo Alto has been working on separating cars, bikes and pedestrians from trains at Caltrain crossings for the last several years. In June 2018, the Palo Alto Council approved a Community Outreach Plan¹ developed by AECOM and Apex Strategies that included plans for a Community Advisory Panel known as CAP. The CAP was made up of 12 community members who were chosen to ideally represent a diversity of thought and neighborhood/geographic representation. The CAP's responsibility was to connect with other community members/neighbors to help inform the process. It had no authority to advise on what grade separation alternatives are best for Palo Alto. The CAP participated in many meetings, but they were unable to create their own agendas and were ultimately only able to respond to what was given to them by Staff and the Consultants and communicate that information to their networks.

In April 2019, the City Council voted² to create the Expanded Community Advisory Panel (XCAP) which included eight original members from the CAP, and six new appointees. The transition from CAP to XCAP initially had similar function, where the group was listening to presentations by the consultants and Staff but were not able to set their own agendas. On September 9, 2020, the Expanded Community Advisory Panel was formalized³ as a body subject to the Brown Act that can vote and make recommendations directly to the City Council with the City Manager's Office providing Staff to the XCAP. The XCAP is tasked with evaluating all the information related to grade crossing alternatives, making appropriate recommendations, and providing other relevant feedback to the City Council.

1.3. What Will Happen Once XCAP Makes Its Recommendations?

XCAP will present its findings to the City Council early 2021, likely through a series of City Council Study Sessions to be able to answer any in-depth questions the Council might have on the XCAP's report and work completed. The XCAP is a volunteer group that has worked diligently to provide the City Council and the community the best possible information and recommendations with respect to grade separations. Ultimately, the elected City Council is responsible for making decisions. The City Council will receive all of the XCAP's work and may choose to follow all, some, or none of the XCAP's recommendations.

1.4. COVID19 Pandemic

In March 2020, the Bay Area began to feel the effects of the coronavirus (COVID19) pandemic. While the long-term impacts are difficult to predict during the ongoing pandemic, the immediate impacts and how they've impacted this process have been described throughout this report.

¹ <https://www.cityofpaloalto.org/civicax/filebank/documents/66293>

² <https://www.cityofpaloalto.org/civicax/filebank/blobdload.aspx?t=67695.84&BlobID=70530>

³ <https://www.cityofpaloalto.org/news/displaynews.asp?NewsID=4689>

1.5. What is an At-Grade Crossing and What is a Grade Separation?

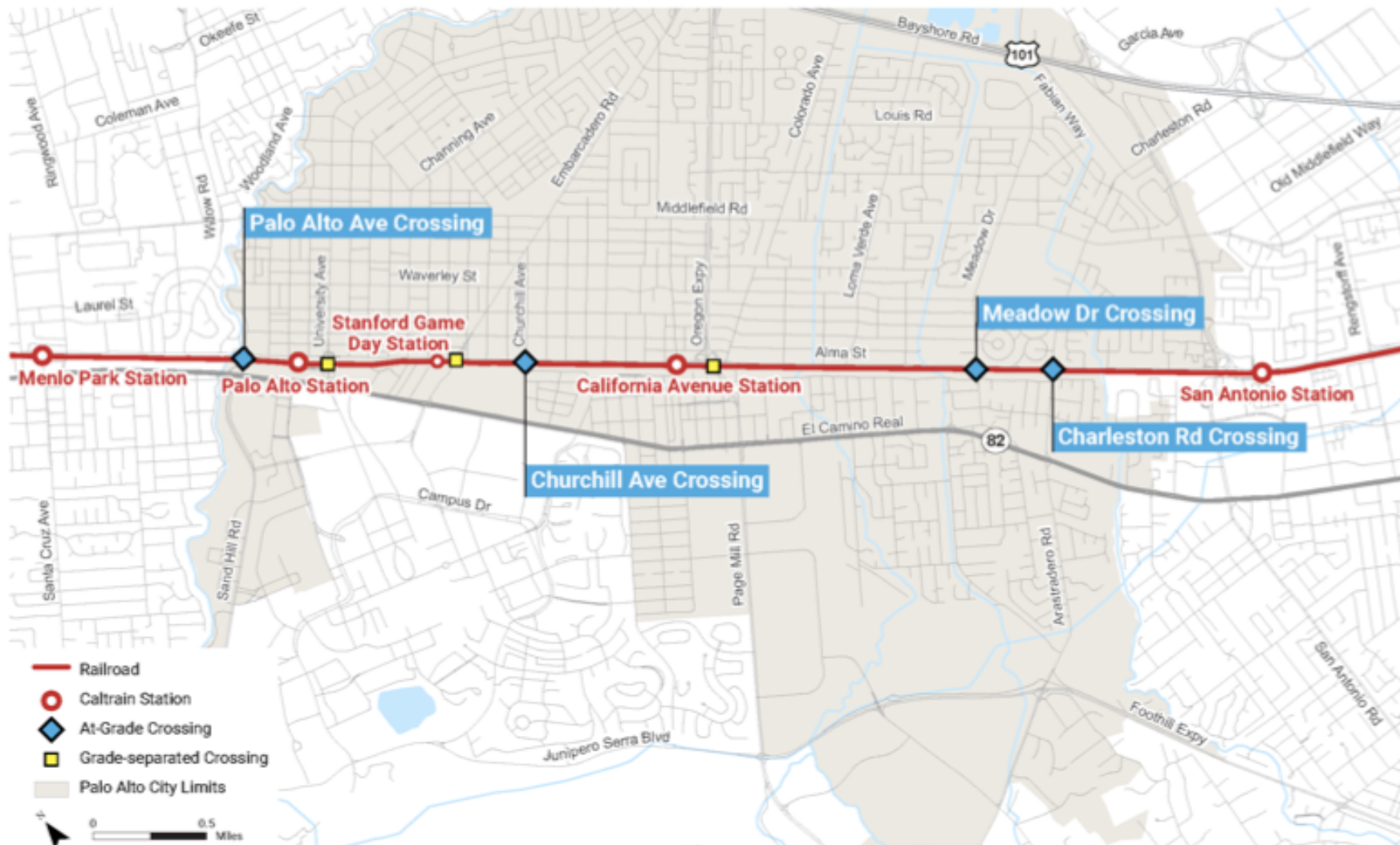
An at-grade crossing (or level grade crossing) is when there is no separation between trains and cars and when a train comes at the existing grade, flashing lights and crossing gates prevent cars from crossing the tracks.

A grade separation is a roadway that is re-aligned over or under a railway to eliminate hazards. *Viaducts* are elevated grade separations, where the train is completely elevated above the roadway on a long bridge or series of bridges, usually supported by a series of arches or on spans between tall towers. *Hybrids* are where the train is partially elevated on an earthen berm that forms a wall and the road is sunken down in a shallow trench. Below grade separations are *Tunnels*, where the train is completely submerged underground and not visible, and *Trenches*, where the train is in an open ditch while cars travel flat across the ditch.

1.6. Palo Alto's Grade Crossings

Today, Palo Alto has seven places where the train tracks and roads intersect with the Caltrain tracks. From North to South, they are Palo Alto Avenue, University Avenue, Embarcadero Road, Churchill Avenue, Oregon Expressway, Meadow Avenue, and West Charleston Road. University Avenue (built in 1940) and Embarcadero Road (built in 1936) are both hybrids (where the road is partly depressed, and the tracks are raised) and Oregon Expressway (built in 1959) is an underpass (where the road is entirely depressed).

Palo Alto Existing At-Grade Crossings



The focus of this report is three of the remaining at-grade crossings on the Caltrain Right of Way (ROW): Churchill Avenue, Meadow Avenue and West Charleston Road. The fourth, Palo Alto Avenue, will be studied as part of the Downtown Coordinated Area Plan.

1.7. Caltrain's Grade Separation Plans

Plans to convert the Caltrain system from diesel trains to electric trains have existed since 1998, but were finally realized in May 2017, when the Caltrain Electrification project finally received funds from the Federal Transit Administration as part of funding provided for the California High-Speed Rail Project.⁴ Electrification of the corridor is currently underway and upon completion (currently estimated as 2023), Caltrain will be able to run many more trains per hour with greater efficiency.

Running more trains will benefit Palo Alto, but will cause congestion at intersections due to increased grade crossing gate down time as cars wait for trains. Grade separations are needed to alleviate that congestion and once built, will help Caltrain continue to expand its service.

In October 2019, the Caltrain Board approved their Business Plan Service Vision which further details the significant expansion of Caltrain service and the need for a fully grade separated corridor, with a price tag of between \$8.5 and \$ 11.1 Billion.⁵ Caltrain's studies indicated pent-up demand that could increase ridership by 3-4x by 2040 (note: these estimates were pre-pandemic). The forecasted level of ridership would be the equivalent of removing an entire US 101's worth of cars off the freeway - and off the local streets leading to and from the freeway.

According to Caltrain's pre-pandemic plans, Electrification is scheduled to be completed in 2023. Once completed, there will be an expected increase in peak hour service from a total of 10 peak hour trains to 12 peak hour trains, which will increase the amount of time that the protective gates are down and therefore increase crosstown travel delays. In February 2020, before the emergence of the coronavirus crisis, Caltrain had identified a shorter-term set of investments that could increase ridership by 20,000 to 25,000 between 2027 and 2030. These investments would enable increasing frequency to 16 peak hour trains. This change would create noticeable additional delays for crosstown travel above the 12 peak hour trains planned for 2023.

In addition to Electrification, the passage of Santa Clara County's Measure B in 2016 provided some of the funding necessary to begin planning and building these grade separations in Palo Alto. (See Section 2.8.1 Santa Clara County Measure B and also see Appendix C - History of Grade Separation Funding Sources). The Electrification of Caltrain and the availability of Measure B funds has driven the need for Palo Alto to build grade separations.

⁴ <https://apnews.com/article/47e07949c19f4e0aa905cf126616b06b>

⁵ Pg. 36 of Appendix B-8-B Caltrain Business Plan Update to Local Policy Maker Group 4-19-2019

1.8. Palo Alto's Need for Grade Separations

Grade separations in Palo Alto are needed to:

- Reduce congestion from increased trains
- Improve safety
- Meet the goals of the City of Palo Alto Comprehensive Plan 2030
- Support public transit goals

1.8.1. Reduce Congestion from Increased Trains

One of the most significant opportunities to reduce traffic congestion in Palo Alto would be the creation of grade separations. In order to meet State goals of reducing greenhouse gas emissions, state law favors public transit over car traffic - hence trains have a priority over cars when traveling through a City.

Normal traffic signals at intersections have a sequence that allows all 4 directions (in a 4-way signal) to take roughly equal turns in getting through the intersection before restarting the sequence. Since trains have priority over vehicles, this is not true at train/vehicle intersections. Instead, when a train approaches the intersection the traffic signal modes are changed, the red warning lights flash and the crossing gates come down to stop cars, bikes, and pedestrians from proceeding and who thus face delays until the train passes and the signaling system resets.

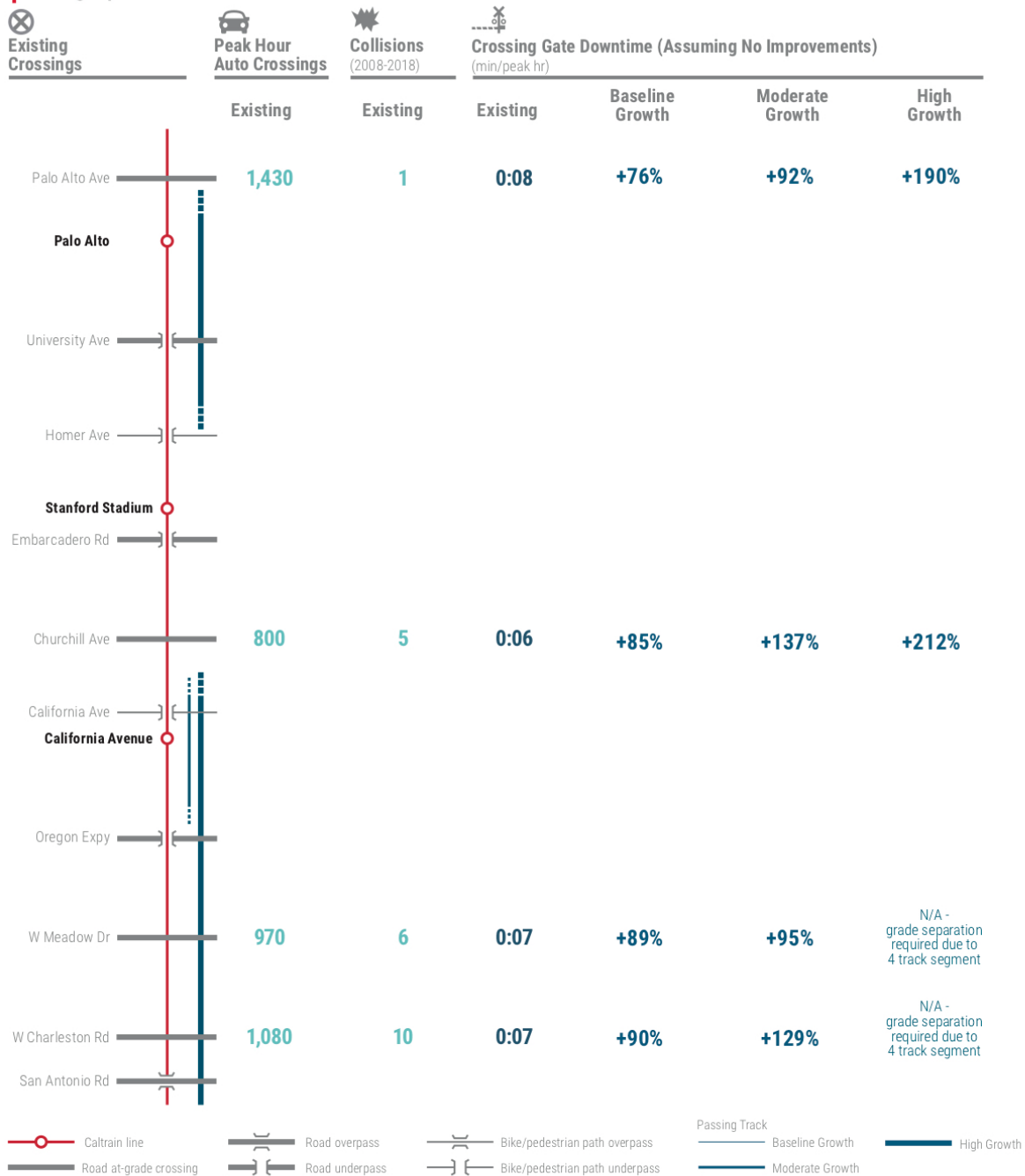
As the number of trains increases, signal preemption events increasingly interrupt the ability of the traffic signals to complete their normal sequence. When this happens repeatedly, as is the case when multiple trains come in a short period of time, cars are unable to clear the intersections (unclearable queues) leading to increased traffic jams and congestion. (Also see Appendix A-4 Queue lengths at Churchill 10-16-19)

The graphic below from Caltrain estimates the delay times that could occur with their future service scenarios (Baseline, Moderate and High).⁶

⁶ Pg. 22 of Appendix B-8-B Caltrain Business Plan Update to Local Policy Maker Group 4-19-2019

CROSSING THE TRACKS

Gate down times shown are indicative projections extrapolated from existing crossing performance. They are examples of "worst case" gate downtimes that could occur if no grade separations or grade crossing improvements were made. The financial component of the Caltrain Business Plan is planning for substantial investments in grade separation and crossing improvements across all scenarios.



Note: Conceptual 4 Track Segment to be refined through further analysis and community engagement.

Source: Appendix B-8-H Caltrain Booklet for City of Palo Alto

Note: In the above chart, in the High Growth Scenario, passing tracks are needed, creating a four-track segment. The FRA requires a grade separation when there are four tracks.

2040 Gate Downtimes

In 2040, projected crossing gate down times vary by scenario. This evaluation does not take into consideration planned or potential grade separations

Gate Down Time by Scenario

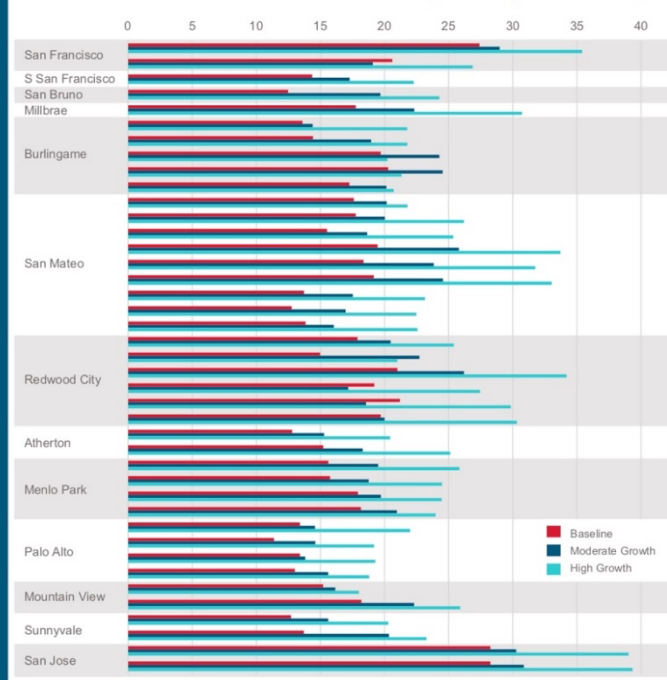
	Shortest	Average	Maximum
Baseline	11	17	28
Moderate	14	20	31
High	18	25	39

Minutes per Peak Hour

Note: Gate downtimes shown reflect the average time crossing gates are down only. Depending on individual crossing and roadway configuration traffic signals may stay red for longer and auto users may experience longer delays

Data presented for Caltrain-owned corridor only.

Estimated Gate Down Time: 2040 (Minutes per Peak Hour)



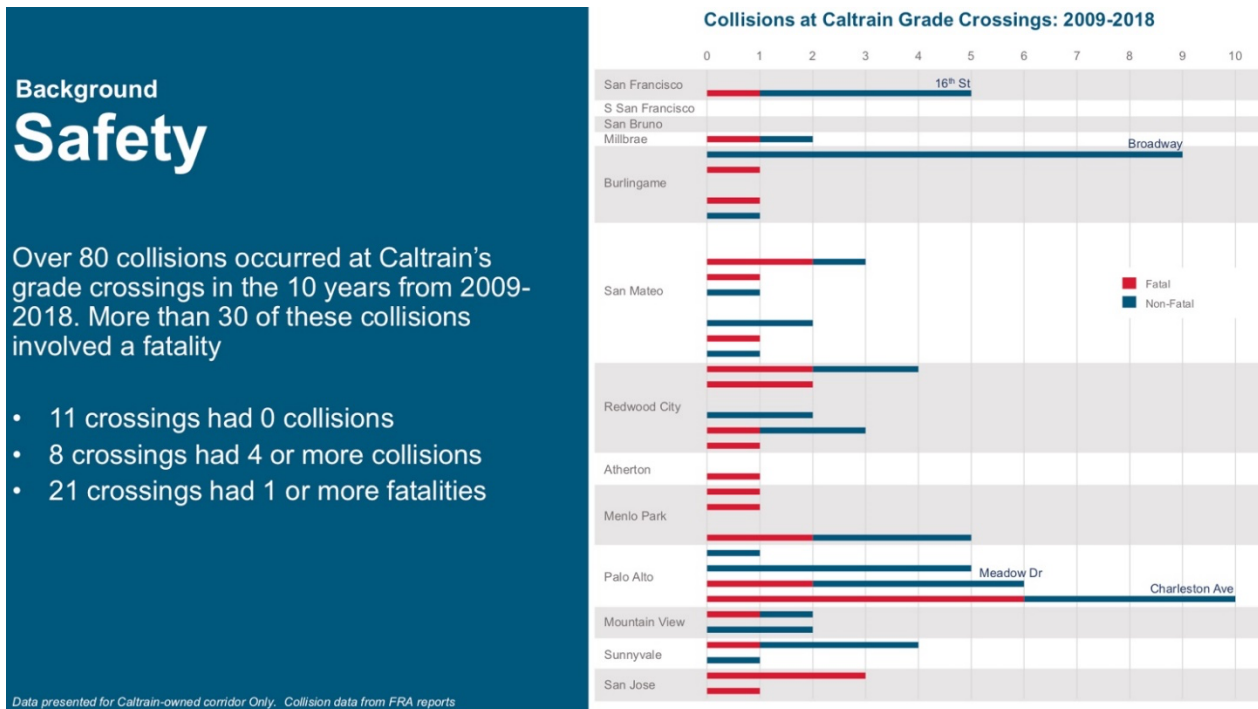
Pre-COVID, at peak hours in the morning and afternoon, traffic signals were disrupted up to ten times in a 60-minute period. Due to inconsistencies in the boarding process, the train schedule is not precise, which means traffic signals cannot be easily synchronized to deal with multiple preemption events.

1.8.2. Improve Safety

Safety is another reason for removing at-grade crossings. Every time cars, pedestrians, and cyclists are in close proximity to trains there is potential for conflict. Pre-pandemic, 96 trains a day traveled the Palo Alto corridor at speeds up to 79 miles per hour, and at the four at-grade crossings there are a total of over 50,000 crossings per day. According to the Federal Railway Administration, Charleston Avenue has the 19th highest⁷ “accident prediction value” in California, and the second highest on the Caltrain system. Caltrain recently provided the following information for the corridor⁸:

⁷ Charleston Avenue's rank used to be much higher – today 15 out of the top 20 scores in the FRA's system are occupied by a light rail system in San Diego with a top speed of 30 miles per hour. Charleston has the fourth highest score in California amongst non-light-rail systems.

⁸ Page 18 of Appendix B-8-B Caltrain Business Plan Update to Local Policy Maker Group 4-19-2019



Chapter 6 on Safety includes more detail on both the history of rail accidents in Palo Alto and specific suggestions to ensure that anything that is constructed is as safe as it can be.

1.8.3. Meet the Goals of Palo Alto's Comprehensive Plan 2030

The Palo Alto Comprehensive Plan contains the City's official policies on land use and community design, transportation, housing, natural environment, safety, business and economics and community services. The Plan is used by the City Council and the Planning and Transportation Commission to evaluate land use changes and to make funding and budget decisions. And it is used by City staff to regulate building and development and to make recommendations on projects. It is used by citizens and neighborhood groups to understand the City's long-range plans and proposals for different geographic areas and it provides the basis for the City's development regulations and the foundation for its capital improvements program.

One of the eight major themes of the Comprehensive Plan (Comp Plan) is reducing dependency on single occupancy vehicles. The City's multipronged strategy includes improving bicycle and pedestrian access throughout the City while also supporting the development of further transit options in the City and throughout the region.

The Comp Plan states "Caltrain grade separations will be prioritized to improve east-west connections for automobiles, transit, pedestrians and bicyclists, and to reduce traffic congestion, improve safety and reduce noise impacts."⁹ The Comp Plan also has several other policies related to grade separations and to creating better East/West bicycle and pedestrian connectivity across the Caltrain tracks. The plan also "recognizes the regional nature of its

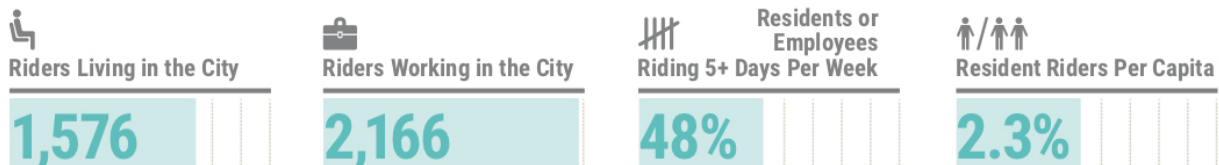
⁹ Pg. 3 of PA Comprehensive Plan <https://www.cityofpaloalto.org/civica3x/filebank/documents/62915>

transportation system” and **seeks to prioritize “Caltrain service improvements and railroad grade separations.”** The appendix includes the Implementation Plan portion of the Comprehensive Plan with highlights on all of the visions, goals and policies that might intersect with future grade separation planning and projects. (See Appendix C-12 Palo Alto Comprehensive Plan Excerpts for more information)

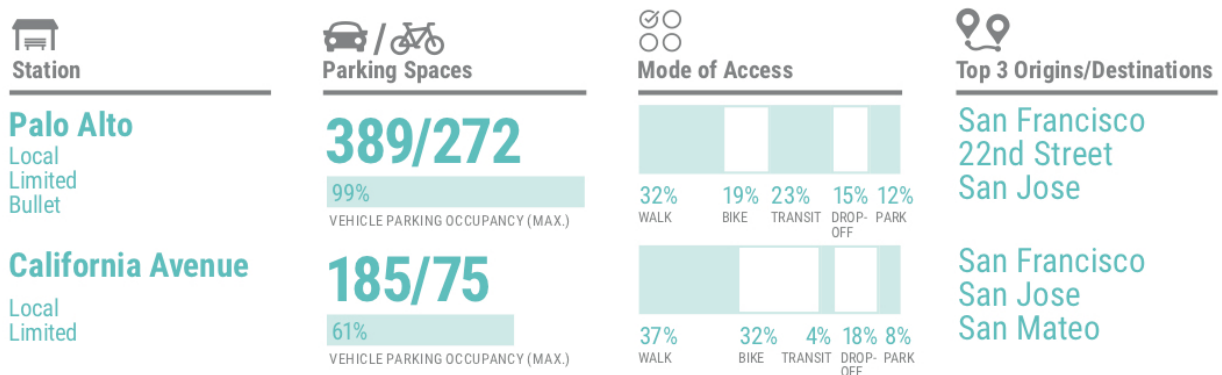
1.8.4. Support Public Transit Goals

Another goal of the Comprehensive Plan is support of public transit alternatives to reach the goal of reducing single occupancy vehicle use. Caltrain is the backbone of the transportation systems on the Peninsula and plays a significant transportation role for Palo Alto and the region. Pre-pandemic, Palo Alto had the second highest ridership outside of San Francisco given it is a significant job center in the region. As part of its Long-Range Service Vision (Business Plan), Caltrain created a booklet highlighting key statistics related to Caltrain in Palo Alto.¹⁰

HOW CALTRAIN IN PALO ALTO IS USED TODAY



STATION CHARACTERISTICS



Caltrain’s growth in the region (pre COVID19) and its expected future expansion are fueled by a number of factors including electrification, worsening of congestion and overall Bay Area growth, and the eventual completion of the Central Subway project¹¹ (linking the Muni Metro light rail system to Caltrain at 4th and King streets and Chinatown, with stops in South of Market (SoMa) and Union Square) allowing a Caltrain connection into the densest parts of San Francisco. The potential

¹⁰ Pdf page 6 of Appendix B-8-H Caltrain Booklet for City of Palo Alto

¹¹ https://www.sfmta.com/projects/central-subway-project?utm_source=Legacy&utm_medium=centralsubwaysf.com&utm_campaign=Vanity+domain&utm_content=

arrival of California High-Speed Rail on the Peninsula and the additional trains they might run only exacerbates the need for grade separations.

Caltrain also plays a key role in Palo Alto's relationship with Stanford University. Stanford's growth is limited by the General Use Permit between Stanford and Santa Clara County whereby Stanford is committed to keep single occupancy vehicle trips to a minimum. If Stanford goes over the agreed amount, they must pay for mitigations. As a result, Stanford has developed a commuter program that relies heavily on Caltrain. In fact, Stanford recently donated \$1 million dollars to Caltrain and signed an agreement to help in the development of Caltrain's Business Plan to ensure expanded service to help mitigate the impacts of Stanford's plans to continue to grow.¹²

1.9. Impacts of the Pandemic

As of the date of this report, the US economy has been severely impacted in response to Covid19. Caltrain's ridership has plummeted as a result of the increased number of people working from home and the general decline in the economy. Caltrain ridership suffered a greater than 90% drop since April 2020.¹³ Caltrain's ridership relative to other transit agencies has been more severe because the majority of Caltrain riders prior to the pandemic were typically riders with greater economic means and who owned vehicles, but still chose to commute by train.¹⁴

The near-term economic outlook is highly uncertain, and the timing and shape of the economic recovery cannot be predicted. During the recovery period there will likely be a transition period during which Caltrain regains some but not all of its pre-Covid ridership. Thus, it is not possible now to predict exactly when Caltrain will need to increase its services to accommodate increased ridership levels. However, the economy of the country and the region has always recovered from prior economic downturns including the Great Depression, the "Great Recession" of 2008-2009, and the local "tech bubble" of 2000-2001. There is every reason to believe that the Bay Area will recover and thrive, because the fundamental drivers of Caltrain ridership, current population jobs and expected population and jobs growth, are still in place. Directly to this point, a Caltrain "Covid-19" ridership survey with over 1600 responses indicated that 55% of respondents will ride Caltrain post-pandemic as often as or more often than before.¹⁵ Less than 1% of respondents answered that their company will expect all employees to work remotely.¹⁶

In the meantime, the impacts of the pandemic have shifted Caltrain ridership patterns, with Palo Alto now being the top transit stop, surpassing San Francisco.

¹² https://www.caltrain.com/about/MediaRelations/news/Caltrain_and_Stanford_University_to_Collaborate_on_Business_Plan.html

¹³ PDF 27 <https://www.caltrain.com/Assets/replaced+ppt.pdf>

¹⁴ Pg. 4 of Appendix B-8-I Caltrain Pandemic Rider Survey TOPLINE REPORT – Fall 2020

¹⁵ https://www.caltrain.com/about/MediaRelations/news/Caltrain_Rider_Survey_Shows_More_Essential_Workers_Onboard.html

¹⁶ Pg. 6 of Appendix B-8-I Caltrain Pandemic Rider Survey TOPLINE REPORT – Fall 2020

Where are riders traveling?

Caltrain ridership patterns have shifted during COVID-19, with ridership comprised of essential workers in healthcare, life sciences, government, and related fields.

Rider Trip Purposes:

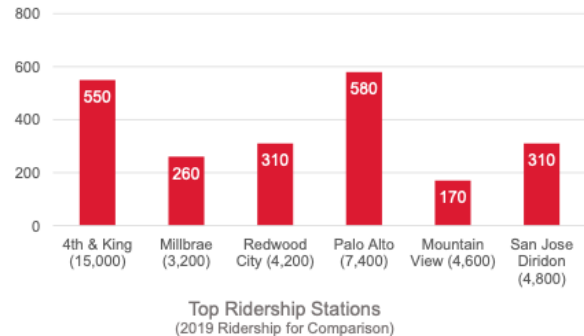
70% of riders commuting to work

50% of riders work in healthcare, life sciences, or government

10% of riders traveling to medical appointments

Ridership during COVID-19 has been more concentrated around stations with major medical centers like Palo Alto and Redwood City, with fewer riders commuting to offices around stations like 4th & King and Mountain View.

August 2020 Weekday Ridership (3,500/Day)



Ridership decline south of Tamien to Gilroy (50 riders per day) mirrors systemwide trends.



Source: <https://www.caltrain.com/Assets/Caltrain+Modernization+Program/Meetings/LPMG/Caltrain+Business+Plan+LPMG+Presentation+Oct+2020.pdf>

In addition, on November 3, 2020 Measure RR passed, finally providing dedicated funding for Caltrain (see Section 2.8.3 Measure RR). The fact that during a pandemic in which Caltrain's ridership has plummeted, Measure RR surpassed the 66.67% threshold in San Francisco, San Mateo and Santa Clara Counties is a strong indication of the voters' confidence that Caltrain remains an important part of the regional transit system that continues to merit significant investment.

It is also possible that grade separation projects would be included in a future "economic stimulus" passed by Congress as part of its response to the current economic situation or as part of a major infrastructure bill. If history is a guide, qualifying projects will need to be "shovel ready" within several years of passage of such laws.

For these reasons, **XCAP believes it is prudent to continue planning work on grade separation projects in Palo Alto.**

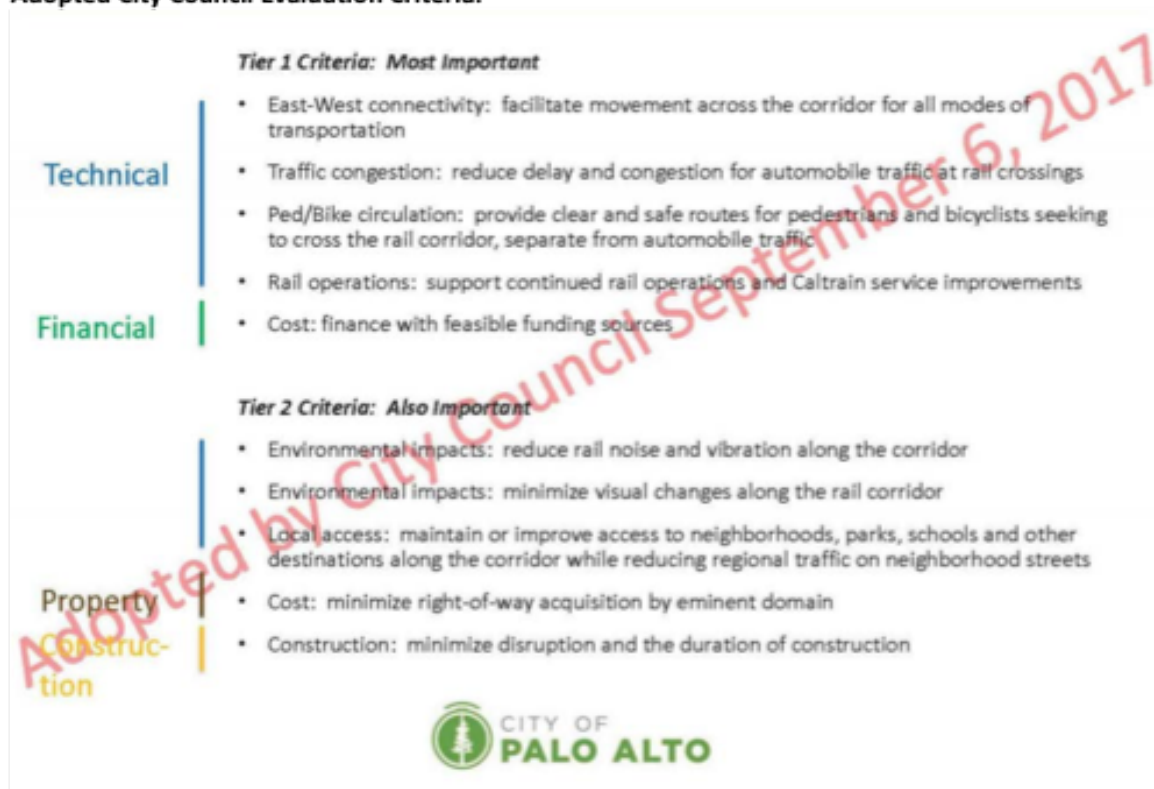
2. Influencing Factors

This Chapter covers a variety of factors that influence any potential decisions related to grade separations; from general technical considerations, like freight operations, to relevant Caltrain and High-Speed Rail policies and the changing need for and funding of grade separations. While not an exhaustive list, it attempts to draw attention to issues that should be considered.

2.1. City Council Criteria

In September 2017, the City Council adopted evaluation criteria they intended to use for grade separation evaluations. In 2018-2019 the Council had significant discussion about removing the tiered levels of the criteria. However, as the process evolved with the formation of the CAP and XCAP, the criteria never returned to Council for further discussion.

Adopted City Council Evaluation Criteria:



Source: <https://connectingpaloalto.com/wp-content/uploads/2019/11/Item-6-Final-Memo-Review-Council-Adopted-Criteria.pdf>

The City Council adopted criteria to form the basis for a summary document created by the consultants known as the Matrix that compares and contrasts the various alternatives. The Matrix expands upon the Council's criteria by including other factors that could be used to make decisions. For more information about how the Comprehensive Plan might be applied to Council Criteria, Appendix A-4-3 Staff Update: Follow up to XCAP Criteria Questions 4-22-20.

2.2. Eminent Domain and Property Acquisition

In the development of the Council Criteria and in subsequent discussions, the issue of eminent domain has been a key component. The Council has repeatedly indicated that they want to minimize the amount of eminent domain, but they very specifically did not prohibit the use of eminent domain outright and the issue of negotiated property acquisition was not fully pursued. The criteria specifically state “Cost: minimize right-of-way acquisition by eminent domain”.

XCAP invited land use attorney Norm Matteoni to make a presentation so the public, XCAP, Council and Staff could better understand the eminent domain process. A transcript¹⁷ of that meeting was posted on the Connecting Palo Alto website, as well as the attachment¹⁸ provided by Mr. Matteoni providing an overview of the eminent domain process and property owners’ rights under the law. This information is available in Appendix B–6 Eminent Domain Information.

2.3. Freight

Freight trains play a regional role in moving goods through the area and reducing the number of trucks needed, reducing pollution and traffic. On the Caltrain ROW, Union Pacific carries freight on diesel trains that travel through Palo Alto three times per night, six nights per week. Even after Caltrain is electrified, these diesel freight trains will continue to operate. The majority of the customers using freight are in the Port of Redwood City, South San Francisco, and the Port of San Francisco.

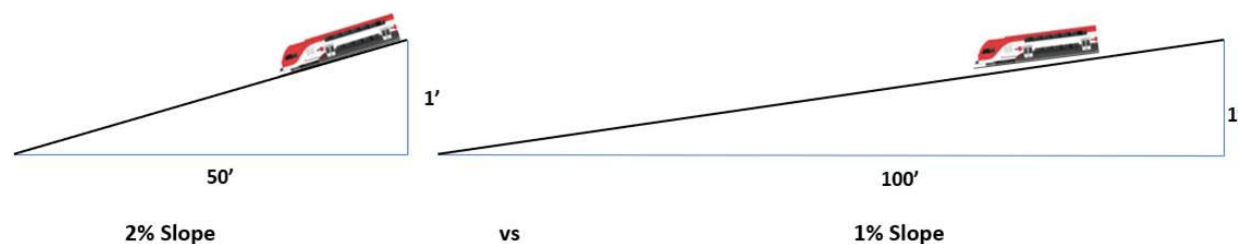
Caltrain owns the right-of-way in Palo Alto, but Union Pacific has several trackage rights agreements¹⁹ that allow them to travel on the corridor. As part of these agreements, throughout the Electrification project and any grade separation projects, Caltrain and Union Pacific must be able to maintain operations. In general, the agreements also provide that Caltrain will work with Union Pacific when making any changes to the infrastructure on the corridor.

While freight represents less than 5% of all the train operations on the Caltrain corridor, the technical constraints of considering freight when designing grade separations have a significant impact on design flexibility. Electrified trains can climb and descend at steeper slopes than freight trains. The majority of the Caltrain corridor has a maximum of 1% slope and that is the present Caltrain standard. When raising or lowering the train tracks to go over or under a road, the grade at which it can travel must be flatter, which in turn requires more distance than a steeper vertical grade. A rise of one foot in elevation in 100 feet of track is a 1% ascending grade. Similarly, a decrease of one foot in elevation in 100 feet of track is a descending grade of 1%. A change from a 1% grade to a 2% is a 50% decrease in the horizontal distance needed to achieve the change in grade. The following graphic illustrates this concept:

¹⁷ See Appendix B-6-3 2020-02-05 XCAP Meeting Verbatim Minutes

¹⁸ Appendix B-6-2 Eminent Domain handout - Feb 5 2020 - Information from Norm Matteoni

¹⁹ <https://www.caltrain.com/about/JPB-Agreements.html>



Freight trains can travel at steeper than 1% grade, and as can be seen above, a small change makes a big difference. In 2017, Union Pacific announced they were looking for a company to sublet their trackage rights to operate freight on the Peninsula. The mayors of San Francisco and San Jose wrote a letter to Union Pacific asking them to consider finding an operator that would be comfortable operating at 2% grade because “In anticipation of Caltrain electrification, the Peninsula cities expect to work with Caltrain to amend the design criteria to provide for a two percent grade design standard.”²⁰ While this change hasn’t happened yet, it indicates the importance of this technical requirement on the ability to build grade separations on the corridor at minimal construction cost. The needs of freight can also make grade separations designs more expensive independent of grade standards, because they require higher and wider clearances than Caltrain trains.

A September 2020 report recently revealed that Union Pacific is now considering selling its trackage rights to freight on the Peninsula and the JPB is in negotiations with Union Pacific to acquire the short line rights for the tracks north of Santa Clara²¹ This developing situation could have implications for design. **Policymakers and staff should continue to advocate to Caltrain for a two percent grade design standard.** Five of the nine grade separation design alternatives considered by XCAP would require a design exception to the one percent standard.

2.4. High Speed Rail and Caltrain Operations

In addition to freight, Caltrain may have High Speed Rail operating on the corridor in the future. In 2008, voters approved Proposition 1A, which authorized funds for the construction of a high-speed rail line between San Francisco and Los Angeles, as part of an eventual system that would also extend to Sacramento in the north and San Diego in the south. HSR trains would run on the Caltrain line between San Jose and San Francisco. The estimated date for HSR operation on the Peninsula Corridor has recently been extended to 2031, and the project has had implementation and funding challenges. Many question whether it will ever arrive on the Peninsula. At minimum, its arrival date is likely to be later than 2031, but its potential arrival has impacts on the corridor planning that have to be taken into account.

²⁰ <https://www.cityofpaloalto.org/civicax/filebank/documents/61071>

²¹ Pg. 16 of <https://www.caltrain.com/Assets/Caltrain+Modernization+Program/Documents/PMOC+Reports/2020-09+September+PCEP+PMOC+Quarterly+Monitoring+Report.pdf>

In 2012, Caltrain and High-Speed Rail signed a Memorandum of Understanding²² committing to a Blended System on the Caltrain corridor which establishes primarily two shared tracks substantially within the existing Caltrain corridor. From Caltrain's website: *"Additional system improvements that need to be defined include HSR stations, passing tracks that can be used by HSR trains to bypass the Caltrain trains that need to stop more frequently, at-grade crossing improvements, and system upgrades to support higher train speeds. Grade separations, a storage/maintenance facility, and other system elements will also be considered in defining the blended system."*²³ According to Caltrain's Business Plan, if HSR comes to the corridor, it will need passing tracks in several areas, including Palo Alto and Redwood City to overtake Caltrain.

HSR thinks otherwise. It claims that it does not need passing tracks in Palo Alto if Caltrain is willing to wait at stations or on sidings while High-Speed Rail passes. Studies have shown, however, that this would significantly impact Caltrain's operational schedule and Caltrain would be unable to achieve their Business Plan goals. Caltrain recently sent a letter to High-Speed Rail as part of HSR's Environmental Impact Report for its proposed San Francisco to San Jose route that made it clear it finds waiting at stations or sidings unacceptable and expects HSR to pay for passing tracks if they decide to run service on the Peninsula. (See Appendix B-8-C - Caltrain Letter to High-Speed Rail - Re: Preferred Alternatives 8-22-19)

It should be noted that under the rules of the FRA, if there are four tracks built, a grade separation **MUST** be built, as it is unsafe and unacceptable for cars to drive over four tracks of trains at a level grade crossing.

2.5. Caltrain Rail Corridor Use Policy and Four-Tracks

The Caltrain Board of Directors, known as the Peninsula Joint Powers Board (JPB) is the owner and operator of the Caltrain corridor. **The JPB has to ultimately approve all designs for grade separations.** As part of its Long-Term Service Vision, Caltrain Board's recently adopted the Rail Corridor Use Policy (RCUP) (See Appendix B-8-G Caltrain Rail Corridor Use Policy 2-6-20) which in part states that Caltrain will not allow grade separations to be built that would preclude the ability to run a four-track system. From Caltrain's email to Palo Alto City Staff:

"The exact location of a potential four track segment is yet to be defined, however. For the purposes of RCUP, which governs Caltrain's use of its own property, we took the most conservative approach and considered the potential for a 4-track segment between San Francisquito Creek Bridge in Palo Alto to just through the Mountain View Station (the area in which a 4-tracks segment is operationally viable for the intended purpose). The ultimate extent of the area preserved for 4-tracks does not need to encompass this full length. However, we would need to work with the City to advance thinking about the City's potential capital projects along the corridor to then

²² <https://www.caltrain.com/Assets/Caltrain+Modernization+Program/Documents/Executed+9+Party+MOU.pdf>

²³ <https://www.caltrain.com/projectsplans/CaltrainModernization/BlendedSystem.html>

make decisions that could constrain the extent of the area under consideration. Until that time, Caltrain will take a very conservative approach – as specified through the RCUP – when it comes to any potential long-term encumbrance of our property.”²⁴

Caltrain has made it clear that any alternatives considered for grade crossings should not preclude the ability to deliver a four-track segment. While the City could initiate the RCUP review process to petition Caltrain staff review the compatibility, Caltrain says “in order to be considered for an exception to the RCUP and be considered compatible, **the onus would be on the City to show via conceptual designs that a potential future four track segment would not be precluded in this area...**” Caltrain goes further and explains “even if the City did this and the proposal was able to be considered ‘potentially viable’ by receiving a compatibility exception through the RCUP, it would still need to undergo substantial design, engineering, and regulatory review before it would be approved as a use for JPB property.”

2.6. Caltrain Corridor Wide Grade Separation Study

In July 2020, Caltrain Representative Sebastian Petty described the Caltrain Corridor Wide Grade Separation Study that is planned. The study represents Caltrain's first attempt to develop a cohesive grade separation strategy for the corridor. A synopsis of the Caltrain presentation was made available in XCAP's update to City Council in Sept 2020 (see Appendix C-4-6 Update #6 09-09-20) and is excerpted below:

- Was scheduled to begin Fall of 2020 (funding secured in this past year's capital budget). Budget authorized hiring a single point of contact to manage work broken up between multiple contractors and phases. Phase 1: expected to take 6 months; entire study about 2.5 years. *(This has been delayed due to COVID and, as of the writing of this report, is expected to start early in 2021).*
- Caltrain will not be involved in specific designs for each City. A corridor and community process, including all local jurisdictions on the corridor, regional and state partners will work to develop and determine the scope, timeframe, contracting method and how the study should be governed. Focus will be policy framework, not specific grade separation or crossing designs.
- Phase 2: Will echo what was heard and seek feedback from city representatives, especially on standards and construction methods and why they're needed to understand mutual implications of all decisions.
- Will consider economies of scale, construction standards and design standards comprehensively (so individual projects are not asked to go through onerous design exemption processes) and how construction contracting, and sequencing approaches can be used to keep costs and impacts under control. Will include organization analysis and governance around project delivery vs. operations and corridor management,

²⁴Appendix B-8-J Caltrain Email Regarding Encroachment 2020-04-22.pdf

structure for decision making on issues that span multiple jurisdictions and impact both cities and rail operations and structure for administering funding.

- Will evaluate, at a corridor level, what standards should be used rather than taking a case-by-case exception approach to ensure Union Pacific is comfortable.

The Corridor-wide grade separation study is also expected to consider grouping grade separation projects together to be able to receive more federal funding.

2.7. Caltrain Governance Reform

As part of its Business Plan, Caltrain is reviewing a possible reform of its governance structure which, if pursued, could also impact how grade separation projects are designed, managed, and funded. In July 2019, Caltrain completed an Organizational Assessment Report²⁵ which explained that the California Legislature has provided enabling authority for two types of structures created for the purpose of building major capital projects. These are Special Construction Authorities and Grade Separation Districts. A Special Construction Authority is an independent agency created by the State legislature to plan and construct specific projects, which, if created, would require comprehensive agreements addressing funding mechanisms, planning and construction requirements, technical specification reviews, and operational agreements.²⁶ By contrast, a Grade Separation District could be created if a board of supervisors in any county could pass a resolution to create a grade separation district, upon a finding that the safety and welfare of the residents of contiguous areas within the county require the formation of a district to provide for a separation of grade. The Grade Separation District would need to be ratified by a majority of the voters within the proposed district in a general election. Under existing legislation, the district would have a 5-member governing board that confers broad powers to the agency, including the power to plan, design and build the project and to exercise the power of eminent domain. A grade separation district also has the power to issue bonds and to levy property taxes subject to obtaining approval from 2/3 of those who cast ballots in a duly called election.

From the report:

“Although implementation of grade separation projects to date within the Caltrain rail corridor have been designed and constructed by means other than a grade separation district (e.g., contractual arrangements between local funding agencies, the JPB and the cities or county in the jurisdiction of the project), there is precedent for the creation of such districts elsewhere in California. In 1954, the Kern County Board of Supervisors invoked the grade separation district enabling authority, resulting in the creation of the Greater Bakersfield Separation of Grade District whose duties were to separate dangerous at-grade intersections of roadways and railroads by means of underpasses or overpasses.”²⁷

²⁵ Report page 89 <https://www.caltrain2040.org/wp-content/uploads/Caltrain-Organizational-Assessment-Full-Report.pdf>

²⁶ Report page 90 *ibid*

²⁷ Report page 91 *ibid*

If Caltrain and/or Santa Clara County were to pursue either of these governance forms, the City of Palo Alto would need to consider their impact on Palo Alto's grade separation strategies.

2.8. Funding for Grade Separations

The City Council directed XCAP not to consider the financing of grade separations and it has not. However, since two significant funding events specific to grade separations were part of the rationale for the City's decision to invest time and money on this issue (2016 Measure B and Caltrain Electrification Funding), XCAP believes it appropriate to comment on the present status of these potential funding sources. Additional historic information related to grade separations is available in Appendix C-2 History of Grade Separation Funding Sources.

2.8.1. Santa Clara County Measure B (2016)

Santa Clara County's Measure B (2016), a 30-year, half-cent countywide sales tax to enhance transit, highways, expressways, and active transportation (bicycles, pedestrians, and complete streets) is considered a substantive "down payment" for grade separations. The measure earmarked \$700 million for eight grade separations including four in Palo Alto (Palo Alto Avenue, Churchill Avenue, East Meadow Drive and Charleston Road), two in Mountain View (Rengstorff Avenue and Castro Street) and two in Sunnyvale (Mary Avenue and Sunnyvale Avenue). The total cost of the eight grade separations will vastly exceed this amount. In order for cities to access Measure B funding, projects must include a minimum of 10% contribution of non-2016 Measure B funding.

Palo Alto, Mountain View and Sunnyvale have yet to negotiate with VTA how the money will be divided and distributed, but some monies have been distributed to Mountain View to begin planning and design. Mountain View recently signed the Castro Street Grade Separation Project Cooperative Agreement²⁸ to access Measure B funding and work is currently underway for 35% engineering of the Rengstorff project.²⁹

In 2000 and 2008, Santa Clara County passed tax measures aimed at making a variety of improvements, including for Caltrain, however cost overruns on BART have meant the promised funds have been raided by VTA. Policymakers must remain focused to ensure that the 2016 Measure B dollars are not raided to cover the cost overruns of the BART extension to San Jose.

2.8.2. Corridor-wide Funding

Caltrain is undertaking a Corridor-wide Grade Separation Study which is expected to look at the potential need to change historic funding strategies along the corridor in order to achieve their Long-term Service Vision Goal.

²⁸ http://santaclaravta.iqm2.com/Citizens/Detail_LegiFile.aspx?MeetingID=3128&ID=7378

²⁹ https://www.caltrain.com/projectsplans/Projects/Caltrain_Capital_Program/Rengstorff_Avenue_Grade_Separation_Project.html

Policymakers should note that since the need for grade separations is now focused on public transit as a regional priority to meet transportation and climate goals, the manner in which these projects are managed, grouped, prioritized, and funded could dramatically shift away from the previously city/county driven model that focused on grade separations for vehicle traffic.

2.8.3. Measure RR

Despite being the seventh largest commuter rail service in the nation, unlike most transit agencies, Caltrain has not had a dedicated source of funding. Since its inception, Caltrain has relied on revenue from passenger fares (70% of operating budget – highest percentage in the country) and on contributions from its Member Agencies: San Mateo County Transit District (SMCTD), Santa Clara Valley Transportation Authority (VTA) and City and County of San Francisco (CCSF).³⁰

Each of the Member Agencies (a) contributes an equal amount of capital funding each year and (b) supplements operating funding based on the percentage of system ridership originating in each County. The levels of both capital and operating funding are determined by the funding capacity of the Member Agency with the least ability to provide its share of funding in any given year. The amount that Member Agency can make available then becomes the standard against which the contributions of the other Member Agencies are calculated.

In the November 2020 election, voters approved Measure RR (2020) establishing a dedicated source of funding for Caltrain as a 30 year one-eighth cent sales tax in San Francisco, San Mateo and Santa Clara County which will provide approximately \$100 million annually.

The impacts of this dedicated funding and the changes that might come from member agencies and their previous funding commitments remains to be seen. The amount of money available from Measure RR seems likely to be dedicated almost exclusively to operations and would likely not have any excess funds for grade separations.

³⁰ <https://www.caltrain.com/about/dedicatedfunding.html>

3. Ideas Discarded before XCAP Began

Before XCAP began, City Council reviewed and discarded several grade separation concepts that it determined to be infeasible or undesirable. This section briefly discusses these discarded alternatives for comprehensiveness purposes and the rationale for their being discarded. The following Staff report discusses the discarded alternatives:

<https://www.cityofpaloalto.org/civicax/filebank/documents/65124>.

3.1. Citywide Tunnel

In May 2019, the City Council on a 4-1 vote (Tanaka dissenting, Kniss and Filseth recused) eliminated the “citywide tunnel” alternative. “Citywide” is a misnomer in that for a tunnel to run from one end of the City to the other it would have to extend into Menlo Park and Mountain View. The tunnel proposed would have originated at the University Avenue station and ended near San Antonio Avenue. The Council’s rationale primarily focused on the estimated cost of \$2.5 to \$3.8 billion, but concern was also expressed for the significant property acquisition, mainly residential, which would be required.

The profile and typical section drawings can be found in the Appendix A 2 and the animation can be found at: <https://vimeo.com/325481133/e987af4a60>.

3.2. Traditional Underpasses

Early conceptual designs for traditional Underpasses (where the train remains where it is, and the road is fully submerged) for Churchill Avenue and Meadow Drive/Charleston Road were briefly studied and rejected in 2014 based on consultant Hatch Mott McDonald’s study³¹ because of the very large number of property acquisitions (~40) along Churchill Avenue, Meadow Drive, Charleston Road and Alma Street which would be required.³²

In late 2019, resident Elizabeth Alexis, recognized that the early conceptual work done on the underpasses at Meadow and Charleston assumed including more traffic lanes than would be required. She proposed a modified Underpass Alternative for Meadow/Charleston which is described and considered in Section 5.5.2.5.

3.3. Closure of Meadow Drive

With the Meadow Drive crossing being less than one mile away from Charleston crossing, the issue of whether Meadow could be closed was raised. According to the Hexagon Traffic Analysis of August 13, 2020, page 56, “The additional traffic on Charleston Road from the proposed closure of E. Meadow Drive would cause these intersections to operate at

³¹ Staff Report <https://www.cityofpaloalto.org/civicax/filebank/documents/44284>

³² HMM Property impacts: <https://www.cityofpaloalto.org/civicax/filebank/documents/44335>

unacceptable levels of service. Therefore, closure of the E. Meadow Drive railroad crossing is not recommended.” Based on this study, the XCAP did not consider a closure at Meadow.

3.4. Churchill Hybrid and Churchill Reverse Hybrid

The Churchill Hybrid and Churchill Reverse Hybrid were reviewed by City Council in May 2018. In the Churchill Hybrid, the road is partially lowered, and the rail is partially raised. The Churchill Reverse Hybrid (also named Shallow Trench) is where the road is partially raised, and the rail is partially lowered. The City Staff report³³ contains few details about why these options were not advanced. Early conceptual drawings produced in 2018 show significant negative impacts to adjacent residential properties due to raising and lowering the roadway which probably would have required significant property acquisitions.

3.5. Ideas Submitted by XCAP to City Council but Rejected

XCAP received a presentation from its own member, Tony Carrasco, which included a concept to build a Viaduct with a roundabout at Embarcadero. XCAP presented this concept to the City Council but the Council chose not to study it.

³³ <https://www.cityofpaloalto.org/civicax/filebank/documents/65124>

4. Churchill Ave

4.1. Summary of Actions

XCAP evaluated three alternatives, the Closure plus Mitigations, the Partial Underpass and the Viaduct for the Churchill Avenue rail crossing.³⁴

XCAP voted to recommend Closure with Mitigations on 9/2/20 by a 6-to-3 vote (No: Phil Burton, Nadia Naik, Keith Reckdahl). XCAP then had two subsequent votes to define the mitigations and a preference for a Bike/pedestrian option. One that identified mitigations in addition to what the consultants proposed, passed on 9/16/20 by a 7-0-2 vote (Abstained: Phil Burton, Tony Carrasco).³⁵ Of the two alternatives for Bike/pedestrian designs, XCAP voted on 9/16/20 7-0-2 vote (Abstained: Phil Burton, Tony Carrasco)³⁶ to recommend Option 2 Bike/pedestrian alternative for the Churchill Closure, which calls for a bicycle/pedestrian tunnel that runs down the middle of Churchill east of Alma Street and then proceeds under Alma and the railroad tracks.

The Recommendations, Majority and Minority Positions and suggestions for future areas of study are in the latter part of this Chapter. If the Council decides to pursue either the Partial Underpass or the Viaduct alternative instead, XCAP has also made suggestions on potential improvements and areas of future study.

Fact Sheets for Churchill are available in Appendix A-1 Fact Sheets, renderings are available in Appendix A-2 Renderings and Plans and animations and exhibits used for the Virtual Town Hall are available in Appendix A-5 Links to Animations and Virtual Town Hall.

Note for the Reader: Colloquially, Palo Altans refer to Caltrain as traveling North/South. Similarly, Alma Street is considered to run North/South where Old Palo Alto and Professorville are considered East of Alma and Palo Alto High School, Southgate and Evergreen Park are considered West of Alma. When looking at a map, however, Caltrain and Alma generally run from Northwest to Southeast. All references to North, South, East and West in this report refer to the colloquial direction, and all images created by the consultants have an arrow in the lower right corner showing true North.

4.1.1. Closure with Mitigations

This alternative considers closing Churchill to vehicular traffic across the railroad tracks and introducing mitigations at Embarcadero Road and Page Mill/Oregon Expressway to handle traffic diverted from the closed Churchill intersection. In this alternative, the railroad tracks

³⁴ See Appendix C-5 2020-09-02 XCAP Meeting Agenda-Preso-Summary

³⁵ See pg. 5 of transcript in Appendix C-5 2020-09-09 XCAP Meeting Agenda-Preso-Summary

³⁶ See pg. 9 of transcript in Appendix C-5 2020-09-16 XCAP Meeting Agenda-Preso-Summary

would remain at their existing location and elevation. A separate tunnel would be provided for pedestrians and cyclists to cross Alma at Churchill, enabling access to and from Palo Alto High School, Stanford University, and points beyond.

Churchill Avenue would become a T-intersection with Alma Street on the east side and would end at Mariposa Avenue on the west side. Two options for the Churchill Bike/pedestrian undercrossing were studied.

4.1.1.1. Closure Option 1

The first option would allow bikes and pedestrians on the east side of Alma to use a call button to activate a traffic signal to go across Alma and then descend a ramp that would run alongside the train tracks, going under the tracks and emerging on the other side of the tracks via another ramp running alongside the rail right of way. In this option, similar to the condition today, bikes and pedestrians would cluster at the intersection waiting for the crosswalk signal.



**Proposed Churchill Avenue Undercrossing Concept - Option 1
- Looking North**



Proposed Churchill Avenue Undercrossing Concept Overview - Option 1

4.1.1.2. Closure Option 2

The second option would provide a straight path running down the center of Churchill Avenue under both Alma and the rail tracks, with vehicle traffic allowed on either side of the entrance to the ramps along the east side. There would be complete separation of vehicle traffic from cyclists and pedestrians, eliminating the need for bicycles/pedestrians to wait for traffic at Alma.



Proposed Churchill Avenue Undercrossing Concept - Option 2
- Looking West



Proposed Churchill Avenue Undercrossing Concept Overview - Option 2

More detailed information about the Bike/Pedestrian tunnels is available in Appendix A-4-5 Churchill Pedestrian Tunnel Info.

4.1.1.3. Additional Mitigations

As part of this alternative, the City would also construct several intersection improvements in order to mitigate the anticipated diversion in traffic resulting from the closure. These improvements would be constructed and funded as part of the overall project. They include:

- A. Construction of a bike/pedestrian overcrossing at Embarcadero Road and Alma Street.
- B. Reconstructing or replacing the existing Alma Street overpass over Embarcadero Road.
- C. Adding a right turn lane from eastbound Embarcadero Road to Kingsley Avenue.
- D. Adding a left turn lane from southbound Alma Street to Kingsley Avenue.
- E. Installation of two new signal lights on the Alma Street overpass at Embarcadero Road, at the Embarcadero slip road and at Kingsley Avenue.
- F. Installing a new signal at Embarcadero Road/Kingsley Avenue/High Street with two possible options: one that provides full connectivity to and from High Street, or an option that maintains the movements to and from High Street as they are today.
- G. Improvements at Embarcadero Road/High Street for bicycles and pedestrians per the Neighborhood Traffic Safety and Bicycle Boulevard (NTSBB) projects plans.³⁷
- H. Optimize signal timing at El Camino and Embarcadero and install an additional westbound left turn lane on Embarcadero onto El Camino and northbound right turn lane on El Camino onto Embarcadero Road.
- I. Signalize on Alma Street both on/off ramps at Alma and Oregon Expressway.
- J. Optimize signal timing and install a westbound right turn lane and northbound right turn lane from Oregon Expressway to El Camino Real.

These mitigations are visible in the figures below. Figure 8 shows Mitigations A through G, Figure 9 shows Mitigation H, Figure 11 shows Mitigation I and Figure 10 shows Mitigation J.

³⁷ The Neighborhood Traffic Safety and Bicycle Boulevard (NTSBB) page:
https://www.cityofpaloalto.org/gov/depts/trn/bicycling_n_walking/ntsbb.asp



Figure 8
Embarcadero/High/Kingsley Improvements



Figure 9
El Camino Real and Embarcadero Road Improvements

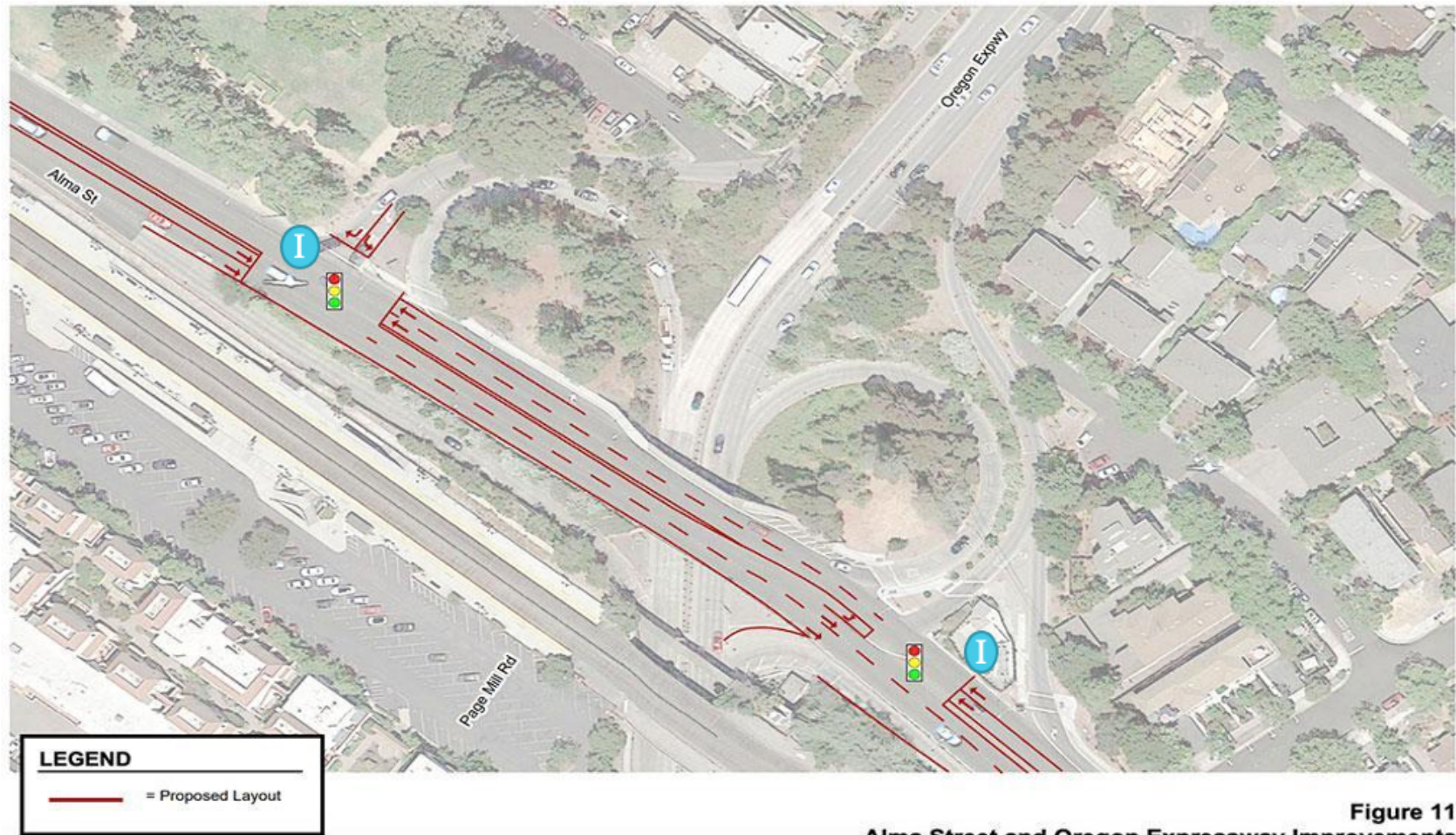
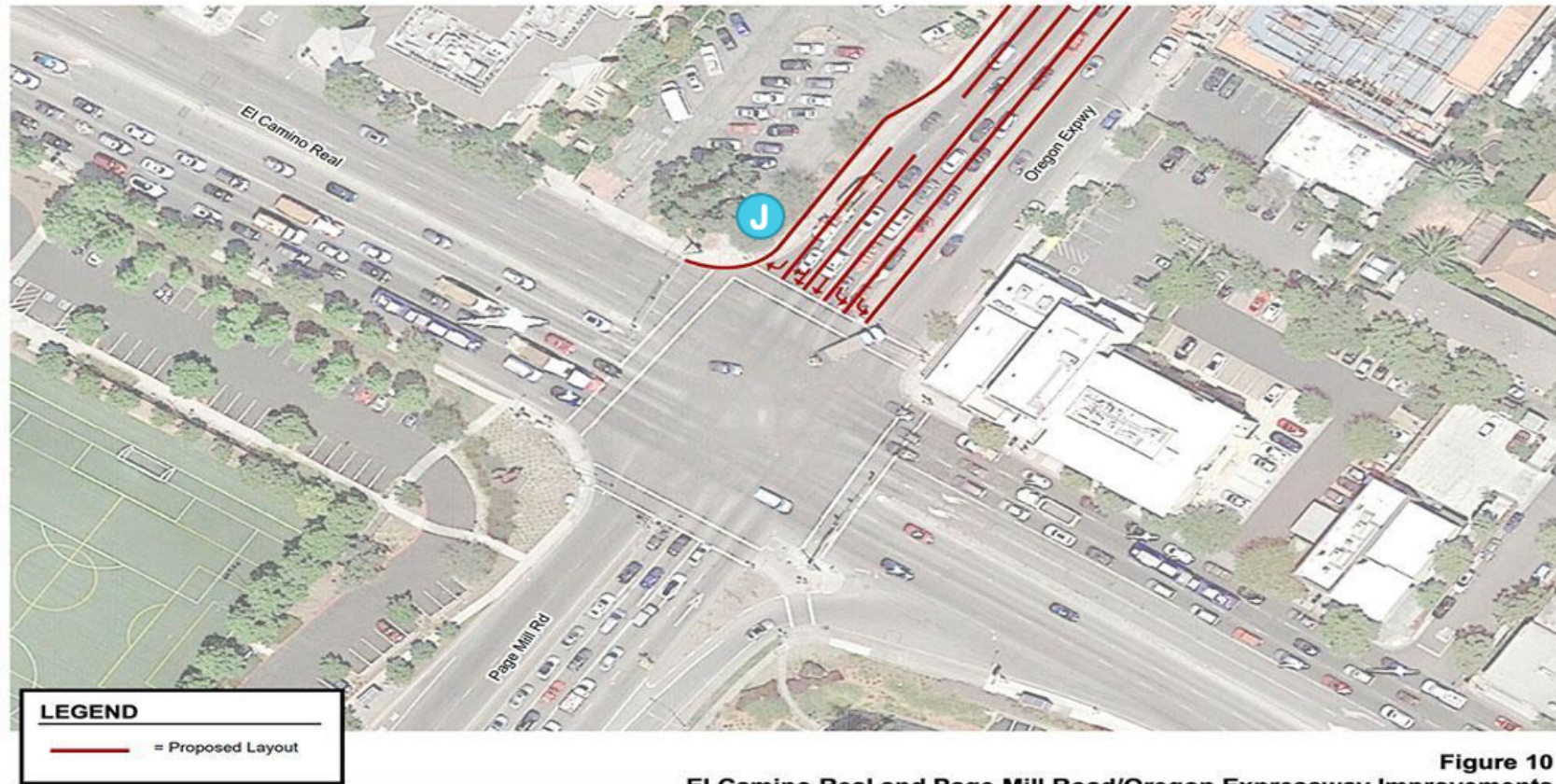


Figure 11
Alma Street and Oregon Expressway Improvements

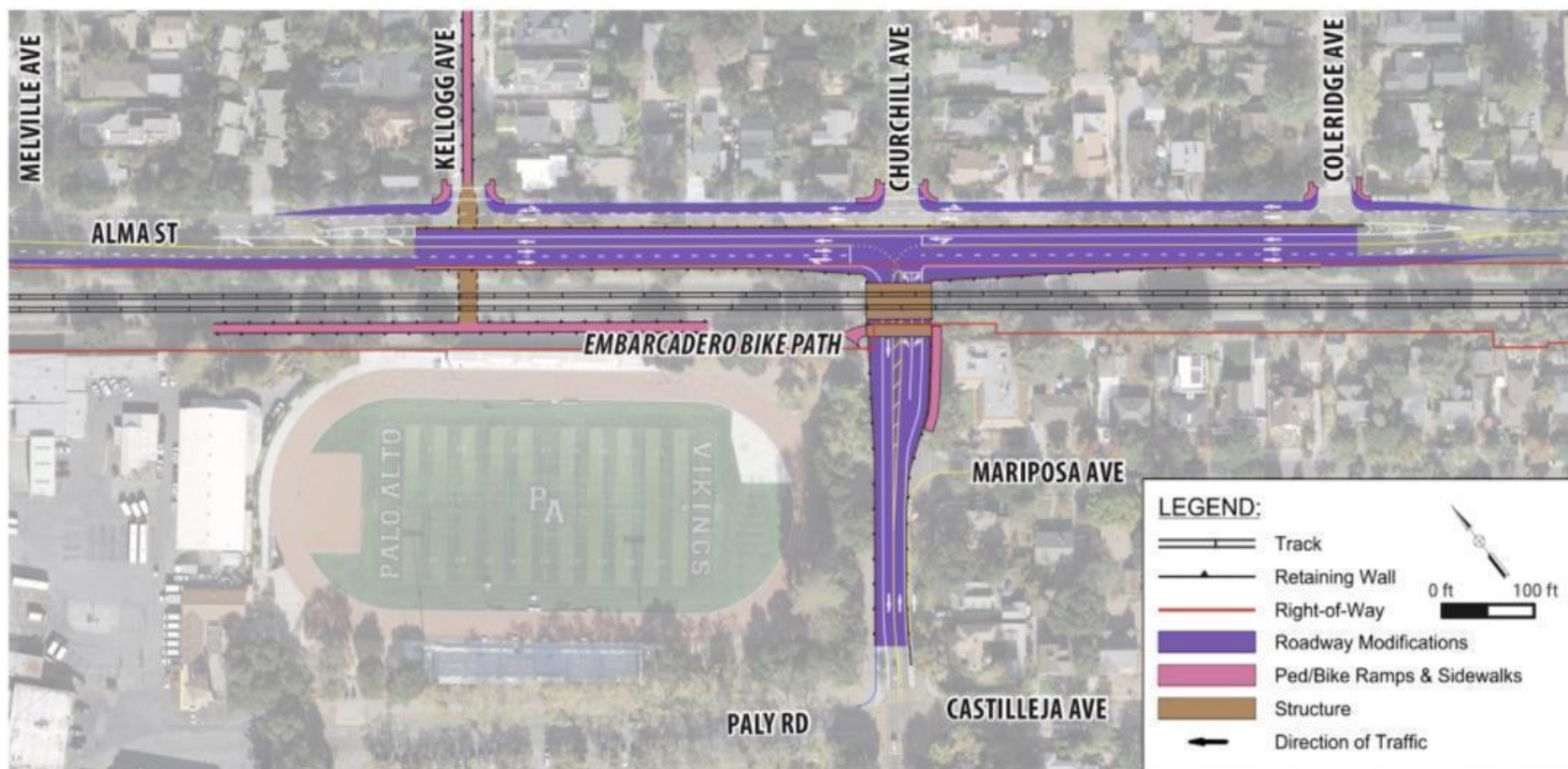


More detailed information about these mitigations is available in Section 4.4.4. Vehicular Traffic Moved Elsewhere Can Be Mitigated and on page 33 of the Traffic Study available in Appendix B-3-1 Final Traffic Study Hexagon.

Also see Appendix A-1 B Churchill Avenue Closure with Mitigations Fact Sheet for more information.

4.1.2. Partial Underpass

The Partial Underpass would separate Churchill Avenue from the current Caltrain tracks via an underpass. However, there would no longer be through traffic on Churchill Avenue east of Alma; instead, it would now form a T-intersection.



Churchill Avenue Partial Underpass Aerial (Plan)

Traffic on eastbound Churchill Avenue from the Palo Alto High School/Castilleja Avenue intersection would descend and pass under the railroad tracks, which would remain at their current grade. The down ramp would terminate at a lowered, signal-controlled, T-intersection at Alma Street where vehicles could make a left turn onto northbound Alma Street or a right turn onto southbound Alma Street, and then ascend and return to existing roadway grade along Alma Street. Thru traffic across Alma is prohibited.



View of Churchill Facing East



View of Churchill Facing West with View of Proposed Partial Underpass

Note: North Alma St. in foreground is at grade with a wall dividing it from Southbound Alma which is below grade at this point.



View of Alma Street Facing South with Palo Alto High School to the Right of the Train Tracks

Traffic on westbound Churchill Avenue would terminate at a T-intersection at Alma Street. Right turns only (onto northbound Alma Street) would be permitted. Similarly, westbound traffic on Kellogg Avenue and Coleridge Avenue approaching Alma Street would be permitted to make right turns only onto northbound Alma Street.

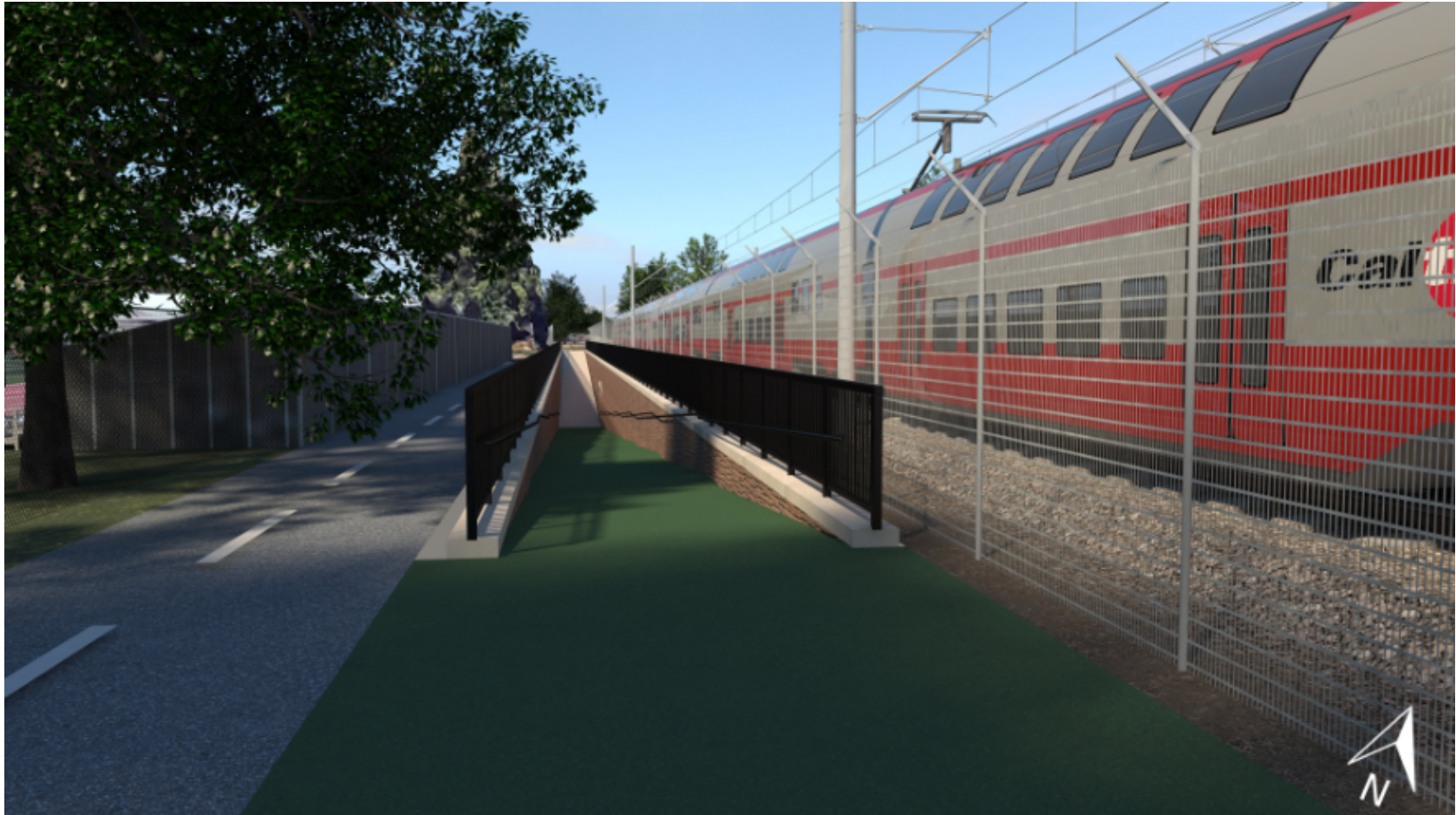
Traffic on southbound Alma Street would operate as it does today except left turns onto Kellogg Avenue, Churchill Avenue and Coleridge Avenue would not be permitted. The Caltrain tracks would be supported on a new rail bridge spanning a lowered Churchill Avenue at approximately its current location. A separate pedestrian/bicycle crossing would be provided at Kellogg Avenue. From westbound Kellogg Avenue, a 10-foot-wide path would descend at the center of the road, at which point it would widen to 20 feet and cross under both Alma Street and the Caltrain tracks, joining the Embarcadero Bike Path adjacent to Palo Alto High School.



Aerial View of Kellogg Avenue at Alma with Proposed Bike/Pedestrian Tunnel



Street Level View of Entrance to Proposed Kellogg Avenue Bike/Pedestrian Tunnel from Old Palo Alto



View of Bike/Pedestrian Tunnel from West Side of Tracks along the Palo Alto High School Bike Path

Please see Appendix A-1-C Churchill Partial Underpass Fact Sheet for more information.

4.1.3. Viaduct

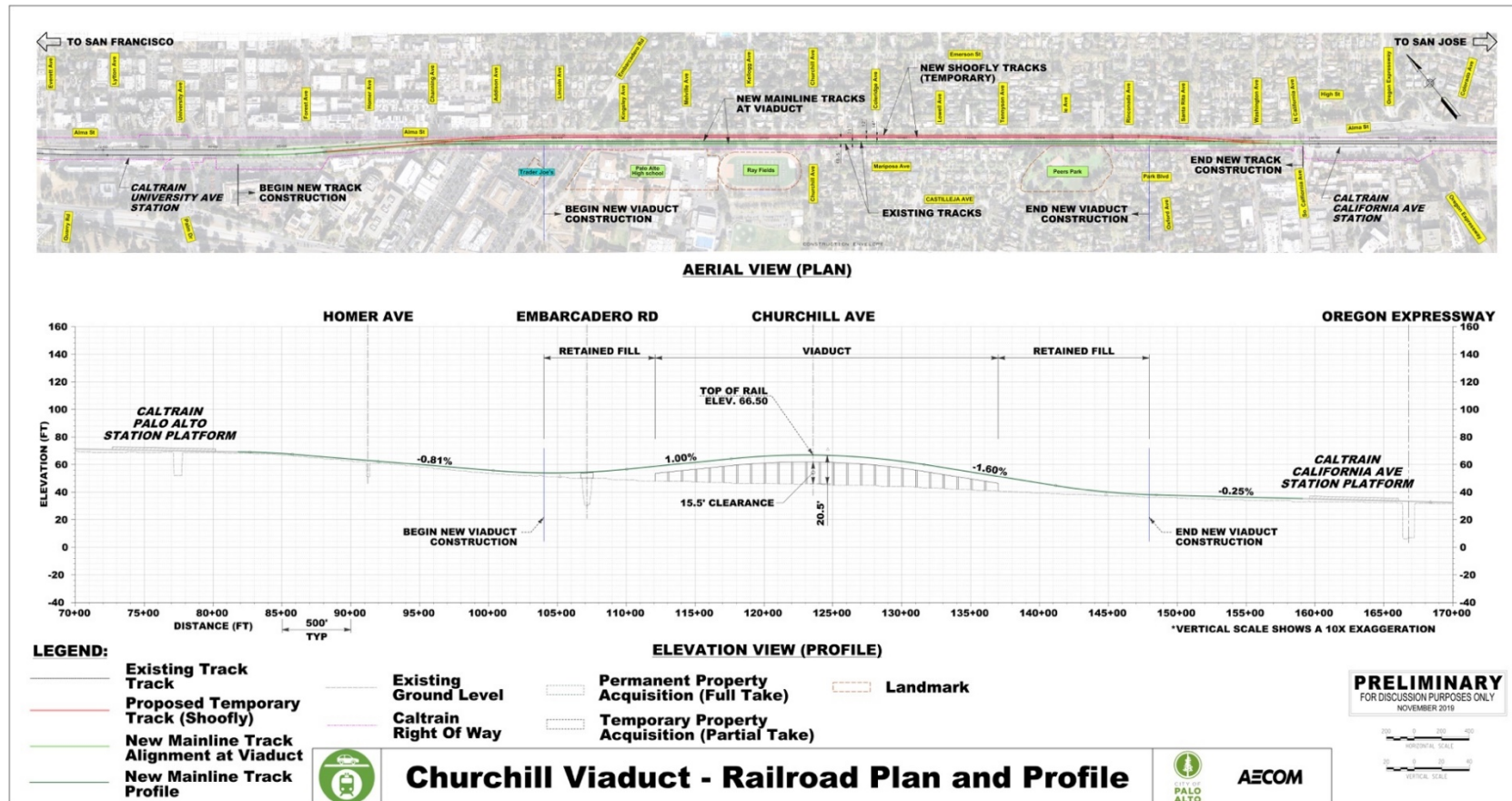
In this alternative the railroad tracks would be elevated on a structure, with the bottom of the structure about 15 feet above ground, (20 feet above ground to top of rail). The viaduct would be topped by six-foot sound wall barriers (parapets), plus an overhead contact system for electrical power that reaches a height of about 30 feet above the top of rail.



Proposed Ground Level View - Looking East
Churchill Avenue Intersection



**Churchill Viaduct on Viaduct Structure - Looking Southwest
(Churchill Avenue/Alma Street Intersection)**



The new electrified railroad tracks would be built at the same location as the existing railroad tracks and, going north to south, would begin rising near Homer Avenue, remain elevated over Churchill Avenue, and return to the existing track grade near the California Avenue Station. The Stanford game day station³⁸ would be eliminated. The roadway at Churchill Avenue would remain at its existing grade and have a similar configuration to what exists today. This design would require expanding the width of Churchill Avenue through the underpass of the railroad to accommodate a new column supporting the railroad structure.

Please see Appendix A-1-D Churchill Avenue Vicinity Viaduct Fact Sheet for more information.

4.2. Compared with City Council-Adopted Criteria

This section compares the alternatives with the city-council adopted criteria for grade separations.

4.2.1.1. Facilitate Movement across the Corridor for All Modes of Transportation

Under Closure with Mitigations, Churchill Avenue vehicular traffic will be somewhat impeded since traffic will be closed to vehicles at the railroad tracks. On the other hand, the movements of pedestrians and cyclists will be safer and more efficient as they will be grade separated from both the railroad and Alma vehicular traffic under Bike/Pedestrian Option 2.

In the Viaduct alternative, Churchill Avenue will be grade separated from the railroad for all modes and will remain open. The Viaduct thus would provide opportunities for additional traffic volumes for all modes.

With the Partial Underpass alternative, Churchill Avenue would be grade separated from the railroad for all modes and remain open, with the exception that through traffic on Churchill Avenue and various turns from and to Alma would no longer be possible. Thus, some vehicular traffic would have to take alternate routes.

4.2.1.2. Reduce Delay and Congestion for Vehicular Traffic at Rail Crossings

The Closure with Mitigations alternative will reduce delay and congestion and delay on Alma but will adversely affect nearby intersections. The mitigations described are intended to reduce these impacts.

Under the Viaduct alternative, rail-crossing-related delay and congestion is eliminated on Alma. No nearby streets would be negatively affected.

In the Partial Underpass alternative, rail-crossing-related delay and congestion on Alma would be eliminated, but certain turning movements to and from Alma would also be eliminated.

³⁸ AECOM's response re:Stanford Game Day Station in Appendix A-4-3 Staff Update: Follow Up to XCAP Criteria Questions 4-22-20

In all alternatives, the railroad crossing gates and warning lights at Churchill Avenue would be removed.

4.2.1.3. Support Continued Rail Operations and Caltrain Service Improvements

With the Viaduct alternative, the Stanford game day station would be eliminated.

4.2.1.4. Cost

Closure plus Mitigations is by far the lowest cost option at \$50 to \$65 million, where the cost comes primarily from the mitigations.

The Partial Underpass alternative is estimated to cost \$160-200 million, and the Viaduct is estimated to cost \$300-\$400 million.

4.2.1.5. Minimize Right-of-Way Acquisition

In both the Closure with Mitigations and Viaduct options, no acquisition of private properties would be required.

In the Closure with Mitigations alternative, there would likely be some minimal impacts to Palo Alto High School property. There could also be some parking loss on the east side of Churchill Avenue for the bike/pedestrian undercrossing (Option 2).

In the Partial Underpass alternative, driveway modifications would likely be required due to the removal of planting strips along Alma Street. Some minor “sliver” acquisition of the high school and/or residential properties fronting Churchill Avenue on the west side of the tracks might also be required. Most significantly, this option’s bike/pedestrian tunnel on Kellogg Avenue would require the elimination of on-street parking on both sides of Kellogg Avenue along the bike/pedestrian ramp for approximately 250-300 feet from Alma Street at an 8% grade. Two “sliver” acquisitions on the corners of Kellogg and Alma might also be required.

4.2.1.6. Reduce Rail Noise and Vibration

In all alternatives, train horn noise and crossing gate warning bells would be eliminated with the removal of the at-grade crossings. Eliminating these horn and bell sounds means that all alternatives will be at least 10 dBA quieter than the situation today.

Electric multiple unit (“EMU”) trains using electric motors, compared to the diesel engines of existing Caltrain trains, will also reduce noise. Note that freight trains running on the tracks will still retain their diesel engines.

In general, the Viaduct and the Partial Underpass would have slightly less noise than a Closure with Mitigations (a difference of about 3 dBA, which is considered barely perceptible)³⁹. If a six-foot-high noise barrier is added to the Closure with Mitigations, then it becomes equal to the others. However, if the Partial Underpass gets a noise barrier, it does significantly better (about 6 dBA difference).

The Viaduct would provide the most reduction of vibration impacts for homes on both the east and west sides of the track. The Closure with Mitigations would have no change in vibration impacts and the Partial Underpass would have little to no change.

4.2.1.7. Minimize Visual Changes along the Corridor

The Closure with Mitigations alternative, with the railroad tracks remaining at existing grade, produces the least visual change of the three alternatives. Residual roadway areas from closure would provide opportunities for landscaping and thus potentially enhance the viewscape when compared with current conditions.

The visual impact of the Viaduct option is the most significant of three options, with railroad tracks approximately 20 feet above the current grade and the trains and attendant structures such as electrical power line poles 30 feet higher. Landscaping with trees could be incorporated for screening where feasible. Depending on the vantage point, the Partial Underpass option would have an impact on views, primarily from the underpass structure itself. Also, mature trees within the Alma Street planting strip, from just north of Kellogg Avenue to just south of Coleridge Avenue, would be removed with landscaping restoration limited due to space constraints.

4.2.1.8. Minimize Disruption and Duration of Construction

Closure with Mitigations would be the least disruptive alternative, requiring only minimal road closures for the mitigations (nights/weekends only). Construction would last for approximately 2 years. It would also have minor noise and vibration impacts during construction.

The Viaduct alternative would require extended lane reductions at Alma Street (one lane in each direction) for the shoofly track. Construction would also last for approximately 2 years and would have moderate noise and vibration impacts.

The Partial Underpass would require closure of Churchill Avenue between Alma Street and Mariposa Avenue for the majority of its 2.5 to 3 years of construction. Alma Street would be one-way northbound for approximately 6+ months. There would be severe noise and vibration impacts during construction according to the noise report submitted to XCAP.⁴⁰

³⁹ From PDF page 7 of Appendix B-1-4 Noise and Vibration Comparative Analysis Report: "...it is widely accepted that people are able to begin to detect sound level increases of 3 dB in typical noisy environments. Further, a 5-dB increase is generally perceived as a distinctly noticeable increase, and a 10-dB increase is generally perceived as a doubling of loudness. Therefore, a doubling of sound energy (e.g., doubling the volume of traffic on a highway) that would result in a 3-dB increase in sound level, would generally be perceived as barely detectable."

⁴⁰ See Appendix B-1-4 Noise and Vibration Comparative Analysis Report

With the Closure plus Mitigations alternative, no temporary railroad track (“shoofly”) will be required. With the Partial Underpass alternative, a shoofly is likely to be required unless an alternate construction methodology and sequencing is acceptable to Caltrain. With the Viaduct alternative, a shoofly is required.

A shoofly track increases the time of construction and the cost of the project.

4.2.2. Additional Considerations

4.2.2.1. Creek/Drainage Impacts

There is no creek in the vicinity of Churchill, so the only considerations are related to drainage impacts.

The Closure plus Mitigations alternative would require a pump station for the bike/pedestrian undercrossing. Also, the pump station at Embarcadero Road would require relocation to accommodate the widening of Alma Street, as proposed in the mitigations.

Similarly, a pump station would be required for the Partial Underpass, to service both its lowered roadway and proposed bike/pedestrian undercrossing.

The Viaduct alternative would have no significant drainage impacts.

4.2.2.2. Long-Term Maintenance

Long term maintenance involves maintaining additional structures built as part of any proposed alternatives. These include the above and below-grade rail and roadway structures and also pumping system facilities that are required for groundwater pumping.

For the Viaduct, the structures that will be built to provide above grade railroad and embankments will require long term maintenance. Similarly, for the Partial Underpass, the road and rail-related structural components will also require long term maintenance.

The Closure Alternative options provide for below-ground pedestrian passageways/tunnels. Also, for the Partial Underpass alternative, the road will be depressed below the railroad structure to accommodate adequate vehicular clearance. Due to high groundwater conditions in the area, the pumping facilities and related structures will be required for these alternatives. Therefore, these alternatives will require long-term maintenance of such pumping facilities and structures.

4.2.2.3. Utility Relocations

The Viaduct option has minimal impacts to utilities.

For the Closure plus Mitigations option, there could be minor utility relocations due to Embarcadero/Alma Street improvements. The potential exists for utility relocations due to the bike/pedestrian undercrossing.

The Partial Underpass option would require major utility relocations because of its lowered roadways.

4.2.2.4. Local Street Circulation Impacts during Construction

Areas in/around the construction areas will be impacted during construction.

For the Closure plus Mitigations option, these would be:

- The path along Palo Alto High School would temporarily be impacted during construction.
- Temporary night and weekend closures of lanes on Churchill Avenue, Alma Street, El Camino Real, Oregon Expressway, and Embarcadero Road.

For the Viaduct option:

- Alma Street reduced to one lane in each direction.
- Removal of right turn lane on southbound Alma Street at Churchill Avenue.
- Temporary night and weekend closures of lanes on Alma Street and Churchill Avenue.

For the Partial Underpass option:

- Lane reduction on Alma Street during construction.
- Likely closure of Churchill Avenue throughout the excavation and construction of the undercrossing and related features.
- Likely closure of Kellogg Avenue for the duration of the bike/pedestrian underpass construction; residential driveway access from one direction only.

The longer it takes to build any of these projects, the more complicated future construction impacts will be due to increased traffic and trains.

4.2.2.5. Caltrain Right-of-Way Impact

The City of Palo Alto would need to negotiate with Caltrain if any encroachment into their right of way is needed and the probability of approval by Caltrain is unknown at this time.

The Closure plus Mitigations option, requires permanent encroachment inside Caltrain's right-of-way for the pedestrian/bike ramps for undercrossing Option 1.

The Viaduct option requires no permanent encroachment inside Caltrain's right-of-way. However, options of a linear park or dual use under the viaduct would require Caltrain approval.

The Partial Underpass design requires permanent encroachment inside Caltrain's right-of-way for the pedestrian/bike ramps (to the undercrossing at Kellogg Ave) and for the lanes/shoulders for southbound Alma Street.

4.2.2.6. Caltrain Design Exceptions Needed

The Closure plus Mitigations and Partial Underpass options do not require any Caltrain design exceptions. The Viaduct option requires a 1.6% vertical grade, whereas the current maximum grade allowed by Caltrain design standards is 1%.

4.2.3. Traffic Studies

The traffic impact of the alternatives has been extensively studied by AECOM's consultant, Hexagon Transportation Consultants, which built upon results from previous consultants, TJKM.^{41 42} Analyses were performed under existing traffic conditions and projected conditions in 2030. They also examined potential mitigations and their projected effects on level of service at various intersections.

⁴¹ Appendix B-3-1 Final Traffic Study Hexagon

⁴² Appendix B-3-2 DRAFT Traffic Study- TJKM - Draft Traffic Impact Study Report - Churchill Ave Closure (Aug 2019)

Analyses of the Closure plus Mitigations, Viaduct, Partial Underpass options showed results summarized in the tables below:

Table 1

Alma and Churchill Grade Separation Alternatives – Existing Traffic Volumes

	Traffic Operations (Existing Traffic Volumes)															
	No Improvements (No Electrification) ¹								Churchill Closure ²				Viaduct ³			
	AM				PM				AM		PM		AM		PM	
	Delay (secs)		LOS		Delay (secs)		LOS		Delay (secs)		Delay (secs)		Delay (secs)		Delay (secs)	
Alma Street & Churchill Avenue	88.9	F			66.67	E			23.58	C	28.23	C	45.39	D	42.73	D
															15.62	B
															21.66	C

Notes:-

1. All turning movements permitted. Analysis assumes 8 trains per hour under existing conditions. Traffic analysis was conducted using PTV Vissim software.
2. The following turning movements would not be possible;- left-turn, right-turn and through traffic from eastbound Churchill, through traffic from westbound Churchill, northbound left-turns and southbound right-turn from Alma. Traffic analysis was conducted using PTV Vissim software.
3. All turning movements permitted. Traffic analysis was conducted using PTV Vissim software.
4. The following turning movements would not be possible;- eastbound and westbound through traffic on Churchill Avenue across Alma Street, left-turn from westbound Churchill, and left-turn from southbound Alma. Traffic analysis was conducted using SimTraffic.

Table 2

Alma and Churchill Grade Separation Alternatives – Future Traffic Volumes

	Traffic Operations (Year 2030 Traffic Volumes)															
	No Improvements (No Electrification) ¹								No Improvements (With Electrification) ²							
	AM				PM				AM		PM			Churchill Closure ³		
	AM		PM		AM		PM		AM		PM		Viaduct ⁴		Partial Underpass ⁵	
	Delay (secs)		LOS		Delay (secs)		LOS		Delay (secs)		LOS		Delay (secs)		LOS	
Alma Street & Churchill Avenue	118.5	F			90	F			173.5	F	178.5	F	25.1	C	30.6	C
													48.4	D	56.77	E
															15.65	B
															30.97	C

Notes:-

1. All turning movements permitted. Analysis assumes 8 trains per hour with no electrification. Traffic analysis was conducted using PTV Vissim software.
2. All turning movements permitted. Analysis assumes 14 trains per hour with electrification. Traffic analysis was conducted using PTV Vissim software.
3. The following turning movements would not be possible;- left-turn, right-turn and through traffic from eastbound Churchill, through traffic from westbound Churchill, northbound left-turns and southbound right-turn from Alma. Traffic analysis was conducted using PTV Vissim software.
4. All turning movements permitted. Traffic analysis was conducted using PTV Vissim software.
5. The following turning movements would not be possible;- eastbound and westbound through traffic on Churchill Avenue across Alma Street, left-turn from westbound Churchill, and left-turn from southbound Alma. Traffic analysis was conducted using SimTraffic.

Traffic conditions at the study intersections were evaluated using Level of Service (LOS). Level of service is a qualitative description of operating conditions ranging from LOS A, or free-flow conditions with little or no delay, to LOS F, or jammed conditions with excessive delays. The acceptable LOS in the City of Palo Alto is LOS D or better for signalized and unsignalized intersections.⁴³

As Table 1 shows, under existing conditions, both the Closure plus Mitigations and the Partial Underpass options result in improvements at Alma/Churchill from today's conditions, raising LOS in the AM and PM from F and E to Cs in the Closure plus Mitigations option, and to B and C in the Partial Underpass option, respectively. The Viaduct option trails slightly at LOS of Ds for both AM and PM.

As Table 2 shows, in 2030, when Electrification is completed but if no improvements are made, the LOS at Alma/Churchill remains an F, but with even more delay, resulting in unclearable queues. Of the three alternatives, Partial Underpass provides the best LOS, with Closure plus Mitigations next and Viaduct last. The Viaduct has the worst LOS at Alma/Churchill because it serves all traffic movements, rather than divert cars to other intersections.

In the Viaduct and Partial Underpass options, some XCAP members noted that if flow were not impeded by the train crossing, the traffic on Churchill might increase due to induced flow attracted by the lack of a train crossing, increasing the possibility of traffic backups in the small section of Churchill between Alma and El Camino. This was not studied by the consultant. Some XCAP members desired more work should be done in this area, but the consultant disagreed.

In addition, further studies are desired by XCAP members to examine the impacts and potential mitigations of bicycle and pedestrian traffic. (see Section 4.3 Recommendations)

4.2.4. Other Information

4.2.4.1. Palo Alto Unified School District (PAUSD)

Letter from PAUSD, dated February 26, 2020:

The Palo Alto Unified School District (PAUSD) has not taken an official position regarding proposed options to mitigate increased rail traffic. Additional details regarding PAUSD usage of the intersection with vehicles, student distractions, and other discussion can be found in the full memo in Appendix B-9 Palo Alto Unified School District Letter 1.

Letter from PAUSD, dated December 7, 2020:

PAUSD asked to participate in any further future review (see Appendix B-9 Palo Alto Unified School District Letter 2).

⁴³ From Introduction of Traffic Study available in Appendix B-3-1 Final Traffic Study Hexagon

4.2.4.2. Palo Alto Council of Parent Teacher Associations (PTAC)

The Palo Alto Council of Parent Teacher Associations (PTAC) submitted a letter on January 18th, 2021 (after XCAP had completed its deliberations) saying that as “one of the key partners of the Safe Routes to School (SRTS) program, PTAC has not had a chance to fully participate in any designs or decisions” and have asked to “work with Staff on future designs of the grade separation projects and any mitigations...” See Appendix B-11 PTA Council.

4.2.4.3. Palo Alto Fire Department

Memo from Palo Alto Fire Department, dated October 30, 2019:

“The data available clearly indicate that only a very small number of incidents (probably fewer than 0.5%, city-wide) will be affected by the closure [of Churchill]. Response time delays for these few incidents may be on the order of a minute or more.”

Full letter in Appendix B-7 Police and Fire Department Letters.

4.2.4.4. Palo Alto Police Department

Memo from Palo Alto Police Department, dated October 30, 2019:

“The Police Department recognizes the local and regional importance of this project and will be able to successfully adapt their responses to whichever option is ultimately selected.”

Full letter in Appendix B-7 Police and Fire Department Letters.

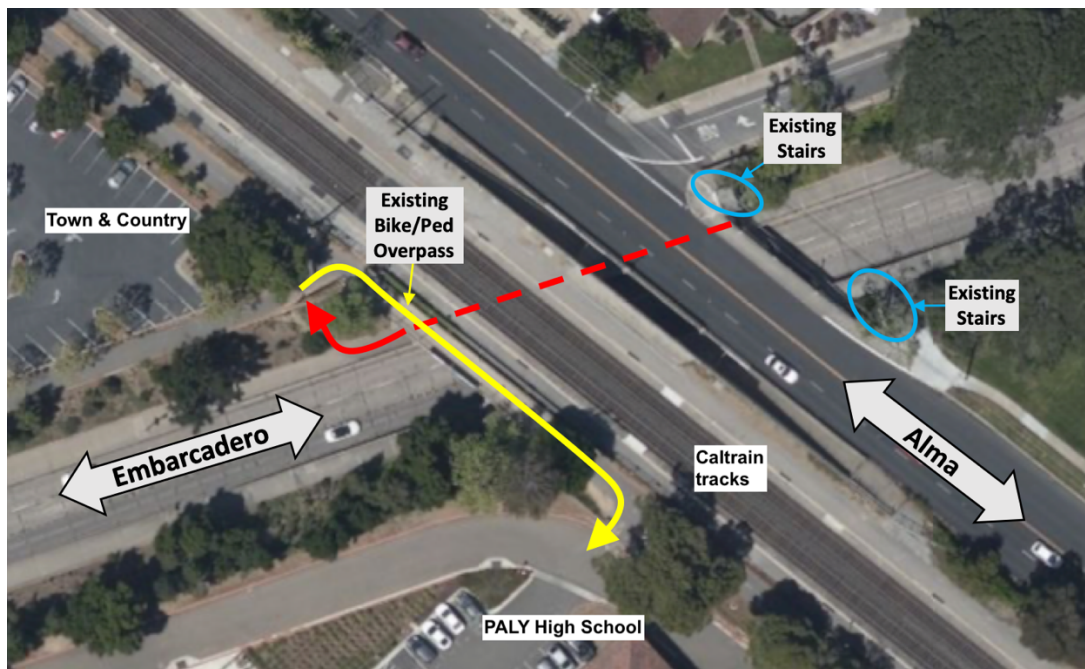
4.3. Recommendations

Six XCAP members voted to recommend Closure with mitigations to the City Council as the preferred alternative for the Churchill grade separation (No votes: Phil Burton, Keith Reckdahl and Nadia Naik). More information about the Majority and Minority positions is in the next section.

The mitigations proposed by the consultants are early conceptual designs, not final plans. In a follow-on motion, XCAP voted for additional mitigations and areas of study if Council selects the Closure alternative. XCAP voted 7-0-2 (Abstain: Tony Carrasco and Phil Burton) for the following additional mitigations:

- Mitigations should include the 2016 Bike Project and evaluate impacts to El Camino and Embarcadero and Embarcadero/Emerson/High Streets and along both sides of Embarcadero (see: Appendix B-14 Embarcadero and El Camino Rail Corridor Study) (approved but removed from the Capital Improvement Program due to COVID - has been pushed out past the 5-year timeline).
- Unofficial student pick-up/drop off locations along Embarcadero slip road and possible safety mitigations needed if more cars travel on that road.

- Embarcadero intersection should be revisited when alternatives for Palo Alto Avenue and Downtown are selected.
- Lincoln/Kingsley/High/Embarcadero multi-way intersection issue needs to be addressed to reduce neighborhood through traffic.
- Consider working with Town & Country on reducing congestion on Embarcadero/El Camino.
- Review proposed Pedestrian overpass over Embarcadero for safety issues (Mitigation A in Figure 8)
- Consider creating a comprehensive bike/pedestrian connection plan.
- Bike/pedestrian path at Seale before building the Churchill bike/pedestrian to allow safe crossing during construction (and how that might be used for phasing a closure).
(Note: bike/pedestrian path is consistent with park use and can be done on dedicated park land).
- Study whether Park Blvd should be reopened between Southgate and Evergreen Park. Consider testing an opening. Neighborhood outreach is critical.
- Consider mitigations (ex. stairs) for the northwest corner of the Embarcadero grade separation, where westbound foot traffic (represented by the red arrow) on the north side of Embarcadero Road travels under the grade separation and then up through landscaping on the northwest embankment towards Town & Country, with many continuing to Palo Alto High School by looping across Embarcadero using the Embarcadero bike/pedestrian bridge adjacent to the railroad tracks (represented by the yellow arrow).



- Consider a traffic signal at North California/Alma to have fewer cars along Churchill and to provide a signalized left out of Old Palo Alto.

Of the choice between Bike/Pedestrian Option 1 or Option 2 (which fully grade-separates bikes/pedestrians from both Alma and Caltrain), XCAP voted in a follow-on motion 7-0-2 (Abstain: Tony Carrasco and Phil Burton) for Option 2 with the following general potential mitigations:

4.3.1.1. Add Bike/Pedestrian Crossing at Seale

- Recommended in the Rail Corridor Plan.
- Adds a bike/pedestrian crossing that can be built while mitigations are being built.
- Would provide a more direct Safe Route to School for Greene and Walter Hays from West of Alma and for Palo Alto High School from students West of Alma and South of Churchill.
- Reduces bike traffic on congested California Avenue bike/pedestrian tunnel and on Churchill tunnel.
- Bikes on the west side of tracks end up on Park Blvd which is a bike path.
- Alternatives for Seale design could be center of the road or property acquisition to create bike/pedestrian ramps to separate from Alma and tracks.

4.3.1.2. Bike/Pedestrian Option 2

- Explore closing Churchill to cars on the East side between Alma and Emerson - only homeowners and their guests would use the road. Residents would enter/exit Churchill from Emerson Street. Explore need and possibility for a turn-around at the end of resulting cul-de-sac.
- Consider the effect of changes on moving trucks, garbage trucks, emergency vehicles, etc. on an altered Churchill Avenue block. Consider any traffic implications including any additional traffic onto Embarcadero.
- Explore use of the area from curb and landscaping between curb and sidewalk on both sides of Churchill Avenue to enable an increase in width of ramp.
- Explore flatter, wider, taller, and fully lit crossing with increased sightlines. Consider moving the entry to ramp further back from Alma to decrease ramp grade.

The main reasons the group preferred Option 2 is the increased safety for bikes and pedestrians resulting from entirely grade separating them from both Alma and the tracks. In addition, there is no queuing from bikes gathering at a traffic signal, which leads to faster bike/pedestrian connections, significantly improving east/west connectivity.

Member Burton abstained because he did not support the Closure and Member Carrasco thought all bike designs needed to be re-conceptualized because both designs were unacceptable since they have tunnels, and he prefers at-grade bike/pedestrian alternatives.

4.4. Majority Position

Six XCAP members voted to recommend the Closure of Churchill for the following reasons for the following 5 key reasons:

1. Lowest cost option
2. Minimal aesthetic Impacts
3. Minimize construction time
4. Vehicular traffic moved elsewhere can be mitigated
5. Safer experience for bicycle and pedestrians

4.4.1. Lowest Cost Option

Closure with Mitigations is by far the lowest cost option, estimated at \$50-65M. The Partial Underpass option is estimated at \$160-200M, and the Viaduct option is estimated at higher still costs of \$300-400M. The likelihood of achieving a funding goal is maximized when the amount sought is minimized.

The Majority felt that additional expenditure of public funds to further study the Partial Underpass is not justified since the Partial Underpass is already an expensive alternative that is unlikely to be improved with additional design iteration. In addition, the Minority's no vote on this motion seems rooted more in their support for further study rather than their belief that the Partial Underpass is actually a superior alternative.

4.4.2. Minimal Aesthetic Impacts

The Closure plus Mitigations option minimizes visual changes of the surroundings. There are no large structures being constructed. The bike/pedestrian underpass will create a new below ground structure, although much smaller in visual impact than a structure that serves vehicles. Proposed mitigations at Embarcadero will result in modifications in lane designations, improved accommodations for cyclists and pedestrians, and new traffic signals, but do not include the construction of large structures nor large modifications of existing structures.

On the other hand, both the Viaduct and Partial Underpass options will have much greater visual impact and resulting controversy.

The Viaduct option will introduce a new above-ground structure that runs for some length, visible from Embarcadero to some point beyond Churchill Ave. Those who own houses with their backyards adjacent to the train tracks will experience a structure with a train running on it over 40 feet in the air. Because of the width of the rail corridor near Churchill, the viaduct would be constructed only a few feet from property lines, increasing the impact on the nearby properties.

During construction, there would be additional visual impact with temporary, shoofly tracks running on Alma Street with Alma Street narrowed down to two lanes, one in each direction.

The Partial Underpass, while below ground, would also create a large concrete structure whose roadways are more complicated than a simple underpass, due to a design that preserves some of its turns and not others. There would be concrete retaining walls arranged to support the proposed turning movements and roadways.

During construction, the Partial Underpass would also require temporary shoofly tracks running on Alma Street, and a subsequent lane reduction on Alma. Both of these changes will result in visual impacts during construction.

4.4.3. Minimized Construction Time

Along with the Viaduct option, the Closure plus Mitigation option has the least amount of construction time at approximately 2 years, thus minimizing any disruption to traffic and the community. In contrast, the construction time for the Partial Underpass is estimated to be greater at 2.5 to 3 years.

4.4.4. Vehicular Traffic Moved Elsewhere Can Be Mitigated

As previously discussed in the Traffic Studies section in this chapter, the vehicular traffic diverted to other roadways by the closure of Churchill can be successfully mitigated, if not improved in service level.

Mitigations were examined by traffic consultant Hexagon at seven different intersections where traffic was projected to be rerouted. Details of currently proposed mitigations can be found in Hexagon's report available in Appendix B-3 Traffic Studies and Presentations - Final Traffic Study - Hexagon Traffic Consultants.

******The following information is directly from the Traffic Study except where noted******

Figure 8 below is a rendering⁴⁴ of the proposed mitigations:



Figure 8
Embarcadero/High/Kingsley Improvements

⁴⁴ Appendix B Final Traffic Study - Hexagon Traffic Consultants - Analysis of Churchill, Meadow and Charleston Grade Separation (Final Aug 2020). Figure 8, page 51.

A summary of projected results of the mitigations, and the affected intersections, is shown in Table 5 ⁴⁵ below:

Table 5
Churchill Closure – Mitigated Intersection Levels of Service under Existing Conditions

			Churchill Closure - Existing Conditions					
#	Intersection	Peak Hour	No Improvements			With Improvements		
			Traffic Control	Avg. Delay (sec.)	LOS	Traffic Control	Avg. Delay (sec.)	LOS
1	Alma Street & Lincoln Avenue	AM	One-Way	>=50	F	One-Way	5.7	A
		PM	Stop	>=50	F	Stop	21.1	C
2	Alma Street & Embarcadero Road	AM	One-Way	>=50	F	Signal	4.8	A
		PM	Stop	>=50	F	Signal	3.0	A
3	Alma Street & Kingsley Avenue	AM	One-Way	>=50	F	Signal	13.3	B
		PM	Stop	>=50	F	Signal	18.3	B
4	El Camino Real/Embarcadero Rd*	AM	Signal	>80	F	Signal	67.1	E
		PM	Signal	>80	F	Signal	61.1	E
5	El Camino Real/Oregon Expwy-Page Mill Rd*	AM	Signal	>80	F	Signal	72.5	E
		PM	Signal	>80	F	Signal	73.5	E
6A	Alma St & Oregon Expwy WB Off Ramp (Oregon Ave)	AM	One-Way	>=50	F	Signal	6	A
		PM	Stop	>=50	F	Signal	6.7	A
6B	Alma St & Oregon Expwy EB Off Ramp	AM	One-Way	>=50	F	Signal	17.9	B
		PM	Stop	>=50	F	Signal	16.0	B
Notes:								
1. Average delay is reported for the worst approach at one-way stop intersections.								
2. Bold indicates substandard intersection level of service.								

⁴⁵ Ibid., Table 5 page 49.

XCAP notes the four existing intersections with STOP signs were analyzed in the traffic study. These intersections were assigned LOS F due to heavy delays experienced on the side streets. In the above chart, Intersections 2, 3, 6a and 6b change from STOP signs to traffic signals. Intersection 1 changes from a STOP sign to a right-turn-only STOP sign. The proposed changes at these intersections indicate improvement to LOS for existing and 2030 traffic conditions.

4.4.4.1. Alma Street Intersections (No. 1, 2 and 3)

With the closure of Churchill Avenue, some traffic would be rerouted to Embarcadero Road. However, the connections for some of the turning movements between Alma Street and Embarcadero Road are circuitous. Traffic from Alma Street that wants to head west on Embarcadero Road must use Lincoln Avenue to Emerson Street. Due to the close spacing, intersections 1, 2 and 3 could be mitigated as a group with the following recommendations (shown in Figure 8).

- Restrict the intersection of Alma Street/Lincoln Street to right-in/right-out only movements.
- Divert left-turning traffic off of Lincoln Avenue by adding a left-turn lane to the Embarcadero Road slip ramp to facilitate left-turns onto Alma Street.
- Install traffic signals at the Alma Street/Embarcadero Road slip ramp and Alma Street/Kingsley Avenue with one controller.
- Install a traffic signal at the Embarcadero Road/Kingsley Avenue intersection to allow left- turns from Kingsley Street onto westbound Embarcadero Road.
- Provide a 75 to 100-foot left-turn pocket on southbound Alma Street at Kingsley Avenue.
- Provide two northbound travel lanes on northbound Alma Street at Kingsley Avenue.

Providing two northbound travel lanes on Alma Street at Kingsley Avenue would require widening of the Alma Street bridge over Embarcadero Road, as the existing width of the bridge can only accommodate three travel lanes on Alma Street. Widening would require extensive modification or potential replacement of the existing bridge structure. No additional right-of-way is needed on Alma Street, south of Embarcadero Road.

These improvements would provide a direct connection between Alma Street and Embarcadero Road. Diverted traffic from southbound Alma Street would not have to use local streets to access Embarcadero Road. In addition, existing traffic on northbound Alma Street would no longer have to go around the block (Lincoln to Emerson) to travel west on Embarcadero. This traffic on Alma would make a right-turn at Kingsley and a left-turn at the proposed traffic signal at Embarcadero Road.

With the proposed improvements, the analysis shows that intersections 1, 2 and 3 would operate at acceptable levels of service during the AM and PM peak hours under existing (see Table 5) and Year 2030 traffic volumes (see Table 6).

Table 6
Churchill Closure – Mitigated Intersection Levels of Service under Year 2030 Conditions

#	Intersection	Peak Hour	Churchill Closure - Year 2030 Conditions					
			No Improvements			With Improvements		
			Traffic Control	Avg. Delay (sec.)	LOS	Traffic Control	Avg. Delay (sec.)	LOS
1	Alma Street & Lincoln Avenue	AM	One-Way	>=50	F	One-Way	14.4	B
		PM	Stop	>=50	F	Stop	15.2	C
2	Alma Street & Embarcadero Road	AM	One-Way	>=50	F	Signal	4	A
		PM	Stop	>=50	F	Signal	3.6	A
3	Alma Street & Kingsley Avenue	AM	One-Way	>=50	F	Signal	13.0	B
		PM	Stop	>=50	F	Signal	14.8	B
4	El Camino Real/Embarcadero Rd*	AM	Signal	>80	F	Signal	73.6	E
		PM	Signal	>80	F	Signal	76.2	E
5	El Camino Real/Oregon Expwy-Page Mill Rd*	AM	Signal	>80 (120.3)	F	Signal	>80 (91.8)	F
		PM	Signal	>80 (108.4)	F	Signal	>80 (92.7)	F
6A	Alma St & Oregon Expwy WB Off Ramp (Oregon Ave)	AM	One-Way	>=50	F	Signal	7.8	A
		PM	Stop	>=50	F	Signal	9.1	A
6B	Alma St & Oregon Expwy EB Off Ramp	AM	One-Way	>=50	F	Signal	24.9	C
		PM	Stop	>=50	F	Signal	21.5	C
Notes:								
1. Average delay is reported for the worst approach at one-way stop intersections.								
2. Bold indicates substandard intersection level of service.								

Note that Figure 8 shows a conceptual design of potential improvements at the Embarcadero Road and Alma Street interchange. If this project were to be pursued, many design details would need to be worked out with regard to maintaining access to existing residential driveways on Embarcadero Road, Kingsley Street, High Street, and the Embarcadero slip ramp.

4.4.4.2. El Camino Real and Embarcadero Road (Intersection 4)

The analysis showed that at the VTA Congestion Management Program intersection of El Camino Real/Embarcadero Road, significant traffic impacts would occur due to reassigned traffic. It is recommended that an additional westbound left-turn lane and a northbound right-turn lane be provided along with signal optimization at this intersection (see Figure 9). With these improvements, the intersection of El Camino Real and Embarcadero Road would operate at acceptable LOS E during both peak hours under existing and Year 2030 traffic volumes.

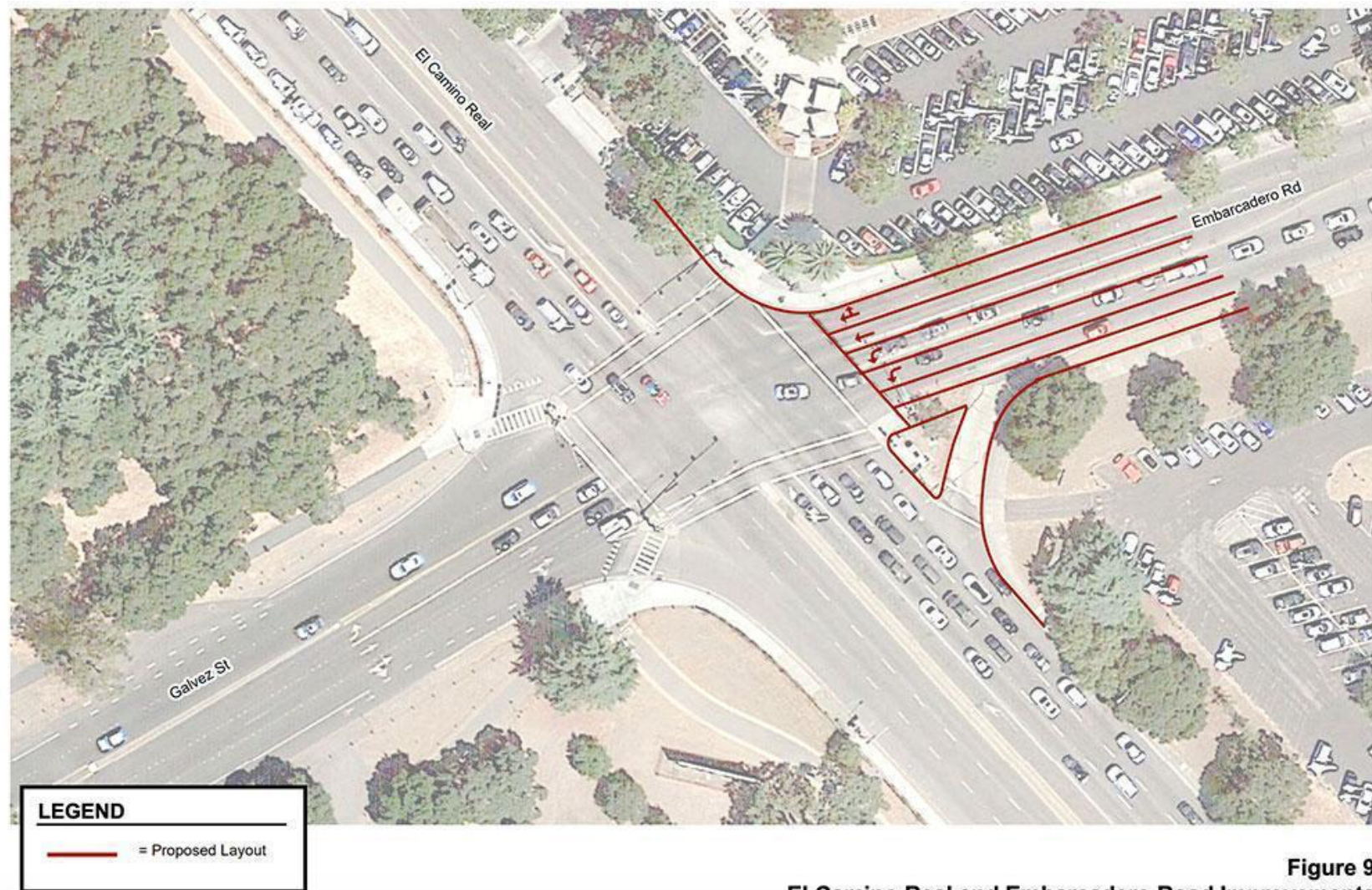
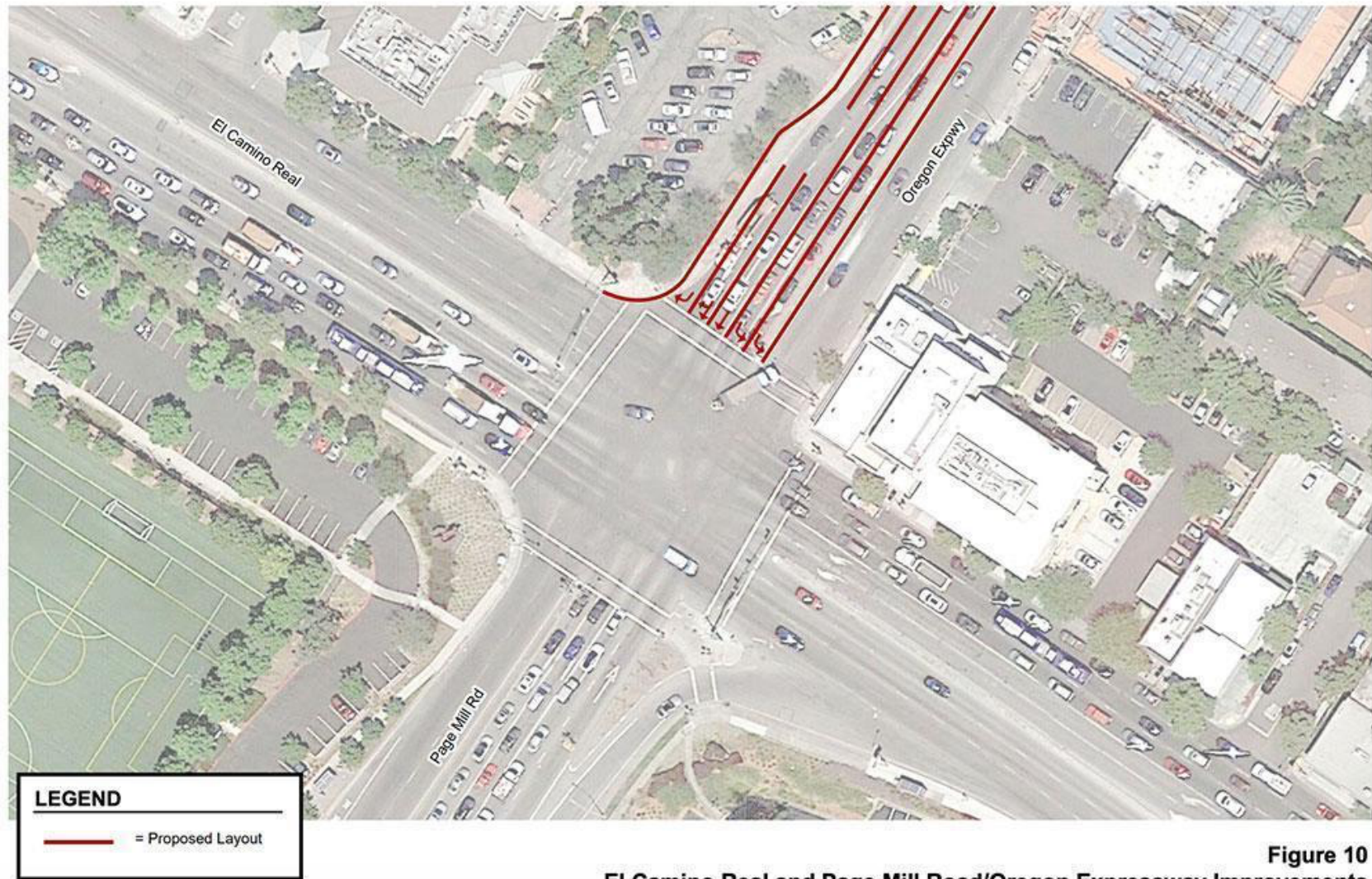


Figure 9
El Camino Real and Embarcadero Road Improvements

4.4.4.3. El Camino Real and Page Mill Road/Oregon Expressway (Intersection 5)

At the VTA Congestion Management Program intersection of El Camino Real/Oregon Expressway-Page Mill Road, the traffic analysis identified significant traffic impacts due to reassigned traffic. The report recommended a westbound right-turn lane from Oregon Expressway to northbound El Camino Real along with optimizing the signal timing (see Figure 10). With these improvements, the intersection would operate at acceptable levels of service during the AM and PM peak hours under existing conditions. Under Year 2030 traffic conditions, the analysis shows that the intersection would continue to operate at unacceptable LOS F with the proposed improvements. However, the intersection delay during both the AM and PM peak hours is projected to be lower than the intersection delay without these improvements.



4.4.4.4. Alma Street and Oregon Expressway (Intersections 6A and 6B)

The traffic analysis identified significant impacts to the intersections of Alma Street/Oregon Expressway with the reassignment. The analysis determined that these intersections currently meet the peak hour signal warrant and recommends traffic signals at both the on and off ramps (see Figure 11). With the proposed traffic signals at both the ramp locations, the intersections of Alma Street and Oregon Expressway are projected to operate at acceptable LOS C or better during both peak hours under existing and Year 2030 traffic conditions.

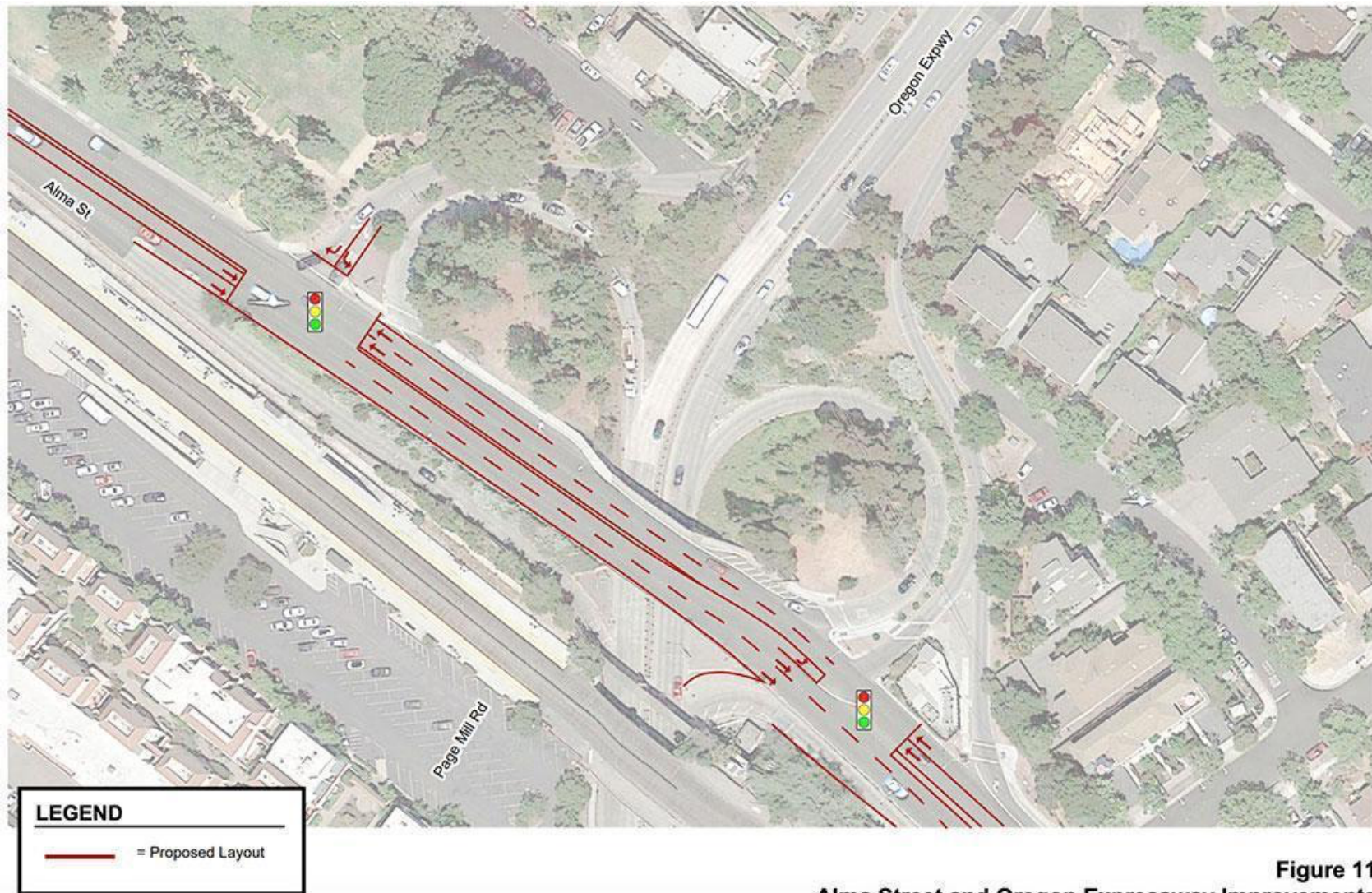


Figure 11
Alma Street and Oregon Expressway Improvements

*****End of Excerpt from Traffic Study*****

4.4.4.5. Impacts to University Avenue

According to the Traffic Study: “Due to the existing congestion on University Avenue, trips from the potential Churchill closure much more likely would be rerouted to Embarcadero Road or Oregon Expressway. The potential Churchill Avenue closure is not likely to impact traffic operations along University Avenue.”⁴⁶

The Minority raised concerns about the Traffic Study, however the Majority feels the work presented was professional and persuasive and that the mitigations presented will sufficiently address the impacts highlighted in the report. It was noted by City Staff that Hexagon Transportation Consultants is the leading resource for work in this area and that their reputation and experience was what led AECOM and City Staff to engage them to work on this project.

The Minority also believes that further analysis might find a need for additional mitigations, which might lead to increased costs. The Majority believes this is piling speculation upon speculation.

4.4.5. A Safer Experience for Cyclists and Pedestrians

The Churchill/Alma intersection experiences a sizable amount of bicycle and pedestrian traffic, especially during the weekdays. Given the proximity to Palo Alto High School, hundreds of high school students travel to and from campus through this intersection.⁴⁷ This intersection also serves as a connection from points north and Stanford University, for both pedestrians and cyclists.

As it stands currently, neither auto traffic nor the train are separated from cyclist or pedestrian traffic. This pattern creates a hazardous condition that has seen many accidents over the years⁴⁸, and is only poised to worsen as Caltrain electrifies its trains and they travel faster and, over time, more often.

By fully separating bicycle and pedestrian traffic from both vehicular traffic and the train, a safer and more enhanced crossing condition can be created for cyclists and foot traffic in and near Churchill Ave. Proposed mitigations at Embarcadero and Alma also address shortcomings in the current bicycle and pedestrian paths there. These should include improvements relating to the areas around Embarcadero at Alma, including Kingsley, High, and Emerson at

⁴⁶ Pg. 50 of Appendix B-3 Traffic Studies and Presentations - Final Traffic Study - Hexagon Traffic Consultants

⁴⁷ Appendix B-3-2 DRAFT Traffic Study- TJKM - Draft Traffic Impact Study Report - Churchill Ave Closure (Aug 2019) page 33: Through their daily traffic counts, they saw approximately 258 cyclists on the days they gathered data. Note that this count was only in the AM, as their PM counts were after students had ended school 2-3 hours before, and thus would not have been seen during their PM count time.

⁴⁸ See Chapter 6, Safety.

Embarcadero as defined by The Neighborhood Traffic Safety and Bicycle Boulevard (NTSBB) Projects.⁴⁹

4.5. Minority Position

Three members of the XCAP (Phil Burton, Keith Reckdahl, Nadia Naik- the “Minority”) did not support the motion, stating that they wanted additional information that the current traffic study did not provide, that the Closure of Churchill would inequitably distribute traffic to other neighborhoods, and that further evaluation of the Partial Underpass should also be explored before any decisions are made.

4.5.1. Additional Traffic Information Needed

The Traffic Study provided baseline analysis to facilitate decision making, but ultimately, it was insufficient for the Minority to support a Closure due to the following areas of concern:

- The few east/west traffic crossings in the City are inextricably linked. The relationship of the future grade separation of Palo Alto Avenue or changes to the existing University Avenue and Embarcadero grade separations should be part of the analysis.
- The report included intersection LOS but without a network LOS analysis of proposed mitigations/improvements, making it difficult to understand the queuing effects of these mitigations on the entire network and whether they create capacity constraints at other intersections. A network analysis may uncover deficiencies that require additional mitigations/improvements, increasing costs.
- The report did not evaluate potential delays to public transit or/and school buses from concentrating more traffic on fewer roadways.
- Bike/Pedestrian mitigations were identified as an area of future study, but the Minority felt the available traffic information was insufficient.
- Analysis describing network impacts of the proposed mitigations beyond 2030 are needed- even if that analysis is within certain bands of uncertainty given the long-range nature of the forecasts. Future scenario analysis should test how sensitive the LOS forecast predictions are to changes in the input assumptions.
- Specific impacts to school operations were not evaluated because detailed information from the school district was unavailable, so additional potential traffic or safety mitigations remain unknown.

The mitigations do not prevent the Closure from relocating Churchill traffic to other neighborhoods. Rather, the mitigations only attempt to reduce the impacts of the relocated traffic.

⁴⁹ The Neighborhood Traffic Safety and Bicycle Boulevard (NTSBB) Projects
https://www.cityofpaloalto.org/gov/depts/trn/bicycling_n_walking/ntsbb.asp

4.5.2. Embarcadero Bridge Concerns

The widening of the Alma Street bridge (part of the existing Embarcadero grade separation) is needed to mitigate some of the proposed changes. Today, the pinch point created by the narrow bridge serves to slow the speed of northbound Alma traffic and the impact of its removal was not addressed.

In addition, the 1936 Embarcadero grade separation could at some point in time need to be retrofitted or replaced, whether due to future earthquake damage or because it has reached the end of its useful life. If rebuilt, it is very unlikely that the new grade separation would retain the current single eastbound lane and limited turning movements. Furthermore, from a network resiliency standpoint, the City should weigh the removal of an east/west arterial. In particular, maintaining the Churchill crossing may be necessary to support traffic during any Embarcadero underpass reconstruction.

4.5.3. Partial Underpass Study

As described in the main report, significant iteration of the Partial Underpass design was cut short and key stakeholders, particularly from the school and bike community, weren't able to fully participate in design iterations. The Minority's concerns have been folded into the upcoming Areas of Future Study section but represent key areas of deficiencies of the incomplete design iteration. If, with full participation from key stakeholders, an agreeable design could be achieved, the Partial Underpass could be a viable compromise addressing the issues of geographic equity. Alternatively, if after full exploration, the Partial Underpass proved infeasible, it could bolster community support for the Closure.

4.5.4. Irreversible Nature of the Decision

The railroad on the Peninsula has historically closed existing at-grade crossings, not re-opened or created new ones. Since today's CPUC is unlikely to grant a reversal, the decision to close Churchill should only be made after careful review of as many foreseeable issues as possible.

4.6. Areas for Future Study

XCAP members noted potential areas for future exploration. These are:

4.6.1. Churchill Closure with Mitigations

1. The following suggestions were made:

- a. Mitigations should include the 2016 Bike Project and evaluate impacts to El Camino and Embarcadero and Embarcadero/Emerson/High Streets and along both sides of Embarcadero (see: Appendix B-14 Embarcadero and El Camino Corridor Improvement Study Aug 2016) (approved but removed from the Capital Improvement Program due to COVID - has been pushed out past the 5-year timeline).
- b. Unofficial student pick-up/drop off locations along Embarcadero slip road and possible safety mitigations needed if more cars travel on that road.
- c. Embarcadero intersection should be revisited when alternatives for Palo Alto Avenue and Downtown are selected.

- d. Lincoln/Kingsley/High/Embarcadero multi-way intersection issue needs to be addressed to reduce neighborhood through traffic.
 - e. Consider working with Town & Country on reducing congestion on Embarcadero/El Camino.
 - f. Review proposed Pedestrian overpass over Embarcadero for safety issues.
 - g. Consider creating a comprehensive bike/pedestrian connection plan.
 - h. Bike/Pedestrian path at Seale before building the Churchill Bike/Pedestrian to allow safe crossing during construction (and how that might be used for phasing a closure). (Note: bike/pedestrian path is consistent with park use and can be done on dedicated park land).
 - i. Study whether Park Blvd should be reopened between Southgate and Evergreen Park. Consider testing an opening. Neighborhood outreach is critical.
 - j. Consider mitigations (ex. stairs) for the northwest corner of the Embarcadero grade separation, where westbound foot traffic (represented by the red arrow) on the north side of Embarcadero Road travels under the grade separation and then up through landscaping on the northwest embankment towards Town & Country, with many continuing to Palo Alto High School by looping across Embarcadero using the Embarcadero bike/pedestrian bridge adjacent to the railroad tracks (represented by the yellow arrow).
 - k. Consider a traffic signal at North California/Alma to have fewer cars along Churchill and to provide a signalized left out of Old Palo Alto.
2. Additional bike/pedestrian crossing mitigation future study areas.
- a. Add bike/pedestrian crossing at Seale.
 - i. Recommended in the Rail Corridor Plan.
 - ii. Adds a bike/pedestrian crossing that can be built while mitigations are being built.
 - iii. Would provide a more direct Safe Route to School for Greene and Walter Hays from West of Alma and for Palo Alto High School from students West of Alma and South of Churchill.
 - iv. Reduces bike traffic on congested California Avenue bike/pedestrian tunnel and on Churchill tunnel.
 - v. Bikes on the west side of tracks end up on Park Blvd which is a bike path.
 - vi. Alternatives for Seale design could be center of the road or property acquisition to create bike/pedestrian ramps to separate from Alma and tracks.
 - b. Bike Option 2
 - i. Explore closing Churchill to cars on the East side between Alma and Emerson - only homeowners and their guests would use the road. Residents would enter/exit Churchill from Emerson Street. Explore need and possibility for a turnaround at the end of resulting cul-de-sac.

- ii. Consider the effect of changes on moving trucks, garbage trucks, emergency vehicles, etc. on an altered Churchill Avenue block. Consider any traffic implications including any additional traffic onto Embarcadero.
 - iii. Explore use of the area from curb and landscaping between curb and sidewalk on both sides of Churchill Avenue to enable an increase in width of ramp.
 - iv. Explore flatter, wider, taller, and fully lit crossing with increased sightlines. Consider moving the entry to ramp further back from Alma to decrease ramp grade.
3. Analyze the impacts of widening the Alma Street bridge on the overall traffic network and any necessary mitigations.
4. Consider a cost-benefit analysis of whether the Embarcadero grade separation might eventually need replacement, whether opportunities exist to improve all turn movements if replaced, and what impact that has on other east/west arterials and their planned improvements since closure of Churchill could impact network resiliency.
5. Consider impacts of any roadway modifications to east/west travel, particularly with regard to decisions made on the future Downtown coordinated Area Plan and the Palo Alto Avenue crossing.
6. Given the impacts to the overall project timelines from COVID, it is expected that an updated Traffic study eventually will be needed. The following suggestions are areas of future study that could be included:
 - Expand Traffic Study to include impacts beyond 2030 - Analysis describing network impacts of the proposed mitigations beyond 2030 are needed. Given the uncertainty of long-range forecasts, analysis with certain confidence bands and future scenario analysis should test how sensitive the LOS forecast predictions are to changes in the input assumptions.
 - Perform network LOS analysis of proposed mitigations and improvements to understand the queuing effects of these mitigations and whether they create capacity constraints at other intersections.
 - Consider potential delays to public transit or/and school buses that may result from concentrating more traffic on fewer roadways.

4.6.2. Churchill Partial Underpass

If the Council would like to pursue the Partial Underpass, further design review should seek to reduce the underpass cost, size, and encroachment within the Caltrain ROW. Some ideas include:

- Explore whether raising the rail tracks by a few feet, which would reduce both the underpass depth and length along both Churchill and Embarcadero, potentially reducing property impacts and cost and improving visual appearances.
- Explore ideas to reduce the width of Churchill's lanes/shoulders to reduce the underpass width, further reducing excavation and construction costs.

- Explore whether it is possible to design a bike/pedestrian crossing closer to Churchill itself to address circuitousness created by having the bike/pedestrian crossing at either Kellogg or Seale.
- Work with Caltrain to address encroachment on their ROW.
- Model whether the building of a Partial Underpass could cause auto traffic inducement.

4.6.3. Churchill Viaduct

If the Council would like to pursue the Viaduct, some ideas for areas of further study include:

- Consider the exploration into a viaduct over Embarcadero, but with a reduced and diminishing height at the Churchill intersection to allow for a Homer-like bike/pedestrian underpass.
- Model whether building a Viaduct at Churchill would induce auto traffic.

4.6.4. Future Outreach Opportunities

Although the City did some outreach, the distractions of the pandemic may have inhibited the community's ability to fully participate in XCAP's Churchill designs and eventual decision.

Palo Alto has an incredibly rich bike/pedestrian community, and collaboration with community members should be encouraged to leverage their insights to improve all future designs. XCAP recommends that further outreach about the Churchill crossing should include the following groups:

- Palo Alto Unified School District (PAUSD)
- Palo Alto High Students
- Palo Alto High School PTSA
- Palo Alto Council of Parent Teacher Associations - PTAC
- Safe Routes to School Team (SRTS)
- City/School traffic liaison committee
- Palo Alto Pedestrian and Bicycle Committee (PABAC) and other bicycle-advocacy organizations
- Stanford University
- Town & Country Village management and merchants
- Palo Alto Chamber of Commerce
- Palo Alto Neighborhoods (PAN)
- Adjacent neighborhood associations
- Castilleja school administration and students
- Caltrain
- Union Pacific Railroad (or future short line operator)

5. Meadow and Charleston Options

5.1. Summary of Actions

The members of XCAP agree that grade separations are important to the community and that Meadow Drive and Charleston Road are important transportation corridors for bicycles, pedestrians, and cars that must be separated from the rails.

Throughout the process, XCAP studied each alternative, and gathered useful information for each option. Importantly, XCAP also championed a new option, the underpass, which was suggested by a citizen and which many hoped would represent a useful compromise between the alternatives that had already been presented.

When asked to recommend a single solution for each of Meadow Drive and Charleston Road, XCAP unanimously agreed they could not decide with the current information available. No alternative received the support of more than three members. In the end, multiple individual members championed the hybrid, trench, viaduct, and underpass options for different reasons. There was, however, unanimous consensus to remove the two South Palo Alto Tunnel alternatives from further consideration.

To be able to select a preferred alternative, there are a series of important questions to answer. Larger questions, such as the need for four-track segments in Palo Alto and the ability of Palo Alto to participate in a corridor-wide grade separation study for the entire CalTrain system, have been discussed elsewhere in this report. Other more specific questions about the individual alternatives are enumerated below.

The XCAP hopes that this section will contain a clear enough presentation of the options that policymakers will be able to gather some of the missing information and make a decision.

5.2. Options Considered by XCAP

At the start of the XCAP process, XCAP members were presented with four options for the Meadow and Charleston grade crossings.

- **Tunnel**, in which the train enters an underground tunnel long enough to pass beneath both Meadow and Charleston.
- **Viaduct**, in which the train passes over the road on an elevated structure, and the road remains at its current level.
- **Hybrid**, in which the train is raised on a berm and the road is lowered into a shallow trench so that vehicles and pedestrians pass underneath the train tracks.
- **Trench**, in which the train is depressed below the ground in an open trench and the road remains at its current level, crossing the trench on a bridge.

In addition, during the XCAP process the committee sought additional ideas from residents. A citizen proposed the **underpass** design, which XCAP took to City Council and which was approved for further study.

In this new **underpass** design, trains stay at grade level, and cars, bicycles, and pedestrians pass underneath. The underpass design also includes a traffic circle, creating an intersection in which cars can make certain turning movements without the need for a traffic light. More information about the development of the underpass design is available in Appendix C-1 History of Meadow-Charleston Underpass Alternative.

Fact Sheets, for all Meadow-Charleston Alternatives are available in Appendix A-1 Fact Sheets, renderings are available in Appendix A-2 Renderings and Plans and animations and exhibits used for the Virtual Town Hall are available in Appendix A-5 Links to Animations and Virtual Town Hall.

5.2.1. Tunnel Options

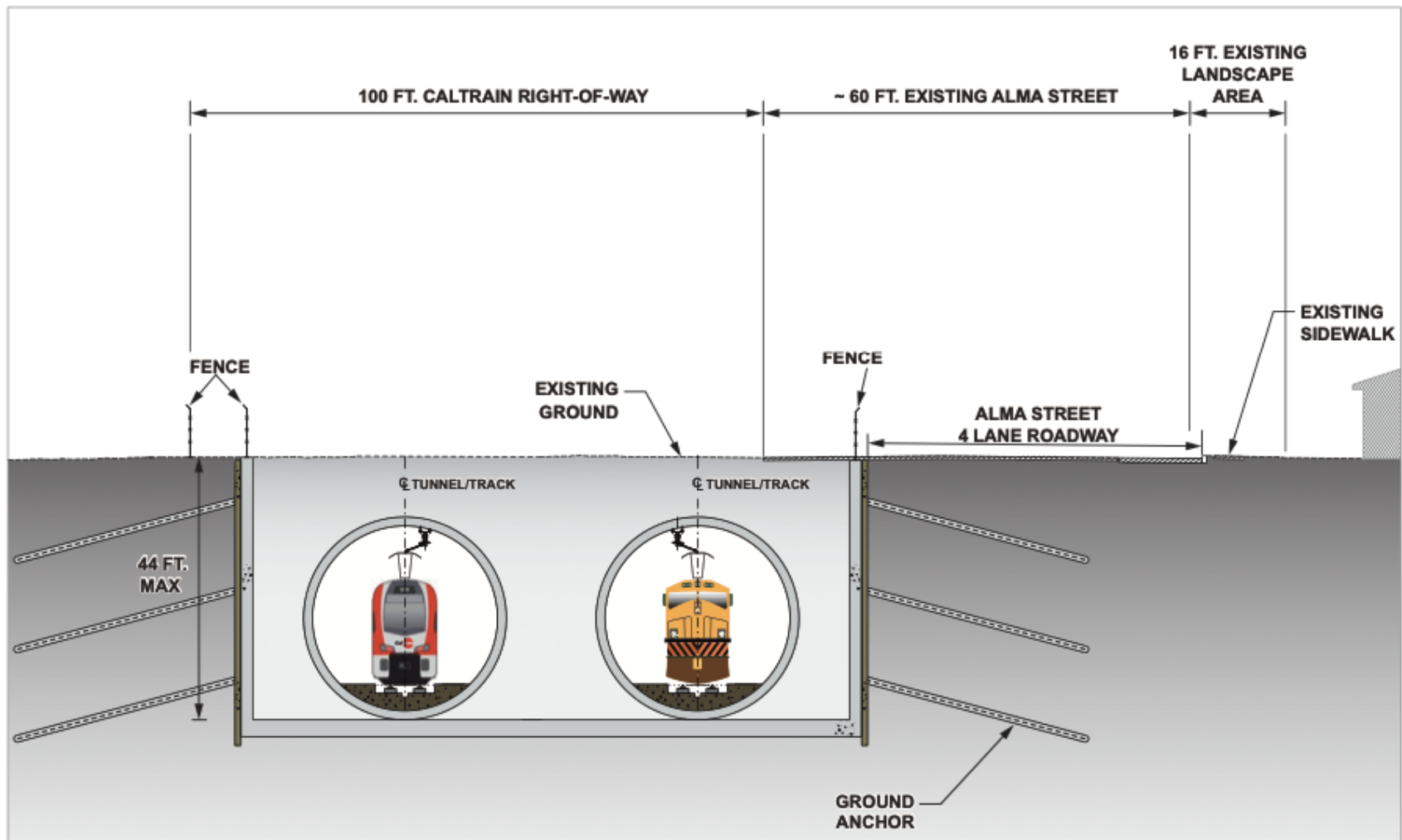
5.2.1.1. Citywide Tunnel (removed prior to XCAP)

In May 2018, the City Council voted to study a Citywide tunnel that ran within the limits of Palo Alto. The term “Citywide” was/is a misnomer because the plans as designed were for a tunnel originating at the University Avenue Station and ending just before San Antonio Road. Early design work showed significant property impacts associated with this alternative. The Citywide tunnel was removed from consideration by the City Council on May 13, 2019, prior to the formation of the XCAP in June 2019.

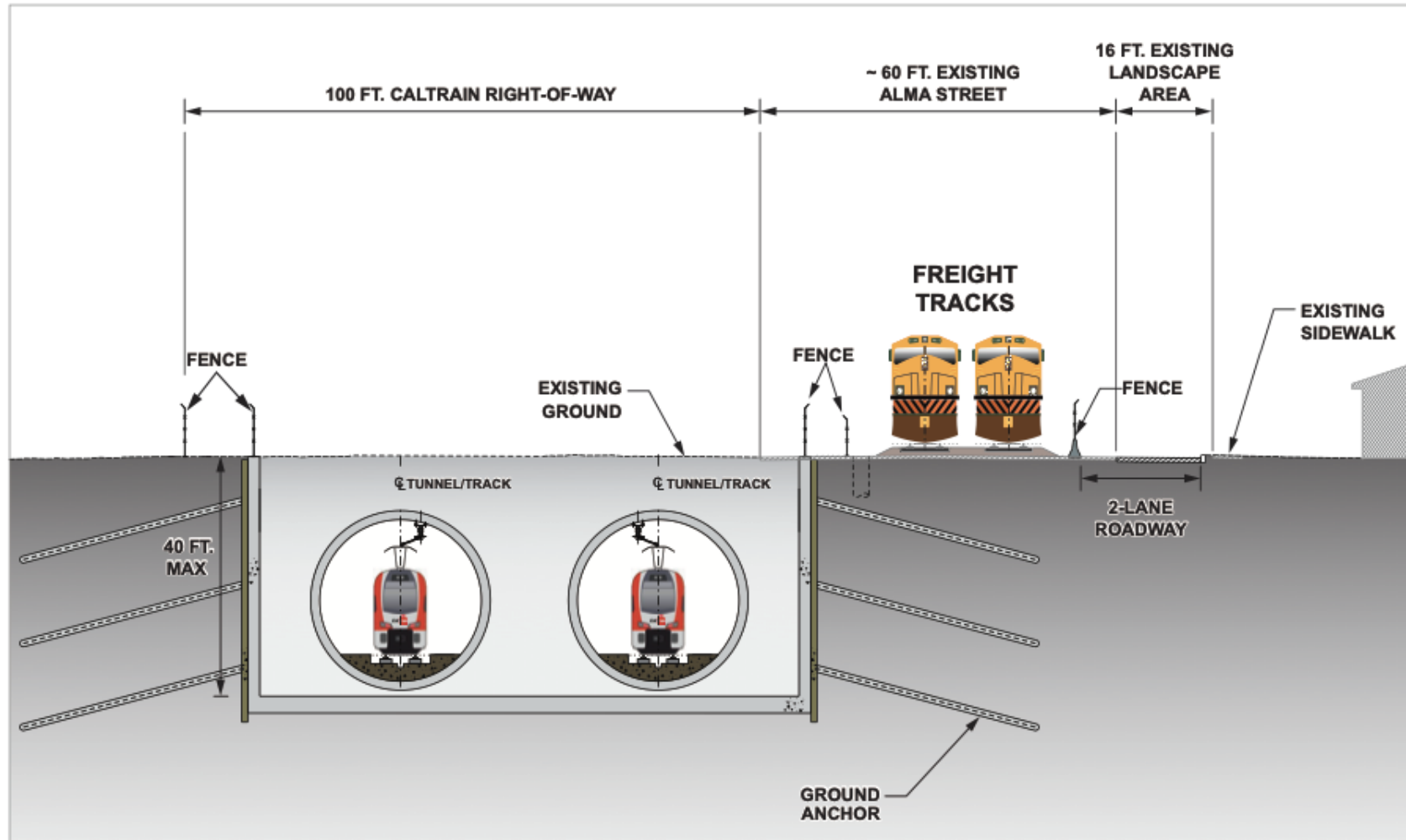
The profile and typical section drawings can be found Appendix A-6 Discarded Alternatives and the animation can be found at: <https://vimeo.com/325481133/e987af4a60>

5.2.1.2. South Palo Alto Tunnels with and Without Freight

Due to significant community interest in an underground alternative, the City Council added two tunnel alternatives for South Palo Alto. In one option, freight would travel in the same tunnel as Caltrain under Meadow and Charleston. In the other, a Caltrain-only tunnel is constructed under Meadow and Charleston and the three freight trains a day remain on a pair of surface tracks. (As described in Chapter 2, freight requires a flatter vertical grade than passenger trains. In theory, this could allow the Caltrain trains to use steeper vertical grades to tunnel underneath the creeks with a smaller impact and possibly lower costs.)



Example Section - South Portal Tunnel - Looking North



Example Section - South Portal Tunnel - Looking North

Ultimately, the South Palo Alto tunnel alternatives were estimated by AECOM as costing roughly between \$1.173 billion and \$1.827 billion. **Because of this high cost, significant construction time and other drawbacks, XCAP unanimously decided to remove the tunnel alternatives from further deliberation.**

Fact Sheets, for the South Palo Alto Tunnel Alternatives are available in Appendix A-1 Fact Sheets, renderings are available in Appendix A-2 Renderings and Plans and animations and exhibits used for the Virtual Town Hall are available in Appendix A-5 Links to Animations and Virtual Town Hall.

5.2.2. Viaduct

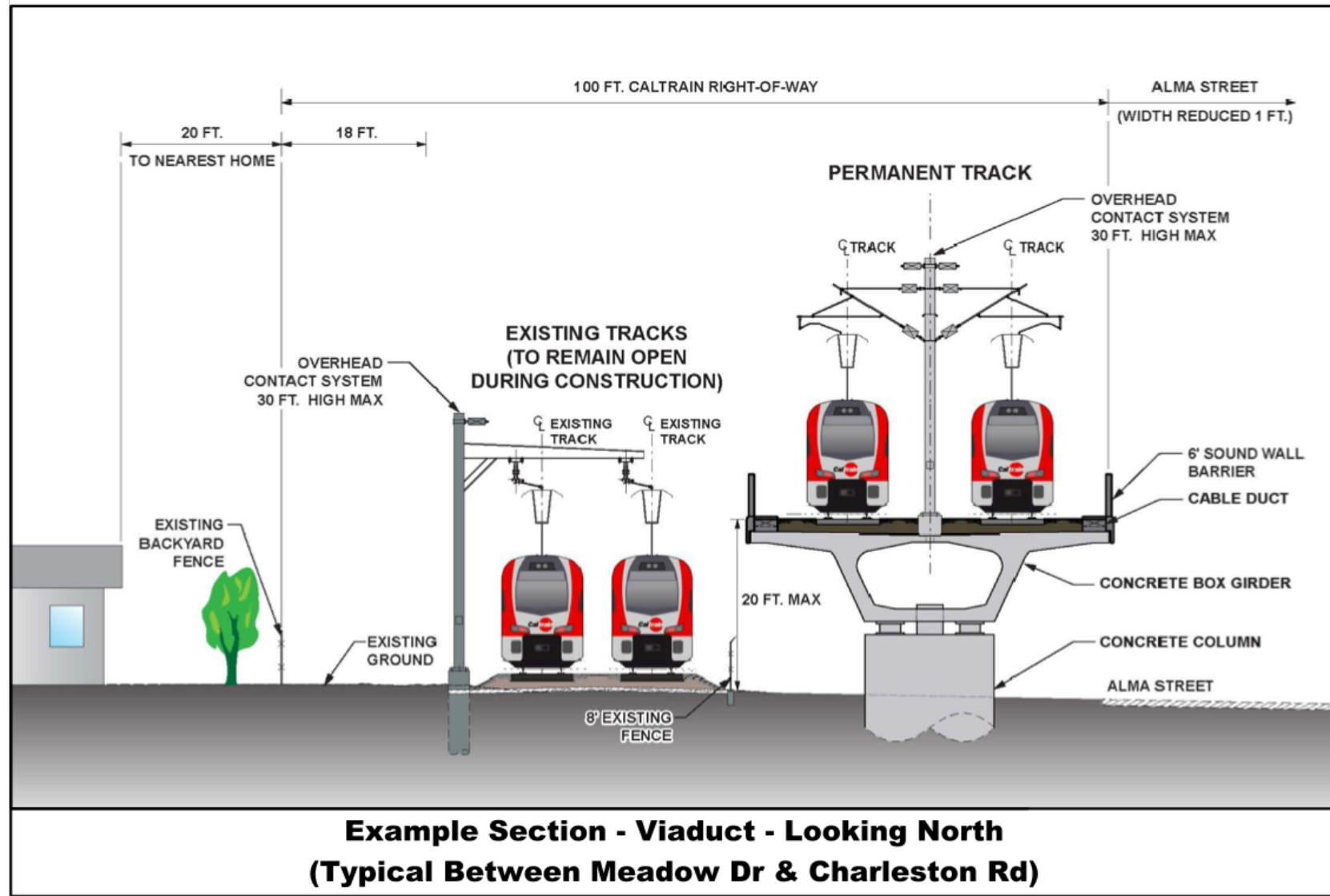
The viaduct option raises the tracks over both Meadow and Charleston Roads on an elevated concrete structure. As designed by AECOM, the bottom of the structure is about 20 feet above ground as it crosses both roads and in between the roads, it rises at about a 1.4 percent grade to meet that height on both ends. The viaduct would be topped by six-foot sound wall barriers, plus an overhead contact system for electrical power that reaches a height of about 30 feet above the tracks.



**Proposed Viaduct Solution Overview - Looking South West
Meadow Drive Intersection**



**Ground Level View - Looking South West
Charleston Road Intersection**



5.2.3. Hybrid

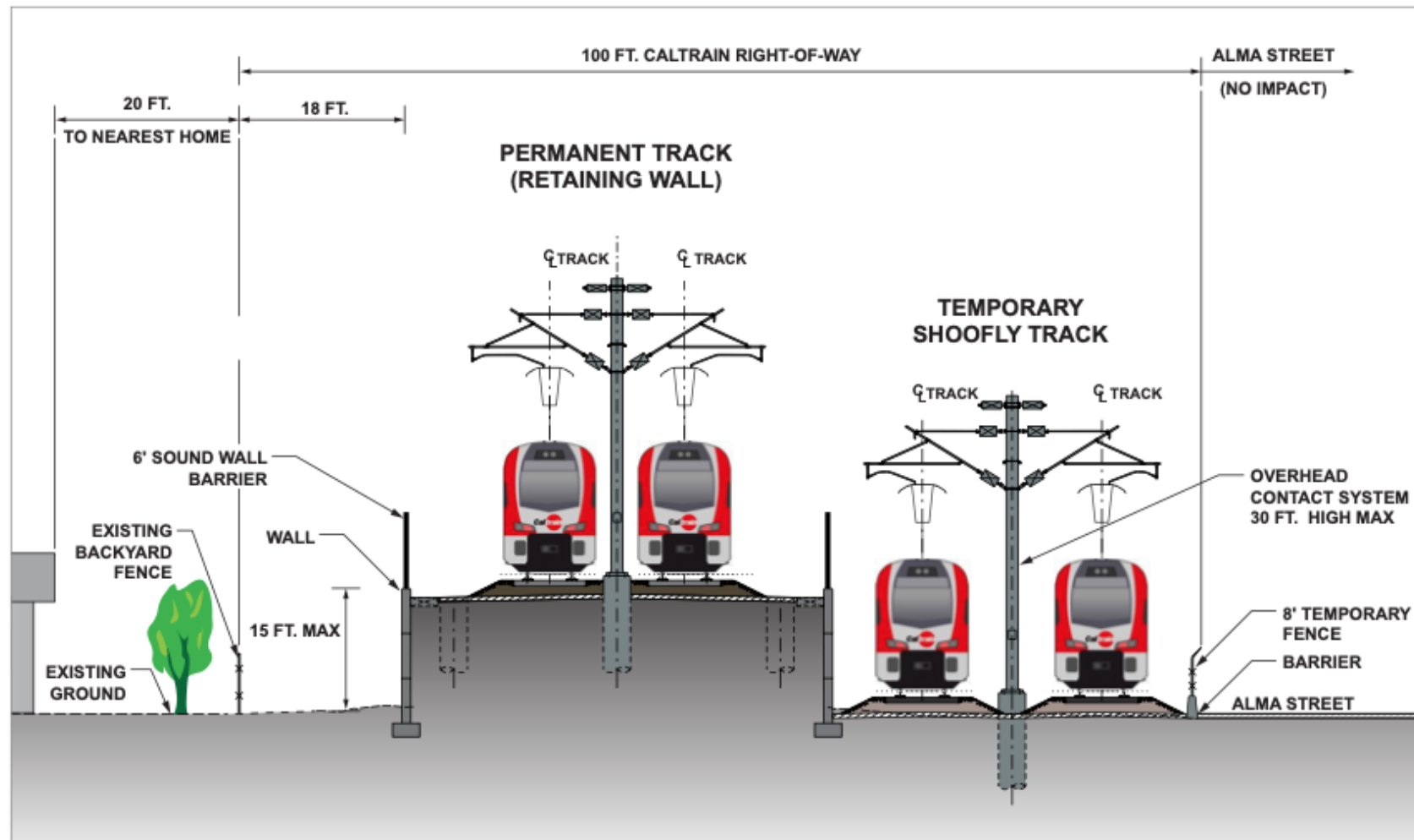
The hybrid option raises the tracks on an earthen berm with a maximum height of 15 feet, and simultaneously lowers the roadway of both Meadow and Charleston Roads so that vehicles can pass under the tracks with the appropriate clearance. The berm would be topped by a six-foot sound wall barrier, and an overhead contact system for electrical power would rise about 30 feet above the track height.



**Proposed Hybrid Solution Overview - Looking South West
Meadow Drive Intersection**



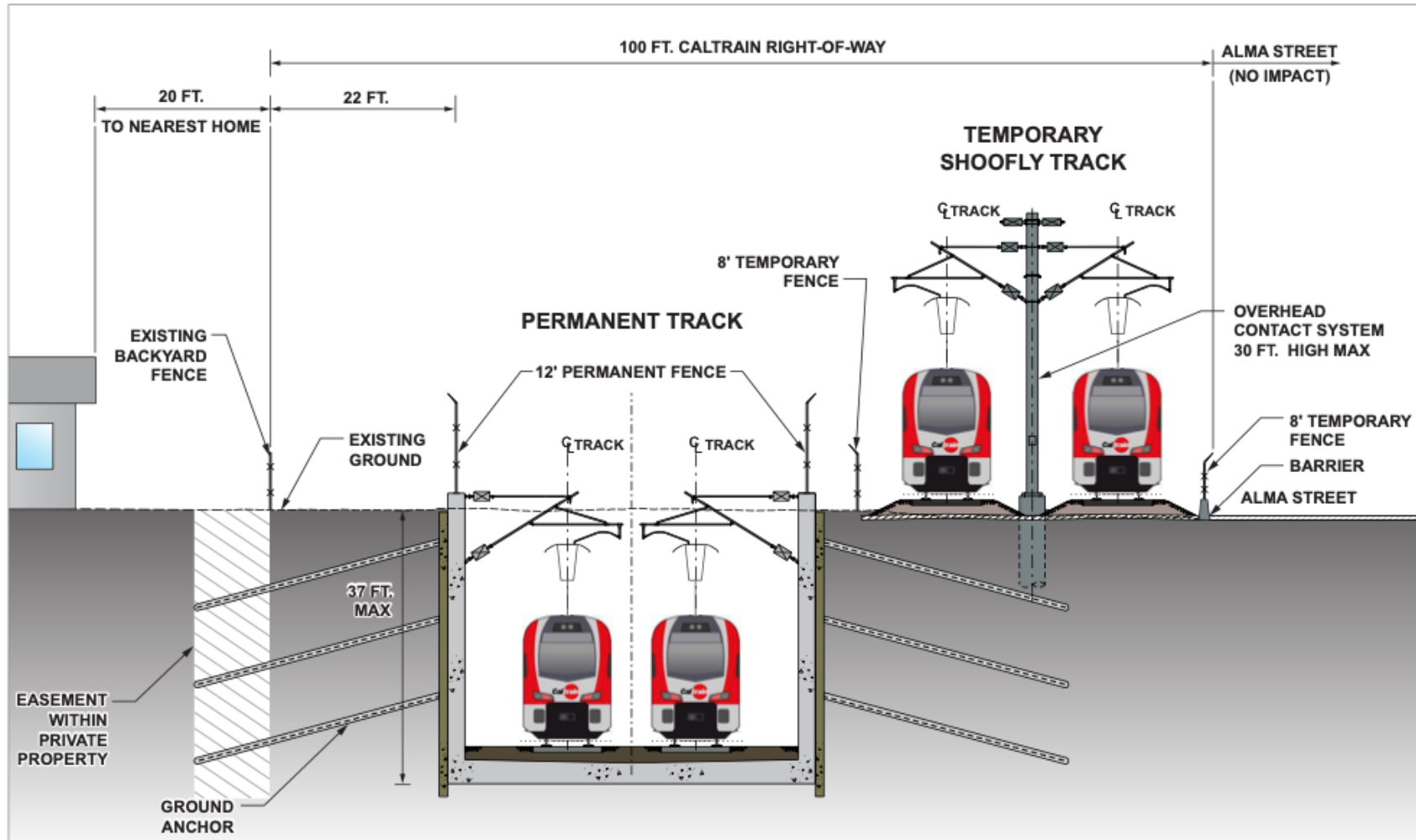
**Ground Level View
Charleston Intersection**



Example Section - Hybrid - Looking North (Typical Between Meadow Drive & Charleston Road)

5.2.4. Trench

The trench option lowers the track below the current level into a 37-foot-deep trench that is wide enough for two tracks. Trains enter and exit the trench via a slope with maximum two percent grade and stay in the trench as they pass below both Meadow and Charleston Roads. Road, pedestrian, and bicycle traffic would cross the tracks at the current grade level on bridges that span the trench. There would be a permanent 12-foot fence surrounding the trench, potentially with higher fencing in the areas where the train is descending into the trench to protect people from the electrified catenary wires.



Example Section - Trench - Looking North (Typical Between Meadow Drive & Charleston Road)



**Proposed Trench Solution Overview - Looking South West
Meadow Drive Intersection**



**Ground Level View - Looking South West
Charleston intersection**

5.2.5. Underpass

The underpass design lowers the roadway below the level of the tracks, leaving the rails at their current level. In order to minimize acquisition of private property, and in order to maximize traffic flow, traffic at Charleston Road is routed to a roundabout, creating a form of a “continuous-flow intersection” in which cars can make all turning movements, in many cases without having to wait at a traffic light.



View of Alma/Charleston Road with Proposed Roundabout in Upper Right Corner



View of Charleston Road Looking East with Bike/Pedestrian Improvements Visible in Foreground



View of Alma Looking South at Charleston with Bike/Pedestrian Path Improvements East of Alma Visible



Charleston Road Roundabout - Looking West

As currently designed by AECOM, this design proposes a more traditional underpass at Meadow Road that does not include the roundabout option. This was done in part because Meadow Drive is narrower than Charleston, leaving less room for a roundabout without greater property impacts.



Meadow Drive Underpass Overview - Looking Southeast

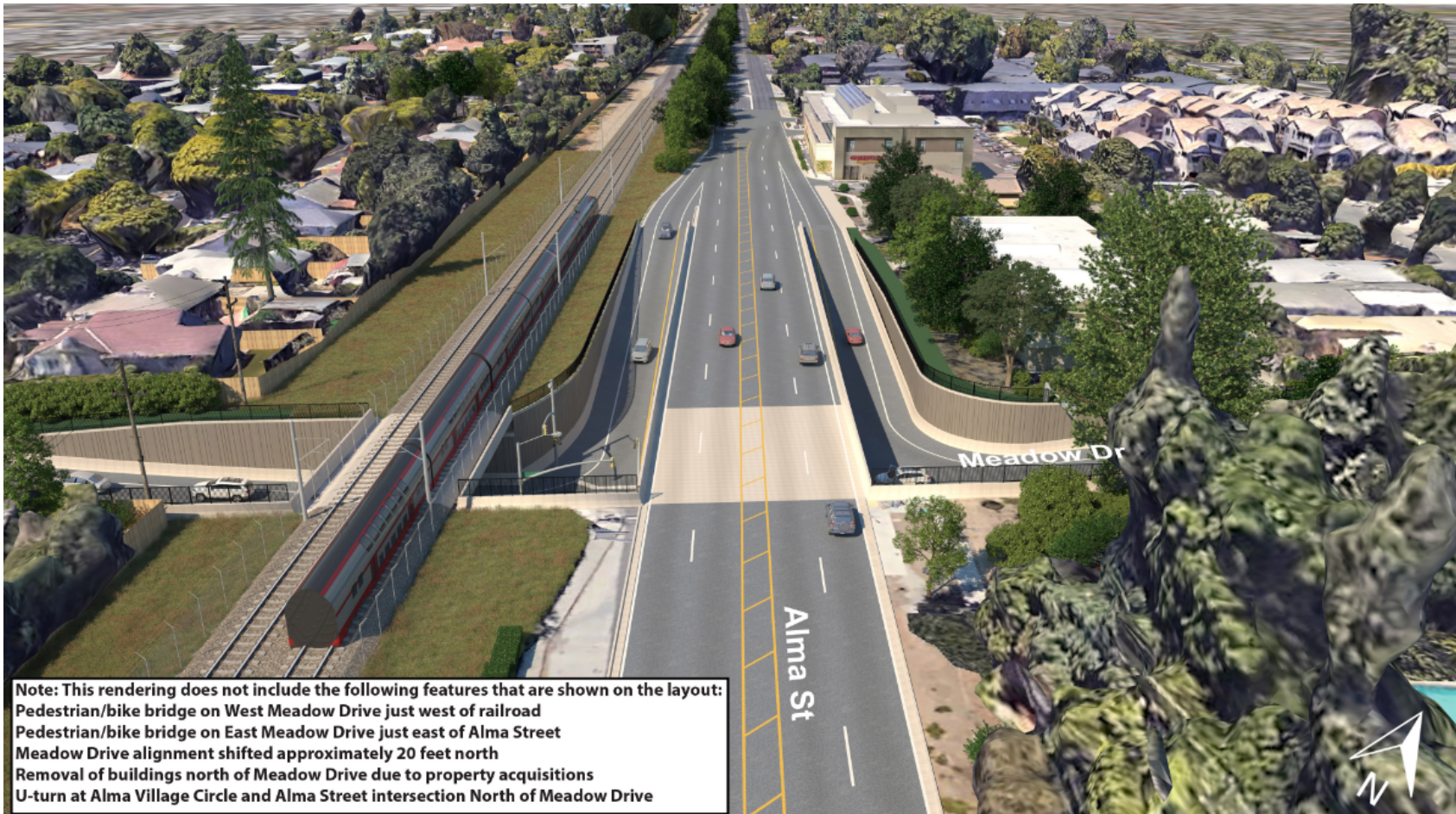
Note: Meadow Drive rendering does not include the following features that are shown on the layout:

- Pedestrian/bike bridge on West Meadow Drive just west of railroad
- Pedestrian/bike bridge on East Meadow Drive just east of Alma Street
- Meadow Drive alignment shifted approximately 20 feet north
- Lowering of Park Boulevard and West Meadow Drive intersection and associated retaining walls
- Removal of buildings north of Meadow Drive due to property acquisitions
- Pedestrian/bike/stair/ramp connection from Park Boulevard to the path on the south side of Meadow Drive
- U-turn at Alma Village Circle and Alma Street intersection North of Meadow Drive

Note: This rendering does not include the following features that are shown on the layout:
Pedestrian/bike bridge on West Meadow Drive just west of railroad
Pedestrian/bike bridge on East Meadow Drive just east of Alma Street
Meadow Drive alignment shifted approximately 20 feet north
Removal of buildings north of Meadow Drive due to property acquisitions



View of Meadow Drive looking West



More information about the development of the underpass design is available in Appendix C-1 History of Meadow-Charleston Underpass Alternative.

5.3. Choosing Between the Alternatives

The XCAP did not reach a consensus or a majority opinion on the remaining options. However, each option had some proponents, and some detractors.

Note that the alternatives chosen for Meadow Dr. and Charleston Rd. must be the same when considering a Tunnel, Viaduct, or Trench, since the distance between them is too short to have, for example, a Viaduct at Meadow and Trench at Charleston. In the case of the Underpass and the Hybrid, it is possible to mix the two alternatives. For more information, see Appendix A-4-4 Memo from Office of Transportation Re: Mixing of Underpass and Hybrid Grade Separation alternatives.

5.3.1. Tunnel

Proponents of the tunnel praised its ability to hide the trains completely from view for part of the rail corridor. As previously described, XCAP voted to remove tunnel options from future consideration and this section will not discuss it further.

5.3.2. Viaduct

Proponents of the viaduct argue that the viaduct can be constructed in the least time and with the least disruption, that it may actually move the tracks further from the nearest homes than other alternatives, and that land under the viaduct could possibly be used for public benefit make it worth considering despite the extra cost.

Detractors are concerned with the visual impact of a large concrete structure in what is mostly a residential area and its possible impact on residents' privacy.

5.3.3. Hybrid

Proponents of the hybrid cite the fact that it would be the least expensive to construct (half the cost of the viaduct and underpass and possibly one-quarter the cost of the trench). It also can be constructed without asking for an exception from Caltrain for a grade greater than one percent.

Detractors share the same concerns of viaduct detractors in that the hybrid will make trains more visible and create large berms at Meadow and Charleston.

5.3.4. Trench

Proponents of the trench argue that lowering the trains reduces their impact on the surrounding residential communities by largely hiding them from view, that some areas over the trench might be used for public benefit, and that the trench leaves bicycles and pedestrians at grade.

Detractors are concerned with the potential for the trench to be the most expensive of the remaining alternatives, and with the potential for the trench to affect the creeks and groundwater.

5.3.5. Underpass

Proponents of the underpass argue that, if more work is done to refine the design, the underpass has the advantage of not raising or lowering the rails and may even reduce traffic congestion because it makes more traffic movement possible without the need for a traffic light. It also is the only option that easily supports separate, dedicated bicycle lanes. The underpass also requires no design exceptions from Caltrain.

Detractors are concerned that the current design has the most severe property impacts of all the alternatives.

5.4. Detailed Comparison of the Options

5.4.1. City Council-Adopted Criteria

This section distinguishes the alternatives based on Council-adopted criteria. Note that the criteria are slightly duplicative in places and will be addressed as appropriate.

5.4.1.1. Facilitate Movement across the Corridor for All Modes of transportation

All of the options separate rail and road traffic, however, the **underpass**, as currently designed, does not allow for all vehicle movements at all intersections. (Bicyclists and pedestrians are addressed separately below.)

5.4.1.2. Reduce Delay and Congestion for Vehicular Traffic at Rail Crossings

All of the options reduce the delays caused by the lowering of the crossing gates to allow for trains to pass. For cars traveling east/west on Charleston across Alma, the **underpass** further reduces traffic delays because no traffic lights are required to traverse the Charleston Road intersection. The underpass also separates bicycles from cars, which further reduces congestion by reducing delays from mixed modes.

5.4.1.3. Provide Clear, Safe Routes for Pedestrians and Cyclists Crossing the Rail Corridor, Separate from Vehicles

The **underpass** option is the only option that includes separate, dedicated bicycle and pedestrian lanes providing a grade separation from both the train and Alma. For all of the other alternatives, (viaduct, trench, tunnel, and hybrid) bicycles and pedestrians would operate as they do today. In general, all of the options presented here would benefit from further careful refinement of the exact routes for bicycles (See Chapter 7 Recommendations and Lessons Learned for more details).

5.4.1.4. Support Continued Rail Operations and Caltrain Service Improvements

None of the options are significantly different in their support for Caltrain operation and improvement once the project is complete. However, XCAP does not have enough information to assess Caltrain's need for four-track segments in Palo Alto. XCAP also does not have enough information to determine the relative complexity of converting any of the options from two to four tracks if Caltrain requires this.

(For information about impacts on Caltrain *during construction*, see Section 5.4.1.10, Minimize Disruption and Duration of Construction below.)

5.4.1.5. Finance with Feasible Funding Sources

AECOM's preliminary engineering produced approximate cost estimates.

While not definitive, these cost estimates provide the following conclusions:

- The **viaduct** and **underpass** would cost roughly twice as much as the **hybrid**.
- The **trench** would cost roughly twice as much as the viaduct and underpass, or four times the cost of the hybrid.
- The South Palo Alto **tunnel** options would cost twice again as much as the trench.

Alternative	Cost Estimate (Low)	Cost Estimate (High)
Hybrid	\$190 million	\$230 million
Underpass	\$340 million	\$420 million
Viaduct	\$400 million	\$500 million
Trench	\$800 million	\$950 million
Tunnel with surface freight	\$1,173 million	\$1,759 million
Tunnel including freight	\$1,218 million	\$1,827 million

In addition to funding from Measure B, additional funding from local, county, state or federal sources will likely be needed to fund the projects due to their high costs. (See Section 2.8 Funding)

Opinions in the community and on XCAP differed on the accuracy of the cost estimates provided by AECOM. Further research on costs is recommended if cost will be a major factor in the Council's final decisions. Policymakers should note that none of the cost estimates from AECOM are for four track alternatives and it is unclear what the cost comparisons across alternatives might be if four tracks were needed. It should be noted that the Underpass design,

which does not move the train tracks at all, *may* be the least impacted, but further study would be required to be sure this is accurate.

5.4.1.6. Minimize Right-of-Way Acquisition (Private Property Only)

The **underpass**, as currently designed, would require the acquisition of several parcels near the affected intersections. Some other options have smaller property impacts: the **hybrid** may require modifications of several driveways, and construction of the **trench** may affect how some neighbors on the west side of Alma can use the underground space in their backyard for swimming pools and trees due to the potential need for ground anchors to support the trench walls.

5.4.1.7. Reduce Rail Noise and Vibration

Generally, the noise impact of all of the solutions is likely to be about the same, with the exception that the **hybrid** will measurably reduce road noise from Alma Street for some areas.

In addition, the **viaduct** provides the most significant vibration reduction. Specifically, the AECOM noise report predicts a “significant reduction” in vibration for the viaduct, a “slight reduction” for the trench and hybrid, and “no change” for the underpass.

In general, noise concerns were raised by many who spoke in public forums and contacted XCAP. More detailed information is available in the Noise Section 5.7.2.

5.4.1.8. Maintain Access to Neighborhoods, Parks, and Schools along the Corridor, while Reducing Regional Traffic on Neighborhood Streets

Most of the options would not introduce any changes in these areas. However, the **underpass**, which as currently designed does not allow all turning movements at Meadow, may increase “cut-through” traffic on nearby residential streets. Similarly, southbound Alma traffic destined for El Camino may choose to turn on Meadow to avoid the Charleston light and roundabout. However, the Hexagon traffic study indicates that these turning motions currently involve a small number of vehicles.

5.4.1.9. Minimize Visual Changes along the Corridor

The **underpass** alternative would not move the train tracks. So, there would be no visual change to the rail corridor from today’s current conditions, although there would be visual changes along additional parts of Charleston and Meadow Roads.

The **trench** alternative lowers the train but will require fencing (similar to the fencing today on the east side of the tracks along Alma) on both sides of the tracks, with some potentially higher fencing in the sections where the train is transitioning deeper into the trench.

The **hybrid** option would raise the train tracks on a berm about 15 feet high and would create an earthen or concrete wall along the length of the right of way except at intersections. The **viaduct** would raise the trains 20 feet in the air compared to today’s existing tracks, but it would

keep open space beneath the tracks. As currently designed, this would move the tracks closer to Alma Street, and farther from homes, than any of the other alternatives. The added height of both of these options in the vicinity of single-story homes could make the trains more visible than they are today.

5.4.1.10. Minimize Disruption and Duration of Construction

Caltrain and freight operations must continue throughout the construction of grade separations. In order to accommodate these operations, temporary, electrified passing tracks (known as shoofly tracks) must be built for all of the alternatives except the **Viaduct**. The **Viaduct** can be constructed alongside the existing tracks without the need for a temporary track, which is why it is the alternative with the shortest construction duration (2 years) and requiring minimal road closures. Other options would potentially take between four and six years to construct, with either lane reductions on Alma Street or the temporary closure of Meadow and Charleston roads during parts of construction.

The noise report, mentioned previously, also addresses noise and vibration during construction. The report predicts “moderate” construction noise impacts for the viaduct, “moderate to severe” noise impacts for the hybrid, and “severe” noise impacts for the trench and underpass.

5.4.2. Additional Considerations

This section describes other potential issues which affect Charleston/Meadow alternatives.

5.4.2.1. Creek/Drainage Impacts

The **trench** and possibly **tunnel** options require diversion of Adobe Creek and either Barron or Matadero Creeks and the construction of a siphon, pump station, or both to get the creek water and wildlife safely across the tracks. The **Hybrid** and **Underpass** options do not impact the creeks but will likely require pumping stations to prevent flooding on the depressed sections of roadway.

5.4.2.2. Long-Term Maintenance

It is likely that the options that require pumping stations will require more maintenance than the others, but other than that XCAP does not have enough information to fully understand the long-term maintenance requirements of these options and the quantification and magnitude of costs relative to normal expenditures.

5.4.2.3. Utility Relocations

Roadways and rail right of ways are typically utility corridors. Utility conflicts with the myriad of existing water, gas, sanitary sewer, electric, telephone/cable/communications, fiber optic facilities in the project vicinity could have significant impacts. Sewer systems are often gravity systems and may require pumps.

Grade separation projects could offer an opportunity to modernize aging utilities or upgrade utilities (Fiber to the Premises Plan, for example). All of the options require some amount of utility relocations. The degree of impacts and any potential long term maintenance costs are unknown and further study will be needed as designs continue to progress.

5.4.2.4. Railroad Operation Impacts during Construction

All of the options but the **Viaduct** require the construction of a “shoofly” track to allow Caltrain options during construction.

5.4.2.5. Local Street Circulation Impacts during Construction

This is covered above in Section 5.4.1.10 Minimize disruption and duration of construction.

5.4.2.6. Caltrain Right-of-Way Impact

None of the Charleston/Meadow options will have a significant impact on Caltrain’s right-of-way, although limited right-of-way use could improve the underpass design. For example, right-of-way use for the underpass ramp from eastbound Charleston to south Alma would shift the roadway to west, allowing a wider sidewalk and/or less property acquisition on the east side of Alma.

5.4.2.7. Caltrain Design Exceptions Needed

The **Trench** and **Tunnel** options require an exception from Caltrain for a 2% grade on the tracks, and the **Viaduct** requires an exception for a 1.4% grade. The underpass does not require a grade exception, although Caltrain approval would be needed for non-traditional construction techniques (such as jacked-box construction) to reduce construction time and cost.

5.5. Pros and Cons of Individual Alternatives

5.5.1. Viaduct

5.5.1.1. Viaduct Advantages

- No acquisition of private property is required.
- All existing traffic movements at both Meadow and Charleston are possible.
- Traffic is not diverted into residential neighborhoods.
- It does not impact the creeks and will not require any new drainage systems.
- Land under the viaduct could potentially be used as public space. Other train viaduct projects around the world, such as in Melbourne, Australia, have successfully created new public amenities as part of viaduct construction.
- The proposed design by AECOM places the viaduct about 40 feet farther from homes on Park Boulevard than the current location of the tracks. This would reduce the visual impact, assuming that Caltrain allows the viaduct to be moved to this outer section of the right-of-way.

- No shoo-fly tracks are necessary.
- It has the shortest construction timeline of all the alternatives.
- Some other alternatives require a 2% Caltrain design exception, whereas a viaduct only requires 1.4% Caltrain design exception.
- Minimal road closures (only nights and weekends) are required during construction.
- If four tracks are necessary, this alternative likely does not preclude the addition of two passing tracks, although the additional tracks would be placed close to the neighboring properties.
- The viaduct will not necessarily produce any more noise than other alternatives.
- The viaduct may significantly reduce the amount of vibrations felt by residents and businesses near the tracks.

5.5.1.2. Viaduct Disadvantages

- It is the tallest alternative with greatest perceived visual impact.
- There are potential privacy concerns given the height of the viaduct relative to the homes adjacent to the tracks on Park Blvd, some of which are part of a single-story overlay zone.
- The viaduct is less expensive than a trench, but more expensive than the hybrid or underpass options.
- The viaduct design keeps bicycle and pedestrian traffic similar to today; it does not degrade bicycle/pedestrian safety, but it also does not improve it.

5.5.2. Hybrid

5.5.2.1. Hybrid Advantages

- Pedestrians, cyclists, and vehicle traffic are all separated from rail traffic.
- All current turning movements at both intersections are retained in this design. No traffic diversions are necessary.
- Maximum height of tracks is 15' versus 20' height for a viaduct.
- Use of solid berm under raised tracks versus structure for viaduct will mitigate sound transmission up to 12 dBA for homes on the west side of the tracks by reducing road noise from Alma Street.
- No full property acquisitions are necessary, although some driveway modifications are required.
- No Caltrain right of way is required to construct this alternative.
- Lowest cost estimate of all Meadow-Charleston alternatives.
- If a four-track system is needed for HSR, the hybrid may not preclude the ability to add two passing tracks.

5.5.2.2. Hybrid Disadvantages

- Water pumps are required for lowered sections of roadway. Their location needs to be determined and additional maintenance costs need to be quantified.
- Shoofly tracks are required during construction, with negative traffic impacts on Alma Street due to lane closures for several years.
- There will be a noticeable visual impact due to an elevated rail on an earthen berm, creating a wall for the length of the structure except at intersections.
- The earthen berm could be perceived as dividing the city/neighborhoods.
- There are potential privacy concerns given the height of the hybrid relative to the homes adjacent to the tracks on Park Blvd, some of which are part of a single-story overlay zone.
- Bikes (particularly young riders) traveling eastbound head downhill towards the intersection could have limited sight distance and may need to stop abruptly to wait for traffic signals.

5.5.3. Trench

5.5.3.1. Trench Advantages

- Enables at-grade crossings over the train tracks for vehicles, pedestrians, and cyclists to reduce the accident and provide better traffic circulation without delay.
- Improves the visual aspects of the neighborhood as the train (including electrical pole and wires) will be hidden from view.
- A “lid” on part of the trench could potentially be used as a park or a playground, therefore improving neighborhood look and feel. However, this would require Caltrain approval, additional engineering work, and higher cost.
- No acquisition of private properties is required.

5.5.3.2. Trench Disadvantages

- If four tracks are needed, the two-track trench as designed would preclude the possibility of adding two more tracks in the future except at great expense.
- Temporary shoofly tracks are required.
- Long construction duration: AECOM estimates a construction timeline of 5-6 years.
- High construction price: AECOM’s estimates are \$800M to \$950M (2025 dollars estimates).
- Technical challenges on dealing with both creeks: AECOM’s design requires diversion of Adobe and Barron Creeks resulting in the need for pump stations. With the pump stations, there will be potential risks to train operations from flooding. Other creek options such as siphons also have technical challenges.

- Unclear how much of an impact a trench 30-40 feet deep will have on the surrounding groundwater. The AECOM design includes groundwater pumping, which likely would lower surrounding groundwater levels. The design could eliminate groundwater pumping by sealing the trench, but even that may disrupt the groundwater flow.
- A non-standard grade of 2% is required.
- The trench design keeps bicycle and pedestrian traffic similar to today; it does not degrade bicycle/pedestrian safety, but it also does not improve it.

5.5.4. Underpass

5.5.4.1. Underpass Advantages

As described above, among all the alternatives, the AECOM Meadow/Charleston Underpass was only an initial concept that did not receive sufficient review. As such, the following lists of pros and cons is a critique of the initial AECOM design meant to inform areas of future study (see Future Study section).

- Minimal visual impacts without disadvantages of tunnel.
- Bikes/pedestrians are fully grade separated from the four lanes of Alma Street.
- Design serves to improve vehicular traffic flow while avoiding traffic inducement. Traffic Study shows Underpass design has better LOS than other alternatives
- Design creates a loop system for bikes/pedestrians - with direct connections to frequent locations. Some trips would be more direct, for others less, but would avoid a lengthy traffic signal at Alma.
- Lower construction duration and impacts than trench and tunnel.
- Potentially lower cost than tunnel, trench, and viaduct.

5.5.4.2. Underpass Disadvantages

- As currently designed, this option requires significant property acquisitions. There is strong community opposition to any potential property acquisitions.
- Complex navigation for bikes and cars.
- Limits certain traffic movements.
- Potential minor traffic diversion through neighborhood (page 26/27 of Final Traffic Report).
- Concerns about accessibility of driveways on arterials being impacted by additional traffic.

5.6. Priority Areas for Future Study

Choices for the Meadow and Charleston crossings share a set of areas for future study areas with other sections of this report. Specifically:

- CalTrain advocacy and coordination with a corridor-wide grade separation project
- The presence or absence of four-track segments in South Palo Alto
- Formalizing impact from the community on bicycle and pedestrian issues
- Geotechnical and groundwater analysis

5.6.1. Geotechnical and Groundwater Analysis

The hybrid, trench, and underpass alternatives all require significant excavation. The XCAP recommends that the council authorize a preliminary geotechnical and ground water analysis. This information is needed to help refine the cost estimates and provide insight about alternative construction methods.

5.6.2. Construction Methods

A technology referred to as “jacked box construction,” in which a precast box is pushed into place, was identified early on as a potential construction method that could be used to avoid needing electrified shoofly tracks which are expensive, disruptive and add significantly to construction time. This method was most recently used⁵⁰ in Florida and Long Island, NY, resulting in significantly shorter construction time.

A design goal of the XCAP Underpass Concept was to avoid moving the tracks at all (to reduce cost, construction time and complexity), but without further geotechnical studies, it is not possible to determine whether this approach is feasible. Caltrain has indicated interest in understanding more about construction methods that could avoid the need to construct electrified shoofly tracks through its Corridor Wide study.

XCAP recommends that Staff provide Caltrain the materials gathered through XCAP and through public comment related to Jacked Box construction for incorporation into Caltrain’s Corridor Wide Grade Separation Study.

5.6.3. Viaduct: Specific Study Areas

- More detailed plans. The plans that XCAP has for the viaduct include very few dimensions, so it is hard to ascertain the visual and other impacts of the proposal. In addition, none of the plans describe the actual structure and shape of the viaduct. This would go a long way to helping the community better understand what is actually being proposed.

⁵⁰ <https://www.orlandosentinel.com/news/transportation/os-ne-brightline-tunnel-construction-20200917-cj66ylrgafah7dlb6iiuekatye-story.html>

- More renderings. XCAP has a few images that show the proposed visual impacts of the viaduct, but not nearly enough considering that the visual impacts are a main disadvantage of this option.
- A plan showing where the viaduct would be placed to one foot of accuracy.
- Cross sections every 100'-200' from east of Alma Street to the first property on Park Avenue, shown with potential screening and sound mitigations.
- A formal accounting of how many properties are affected by the viaduct showing a longitudinal profile of the track elevation compared to the lots affected.
- Additional noise analysis, including a prediction for noise levels farther from the tracks. A large number of commenters are concerned that the viaduct, because of its height, will transmit sound farther than the other alternatives and they would like to understand what this will actually mean.
- A partnership with a landscape architect and/or urban designer is highly recommended to ensure that the planned structure and any improvements to the land under the structure are compatible with the look and feel of the rest of the city.

5.6.3.1. Usable Space

Policymakers should consider the possibility that negotiating with Caltrain could provide the City with a new opportunity – space at ground level that would previously have been occupied by train tracks would now be vacant. What sorts of things could the city do with that space?

For instance, a large transit project in Melbourne that included many viaducts⁵¹ included public art, parks, gardens, and other facilities in the space opened up by the construction project. Similarly, the Ohlone Greenway in the East Bay runs partially on land adjacent to a BART viaduct.⁵² Similar designs could be an asset to Palo Alto.

The XCAP recommends further study of potential uses of this space be considered as part of Caltrain's Corridor-wide grade separation study. Caltrain may have multiple places where cities would be asking for similar use permits, and they could consider acceptable public uses as part of their study.

5.6.3.2. Maintenance

If the viaduct concept is pursued further, XCAP recommends that Staff work with Caltrain to negotiate the long-term maintenance of this land after construction and in perpetuity to maintain attractive landscaping. Standards related to this issue, including whether fencing will be needed should be clarified and included in formal agreements. More information related to fencing is in Chapter 6.

⁵¹ <https://www.foreground.com.au/transport/melbourne-sky-rail-lessons-learned/>

⁵² https://en.wikipedia.org/wiki/Ohlone_Greenway

5.6.3.3. Visual Design and Privacy

To improve the visual appeal of a viaduct, XCAP would recommend consideration of a variety of construction materials, shapes, and surface treatments that could enhance how a viaduct fits into the landscape. Any viaduct should be designed in close collaboration with the community, working with landscape and urban designers, to build community support. The use of noise barriers as a potential way to increase privacy for the homes along the tracks should be explored.

5.6.4. Hybrid: Specific Study Areas

- Could the maximum track height be lowered to less than 15 feet? How much can the tracks be lowered before full or partial property acquisitions are required?
- Could there be some partial acquisitions that could enable some advantage in height?
- Which properties would require driveway modifications?
- What sound mitigations can be done and what do they look like?
- What do the bike and pedestrian pathways look like in more detail?
- Can the maximum grade on the bike and pedestrian ramps be lowered to 5% or less? What is the impact on total ramp length (and possibly properties)?
- What mitigations are possible for eastbound bikes traveling downhill that may have limited sight and limited stopping distance approaching the Alma intersection?
- If the building of the grade separation increases capacity and induces more traffic, what additional protections will be necessary to mitigate more bikes sharing the road? (Example: Will protected bike lanes be needed and how far would they need to extend?)
- Would this design preclude the ability to add two additional tracks for HSR if required?
- Is there enough queuing space for cyclists traveling eastbound towards each intersection to accommodate those waiting for a traffic signal?

5.6.5. Trench: Specific Study Areas

The trench is desired by many because it removes the train from view, but a trench design involves significant engineering challenges. It is important for the community and Council to have realistic expectations: a trench design will not be easy, but it is not impossible. Because this is such a complicated design, it is critical that the City select a consultant with trench experience.

The engineering challenges of a Charleston/Meadow trench include the following:

- Because the water table is relatively shallow in the Charleston/Meadow area, the trench may affect groundwater both during and after construction. This includes the potential of the groundwater leaking into the trench and the potential for the trench interfering with the flow of groundwater.

- Because both Baron Creek and Matadero Creek are relatively close to Meadow Drive and Charleston Road, the trench can potentially interfere with the creeks' water flow. Any modification to the flow of these creeks requires the approval of Valley Water and other regulatory agencies.
- The trench walls must be supported to prevent the walls from caving in. Some methods for providing such support may extend outside of the trench, possibly affecting or constraining public and/or private property.
- Because trench involves changing the elevation of the tracks, any trench design affects train operations and thus requires Caltrain approval. In particular, Caltrain must approve both the track slope and vertical curvature that is used in the trench.
- Like many of the alternatives, the trench involves extensive construction, requiring both significant budget and a significant construction duration.

Some of these issues are coupled. For example, some approaches that reduce the trench/creek interference result in a deeper trench, which may increase groundwater impacts.

Additional information is available in Appendix C-3 Concerns with Meadow-Charleston Trench Design.

5.6.5.1. Possible Trench Design Techniques

Because of the variety of engineering challenges, any successful trench design will require many iterations. Possible trench-design approaches to consider include:

- The trench must be deep enough to pass below the Charleston and Meadow bridges. The current design has the rail 30 feet below the road surface; this trench depth could be reduced by designing bridges with thin decks and providing minimal clearances under the bridges. Every foot of reduced trench depth reduces the trench length by 100 feet, thereby reducing construction costs and potentially reducing trench/creek interference.
 - Designers should consider how to reduce bridge-deck thickness, including using truss bridge design. In particular, a bow-string arch or tied-arch design with a short height might produce an attractive design that appeals to the community.
- The Hatch Mott McDonald trench design (October 2014) chose to avoid creek impacts by routing the trench under the creeks, resulting in a longer, deeper trench.
 - This over-the-trench routing is more feasible for the shallow low-flow Barron Creek, but routing Adobe Creek's larger flow above the trench would require significant collaboration with Valley Water.
 - This longer trench could also impact the Caltrain crossover-track section just north of San Antonio. Like many other things, any crossover-track relocation would have to be approved by Caltrain.
- Caltrain's preferred maximum grade (slope) is a 1% grade but grades up to 2% are allowed with a Caltrain design exception.

- The trench's creek interference is affected not only by the maximum allowable grade, but by the allowable vertical curvature. The vertical curvature affects how quickly the tracks can change their grade. If Caltrain allows a more-rapid vertical curvature, the trench will be able to change elevations more rapidly, making it easier to avoid creek impacts and also reducing the trench length and cost.
 - If Caltrain does not grant a 2% design exception, the trench design might be impossible. The Hatch Mott McDonald deep trench approach might work, but there could be potential impacts with the San Antonio Caltrain station.
- Trench interference with Adobe Creek can be reduced by maximizing the slope of the tracks between Adobe Creek and Charleston Road. That is, move as much vertical curvature north of Charleston and south of Adobe Creek so that the Charleston/Adobe stretch is as steep as possible.
 - Slightly elevating the track south of Adobe Creek allows some of the vertical curvature to occur south of Adobe Creek, allowing the tracks to cross the creek at an incline.
 - Similarly, moving the vertical curve to the north of Charleston Road also maximizes the slope between Charleston and Adobe Creek. However, this does increase the maximum depth of the trench.

5.6.5.2. Questions for Caltrain

- Is it possible for Caltrain to loosen the constraints on maximum grade, maximum vertical curve, and length between vertical curves allowed for passenger and freight trains?
- Considering that relatively few freight trains operate on the Caltrain corridor, would reducing the design speed for freight help loosen those constraints further?
- If a trench is constructed for the Charleston and Meadow intersections, would a trench lid be possible between Charleston/Meadow and how long could the lid sections be while still allowing adequate spacing for emergency access?
- A crossover track section is currently located north of the San Antonio station. Must this crossover remain in its current location? If the current location interferes with a grade-separation design, could the crossover be moved south of the San Antonio station?

5.6.5.3. Adobe Creek Analysis

- Any trench interference with Adobe Creek can potentially be mitigated by widening the creek below the trench. To the first order, the cross-sectional area of the creek must match the cross-section of the creek's culvert under Alma.
 - What are the cross-sectional dimensions of the Adobe Creek culvert currently under Alma?
- In trench interference with Adobe Creek cannot be avoided, a siphon (either a passive or powered) could be installed to route the water under the trench.
 - If a passive siphon is used to pass the water under the rail trench, what maintenance must be performed to keep sediment from reducing the siphon

performance? Could a sediment trap be constructed upstream (e.g., near Miller Ave) to reduce the sediment that reaches the siphon?

- If a powered siphon is used to pass water under the rail trench, what are the impacts of a power outage on the siphon? That is, would the unpowered siphons still allow significant passive flow?
- During dry periods, would siphons (either passive or powered) allow standing water which might allow mosquito breeding?

5.6.5.4. Barron Creek Analysis

- If Barron Creek is made to flow over the trench, the trench could be shortened if Barron Creek can be moved south.
 - Currently, Barron Creek flows north along the west side of the tracks before crossing under the tracks and Alma. Designers should investigate whether Barron Creek can be made to cross the trench then flow north on the east side of the tracks (or on the east side of Alma). That is, make Barron Creek cross the trench at the same point that it crosses Park Blvd.

5.6.5.5. Groundwater Analysis

- Groundwater can be impacted during construction. Some construction techniques completely seal the trench during construction, while others require varying amounts of dewatering pumping during construction. Since large-scale pumping during construction can dramatically lower the local water table, the trench design should carefully consider the groundwater impacts during construction.
 - For example, the Carlsbad trench project identified three construction techniques (Secant Pile Wall, Slurry-Diaphragm Wall, Deep Soil Mixing Wall) which seal the site in order to minimize the amount of dewatering required during construction. Would these construction techniques similarly seal a Charleston/Meadow trench?
- While a sealed trench prevents groundwater leakage into the trench, it can still impact groundwater by interrupting the flow of groundwater. Palo Alto needs to analyze how a 30–40-foot trench affects groundwater flow.
 - For example, after measuring groundwater depths and collecting soil samples, the Carlsbad trench project performed an analysis to predict the amount of groundwater mounding on the upgradient side of their trench wall. For a 50-foot trench model, their analysis predicted groundwater mounding ranging from 0.2 to 4 feet.
 - A similar analysis should be performed for Palo Alto soils to predict the groundwater impacts for a Charleston/Meadow trench, along with identifying any possible design techniques (such as permeable fill adjacent to the trench) that may mitigate groundwater impacts.
 - Considering that developments along El Camino have deep basements, how much of an incremental effect would a trench have on groundwater flow? Do the

El Camino developments push the groundwater flow deeper? Or can groundwater flow around the buildings?

5.6.5.6. Project Cost and Duration

- While geographic and inflation complicate the comparisons, the AECOM cost estimates for a Charleston/Meadow trench do not seem consistent with the Reno, San Gabriel, and Carlsbad trench projects with data that has been publicly available. An independent cost estimate of AECOM's work seems warranted given the large disparities and the overall high cost of the project itself. Any cost comparisons should delineate the reasons for any cost differences between these projects and a Charleston/Meadow trench.
- Similarly, the AECOM construction duration estimates do not seem consistent with the actual schedules for Reno and San Gabriel. An independent assessment of construction duration should include a description of reasons for any schedule difference between a Charleston/Meadow trench and the Reno and San Gabriel trenches.

5.6.6. Underpass: Specific Study Areas

The Charleston and Meadow Underpass designs were created in response to the criticisms of the visual impact of the viaduct and hybrid options, the higher costs of a trench or tunnel, the need to allow for a four-track eventuality, and the prolonged construction impacts of both other alternatives. Unlike the Churchill Partial Underpass concept, which was submitted by an engineer and an architect that provided conceptual 3D drawings, the Meadow/Charleston Underpass concept began with a conceptual sketch. Once COVID hit, the underpass suffered from limited review and iterative improvements, new restrictions on consulting expenses based on the new budget limitations, and the limits of Zoom meetings. In addition, the consultants' design for Meadow differs significantly from the original proposal.

XCAP recommends further iteration of the conceptual designs for Meadow/Charleston. Overall, concerns raised by the initial concept include:

- The need for property acquisition compared to other alternatives.
- Bike/Pedestrian access, particularly on the west side of the tracks.
- The complexity of routes for bikes, pedestrians, and vehicular traffic.
- Potential traffic diversion into existing neighborhoods.
- Difficulty getting in and out of driveways for homeowners along Charleston on the East side.
- A lengthy construction period.

5.6.6.1. Underpass Process and Considerations

While the AECOM preliminary design is a useful starting point for understanding the tradeoffs between ease of turn movements and potential property impacts, a more developed alternative may differ substantially from what AECOM finally presented to XCAP. While XCAP members provided cursory feedback on AECOM's alternative, it was clear further technical iterations were

necessary and, for time and budget reasons, substantive comments could not be incorporated into a revised alternative.

Unfortunately, the COVID emergency also meant that the video prepared for the Virtual Town Hall which was really a construction phasing video, did not match the renderings and plans, and thus did not include critical bike connections and did not highlight an additional turn movement (at Meadow) which had been discussed.

5.6.6.2. Public Outreach

Overall, the XCAP process has made it clear there are no alternatives that stand out as clear winners that easily achieve consensus community support. All the alternatives have pros and cons that must be weighed or resolved. The Underpass alternative has the highest possibility of property acquisition or eminent domain, thus the design refinements and public outreach on this alternative likely needs to be extensive so the community can understand the trade-offs and mitigations being considered. This point is especially important if the alternative requires additional funding from the community.

The Meadow/Charleston Underpass alternatives did not receive the benefit of a live Town Hall with the ability to explain the concept. The Virtual Town Hall explained the existing AECOM design, but did not present it as a preliminary concept that needed more iterations to address the significant issues identified. And the inconsistencies between the drawings and the videos led to some confusion, further impacting the public's ability to understand the initial concept. In the future, it is critical to ensure all work is consistent across all modes of communication, particularly on bike/pedestrian design.

5.7. Additional Considerations

5.7.1. Traffic Studies

Traffic studies were performed by Hexagon Transportation Consultants. The report can be found in Appendix B 3 1 Final Traffic Study – Hexagon Traffic Consultants. Traffic analyses were performed considering Meadow and Charleston together.

5.7.1.1. Meadow and Charleston Viaduct

The results of the traffic study for existing traffic conditions on the Meadow and Charleston Viaduct are summarized in the table below:

Table 3
Meadow and Charleston Grade Separation Alternatives – Existing Traffic Volumes

Traffic Operations (Existing Traffic Volumes)									
No Improvements									
(No Electrification) ¹									
Viaduct ²									

Analyses of the traffic in future conditions are summarized in the table below:

Table 4
Meadow and Charleston Grade Separation Alternatives – Future Traffic Volumes

Traffic Operations (Year 2030 Traffic Volumes)													
	Traffic Control	No Improvements (No Electrification) ¹				No Improvements (With Electrification) ²				Viaduct ³			
		AM		PM		AM		PM		AM		PM	
		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
		(secs)		(secs)		(secs)		(secs)		(secs)		(secs)	
Meadow Drive													
Alma Street & Meadow Drive	Signal	215.03	F	318.96	F	318.39	F	502.87	F	68.93	E	238.26	F
Charleston Road													
Alma Street & Charleston Road	Signal	330.72	F	330.31	F	421.58	F	535.47	F	114.94	F	274.50	F
Notes:-													
1. All turning movements permitted. Analysis assumes 8 trains per hour with no electrification. Traffic analysis was conducted using SimTraffic.													
2. All turning movements permitted. Analysis assumes 14 trains per hour with electrification. Traffic analysis was conducted using SimTraffic.													
3. All turning movements permitted. Traffic analysis was conducted using SimTraffic.													

The results show that level of service returns to F when modeled under future traffic conditions in 2030, and level of service remains the same as it does today.

5.7.1.2. Meadow and Charleston Hybrid

Traffic impacts would be similar to that of the Viaduct.

5.7.1.3. Meadow and Charleston Partial Underpass – With U-Turn at Alma Village Circle

Traffic analyses involved three options for the northbound and southbound ramp intersections at Meadow Drive:

1. Traffic signal at the Alma southbound off-ramp and no control at the Alma northbound off-ramp. Left-turning traffic from eastbound Meadow would have to find gaps in the uncontrolled traffic flow on westbound Meadow.
2. Traffic signal at the Alma southbound off-ramp and an all-way stop control at the Alma northbound on-ramp.
3. Traffic signals at both the southbound off-ramp and northbound on-ramp.

The results are summarized in the table below:

Table 5
Meadow and Charleston Partial Underpass with U-Turn at Alma Village Circle – Future Traffic Volumes

Traffic Operations (Year 2030 Traffic Volumes) - Partial Underpass															
	Traffic Control	Option 1				Traffic Control	Option 2				Traffic Control	Option 3			
		AM		PM			AM		PM			AM		PM	
		Delay (secs)	LOS	Delay (secs)	LOS		Delay (secs)	LOS	Delay (secs)	LOS		Delay (secs)	LOS	Delay (secs)	LOS
<u>Alma Village Circle</u>	Signal	18.84	B	19.37	B	Signal	18.38	B	20.1	B	Signal	18.86	B	20.7	B
<u>Meadow Drive</u>															
Alma Street SB Off-Ramp & Meadow Drive	Signal	10.92	B	11.94	B	Signal	12.11	B	14.91	B	Signal	13.47	B	14.43	B
Alma Street On-Ramp & Meadow Drive	Uncontrolled	5.10	A	5.10	A	AWSC	7.90	A	7.90	A	Signal	9.50	A	9.90	B
Meadow to NB Alma (On-Ramp)	Yield	35.80	E	27.00	D	Yield	35.10	E	28.20	D	Yield	37.30	E	28.60	D
<u>Charleston Road</u>															
Alma Street & Charleston Road (N)	Signal	13.61	B	25.97	C	Signal	18.23	B	26.36	C	Signal	14.90	B	27.40	C
Alma Street & Charleston Road (S)	Signal	20.75	C	19.24	B	Signal	20.25	C	19.61	C	Signal	21.24	C	19.30	C
EB Charleston to SB Alma (On-Ramp)	Yield	8.60	A	38.90	E	Yield	9.80	A	38.40	E	Yield	9.00	A	38.50	E
Mumford Place & Charleston Road	Roundabout	6.08	A	9.71	A	Roundabout	6.15	A	11.94	B	Roundabout	5.88	A	11.11	B
Notes:-															
AWSC - All Way Stop Controlled															
1. Option 1 - At the Medow Dr and Alma NB-On Ramp intersection, analysis assumes through traffic on Meadow does not stop. Left-turns from Meadow to Alma northbound would yield to westbound traffic on Meadow. The delay for the eastbound left-turns is shown in the table.															
2. Option 2 - At the Meadow Dr and Alma NB-On Ramp intersection, analysis assumes an all-way stop control.															
3. Option 3 - At the Meadow Dr and Alma NB-On Ramp intersection, anaysis assumes a traffic signal.															
4. The following turning movements are restricted at Alma/Meadow and Alma/Charleston due to the partial underpass.															
- Alma/Meadows - right-turn from eastbound Meadow, left-turn from westbound Meadow, left-turn and right-turn from northbound Alma.															
- Alma/Charleston - left-turn from eastbound Charleston, left-turn from northbound Alma, right-turn from southbound Alma.															
5. The analysis assumes a northbound U-turn lane at Alma/Alma Village Circle signal to allow northbound traffic on Alma Street to make a U-turn and use the southbound off-ramp to Meadow Drive.															

When compared to the level of service with existing intersection designs, all three options show improvements in level of service. The improvements are very similar, with perhaps Option 1 edging out the other two options with slightly more improvement than the others.

5.7.2. Noise

The Noise and Vibration Final Report is available in the Appendix B 4 Noise and Vibration Comparative Analysis Report. The report explains that of all the types of noise caused by trains (horns, propulsion/engine noise, wheel/rail noise and other), the most significant source in a “train pass by event” is the horn. The Federal Railroad Administration requires that train engineers sound their horn four times when approaching a grade crossing.⁵³ All of the options would eliminate horn noise, which would very significantly reduce noise compared to the situation today.

Table 5-1 provides a summary of how the relative contributions of rail and road noise sources may be expected to change as a function of proposed alternatives. Most noise source levels will be reduced by most alternatives as they introduce more noise reducing features such as increased shielding from noise barriers or structures, however, it is noted that engine noise from hybrid and viaduct alternatives could increase slightly since the increased elevation of the rail path may reduce the effectiveness of first row shielding at second row homes.

Table 5-1 Noise Source Changes by Alternative

Proposed Alternative	Potential Noise Reduction			
	Horns/Bells	Wheel/Rail	Engine	Road
Existing	No change	No change	No change	No change
EMU trains	No change	No change	Reduction	No change
Closure	Reduction	No change	No change	No change
Trench	Reduction	Reduction	Reduction	No change
Viaduct	Reduction	Reduction	Reduction ¹	No change
Hybrid	Reduction	Reduction	Reduction ¹	Reduction ²
Tunnel (passenger + freight)	Reduction	Reduction	Reduction	No change
Tunnel (freight at grade)	Reduction	Reduction	Reduction	Reduction
Underpass	Reduction	No change	No change	Reduction ³
1) May create some increased noise level beyond first row for diesel freight events 2) decrease at receivers to west 3) depends on new roadway configuration				

Source: pg. 20 Noise Vibration Comparative Analysis Report

It should be noted in the chart above that the noise report did not consider the possibility of using a noise parapet (sound wall) to reduce wheel/rail noise, but that if this noise treatment were applied, there would be a reduction.

Also, in the chart above, Closure is only an alternative for Churchill (not Meadow/Charleston).

⁵³ <https://railroads.dot.gov/highway-rail-crossing-and-trespasser-programs/train-horn-rulequiet-zones/train-horn-rule-and-quiet#:~:text=Under%20the%20Train%20Horn%20Rule,of%20all%20public%20grade%20crossings.>

Generally, the noise impact of all of the solutions is likely to be about the same, with the exception that the hybrid will measurably reduce road noise from Alma Street for some areas.

Commenters to XCAP expressed the desire to learn more about the noise impacts -- in particular, the noise study provided to XCAP did not provide data on noise effects more than two homes away from the rail corridor. In addition, the report indicated "Second row homes to both the east and west receive some acoustical shielding by the first row of homes" but neighbors questioned this concept since homes along the West side of the track are only one story and train in some scenarios could be higher than a single-story home. Additional data may be necessary in order to address community concerns.

For ground vibration, the report found the following:

Table 6-1 Potential Change in Ground-Borne Vibration by Alternative

Alternative	Qualitative Change in Ground Born Vibration
Grade Crossing Closure	No Change
Churchill Viaduct	Significant reduction for homes both east and west.
Meadow/Charleston Viaduct	Significant reduction for both east and west, but slightly better for west.
Hybrid	Slight reduction for homes both east and west
Trench	Slight reduction for homes both east and west
Tunnel, passenger and freight	Probable slight reduction for homes both east and west
Tunnel, freight at grade	Slight reduction for homes to west, possible increase for homes to east for nighttime freight events (which would be moved closer to homes)
Underpass	Little or no change
Source: FTA 2018, Table 6-12	

As seen in Table 6-1, most of the proposed alternatives would either create no significant change or perhaps a slight improvement in ground-borne vibration. The viaduct alternative may provide a significant improvement. Only the Tunnel with at-grade freight alternative would likely increase vibration levels slightly for homes to the east, but only for the few nighttime freight train events.

It should be noted that, if one alternative is selected for construction, a more detailed ground vibration engineering analysis should be completed to develop a more detailed vibration impact assessment and provide detailed recommendations for vibration mitigation features to be incorporated into the final design.

Source: pg. 24 Noise Vibration Comparative Analysis Report

As can be seen in the figure above, the Viaduct provides the most significant vibration reduction.

Finally, the report also discussed the relative noise impacts during construction:

Table 7-1 Potential Construction Noise and Vibration Issues by Alternative

Alternative	Estimated Activity Creating Construction Noise and Vibration Impacts
Grade Crossing Closure	Minor construction noise impacts. Intersection modification to Alma at Churchill and construction of pedestrian underpass. No temporary track construction required. May require backhoe, jackhammers, excavator, concrete mixers, dump trucks. Two year duration.
Viaduct	Moderate construction noise impacts. Construction, use and demolition of temporary tracks, removal of current tracks, installation of pillars, pathway and new track system. Will require use of dozers, graders, cranes, concrete trucks, heavy trucks, pneumatic tools, tie cutters/inserters. Two year duration.
Hybrid	Moderate to severe construction noise impacts. Construction, use and demolition of temporary tracks, removal of current tracks, construction of raised railbed, bridges over cross streets, and new track system. Will require use of dozers, graders, cranes, concrete trucks, dump trucks, pneumatic tools, pile drivers, tie cutters/inserters and truck haul routes to import fill. Four year duration.
Tunnel, passenger and freight	Moderate to severe construction noise impacts. Construction, use and demolition of temporary tracks, removal of current tracks, boring and construction of tunnels and approach trenches, install new track system. Will require use of dozers, excavators, tunnel boring machine, cranes, concrete trucks, dump trucks, pneumatic tools, tie cutters/inserters, and truck haul routes to move material. Six year duration.
Tunnel, freight at-grade	Moderate to severe construction noise impacts. Construction of new at-grade freight tracks, removal of current tracks, excavation and construction of trench, road bridges over trench, construct new freight track pathway, install new track system. Will require use of dozers, excavators, cranes, concrete trucks, dump trucks, pneumatic tools, tie cutters/inserters and truck haul routes. Six year duration.
Trench	Severe construction noise impacts. Construction, use and demolition of temporary tracks, removal of current tracks, excavation and construction of trench, construct road bridges over trench, install new track system. Will require use of dozers, excavators, cranes, concrete trucks, dump trucks, pneumatic tools, pile drivers, tie cutters/inserters and truck haul routes to remove material. Six year duration.
Underpass	Severe construction noise impacts. Construction, use and demolition of temporary tracks, removal of current tracks, excavation and construction of underpass roadways and ramps, construction of road and rail bridges, install new track system. Will require use of dozers, excavators, cranes, concrete trucks, dump trucks, pneumatic tools, pile drivers, tie cutters/inserters and truck haul routes to remove material. Unknown duration.

Source: FTA 2018, Table 7-1

Source: pg. 25 Noise Vibration Comparative Analysis Report

5.7.3. Agencies Involved in Groundwater and Creek Issues

According to Joe Terisi, a Registered Civil Engineer⁵⁴, our local creeks are assigned the following “listed beneficial uses” by the Regional Board’s San Francisco Bay Basin Plan:

5.7.3.1. Matadero Creek

- Cold Freshwater Habitat (COLD)
- Warm Freshwater Habitat (WARM)
- Fish Migration (MIGR)
- Fish Spawning (SPWN)
- Preservation of Rare and Endangered Species (RARE)
- Wildlife Habitat (WILD)
- Water Contact Recreation (REC-1)
- Noncontact Water Recreation (REC-2)

5.7.3.2. Adobe Creek

- Cold Freshwater Habitat (COLD)
- Warm Freshwater Habitat (WARM)
- Wildlife Habitat (WILD)
- Water Contact Recreation (REC-1)
- Non-Contact Water Recreation (REC-2)

5.7.3.3. Permitting Agencies

Matadero and Adobe Creek are subject to the jurisdiction of several permitting agencies. It is likely that all of the agencies below would have to be consulted in order to successfully plan any changes that could affect the creeks:

- Federal Emergency Management Agency
- Valley Water (formerly Santa Clara Valley Water District)
- State Department of Fish & Wildlife Stream Alteration Agreement
- Regional Water Quality Control Board Section 401 Water Quality Cert
- US Army Corps of Engineers Section 404 Permit

⁵⁴ Mr. Terisi was the Stormwater Manager for the City of Palo Alto from 1990 to 2016. More information is available in Appendix B-2-C Update from Technical Working Group Regarding Review of New Ideas pages 12-16

6. Rail Safety in Palo Alto

Historically, safety drove grade separation projects in many cities, including the underpass at Embarcadero Road here in Palo Alto. Operation Lifesaver⁵⁵, a non-profit funded by both the federal government and the railroad industry, estimates that 95% of railroad fatalities in the US are due to either pedestrian trespass or accidents at grade crossings.

This section attempts to record the current state of grade crossing safety in Palo Alto, and recommend how the City can move forward to ensure that our community will be safer in the future.

6.1. Incident Data

Between 2008 and August 2020, there were 25 incidents at Palo Alto's four grade crossings in which a train struck, or nearly struck, either a pedestrian or a vehicle.⁵⁶ Eight were fatalities.

In the same period, there were 11 incidents — seven with vehicles and four with pedestrians — at the Charleston Road crossing alone. All of the pedestrians were killed, and all were ruled a suicide according to data provided by the Federal Railroad Administration. One of the two vehicular fatalities was ruled a suicide.

At East Meadow Drive there were six incidents — four with vehicles and two with pedestrians. Both pedestrians were killed, and both were later ruled suicides according to the FRA database. In addition, a vehicle went around the gate in 2007 and an occupant was killed, although it was not ruled a suicide.

At Churchill Avenue there have been seven incidents during the 2008 - 2020 time span, all involving vehicles, and none fatal. (However, these seven accidents accounted for \$63,500 in vehicle damage according to the FRA.) There has also been one incident at Palo Alto Avenue in this period, which was not fatal.

The Federal Railroad Administration maintains a system called the Web-Based Accident Prediction System⁵⁷ with data about every incident on every rail crossing in the US. A query of this database on August 6, 2020 produced the following summary data for our crossings in Palo Alto:

⁵⁵ Operation Lifesaver: <https://oli.org/>

⁵⁶ <https://safetydata.fra.dot.gov/webaps/>

⁵⁷ Web-Based Accident Prediction System: <https://safetydata.fra.dot.gov/webaps/>

Crossing	Predicted Collisions	Incidents Since 2015	Trains/Day	Train Speed	Vehicles/Day
Charleston Rd	0.543445	6	96	79	20,000
Churchill Ave	0.422541	5	96	79	12,000
East Meadow Dr	0.358559	4	96	79	9,331
Palo Alto Ave	0.058481	0	96	79	14,200

The “Predicted Collisions” column in this table is described by the FRA as the “probability that a collision between a train and a highway vehicle will occur at the crossing in a year.”

The value for Charleston Road, in other words, predicts a collision about every two years, and the aggregated data would suggest at least one grade crossing accident in Palo Alto every year. This value is currently the 19th-highest prediction score in California, and higher than any other crossing in Santa Clara County, based on queries to the WBAPS.

This number should be used carefully, however, as the FRA also states: “WBAPS does not state that specific crossings are the most dangerous. Rather, the WBAPS data provides an indication that conditions are such that one crossing may possibly be more hazardous than another based on the specific data that is in the program.” More detailed information is available on the Web-Based Accident Prediction System website: <https://safetydata.fra.dot.gov/webaps/>.

The railroad crossings in Palo Alto have historically created health and safety challenges for vehicles, pedestrians, and bicyclists. For example, according to the Palo Alto Historical Association website⁵⁸, a tragic collision at the crossing near Palo Alto High School in 1927 sparked a movement to improve safety at that intersection. Public advocacy and insistence on building an underpass (then known as a “subway”) led to the construction of the Embarcadero underpass nine years later in 1936.

Much later, Palo Alto suffered two youth suicide cluster incidents in 2009-10 and 2014-15, including the four pedestrian deaths at the Charleston Road grade crossing that were later ruled suicides. The City of Palo Alto subsequently implemented several measures to support our youth’s health and well-being, including public education about mental health resources⁵⁹. A comprehensive strategy was developed with input from key leaders in adolescent behavioral health, education, law enforcement, and Caltrain, also evolved to address means restriction (reducing access) and railroad safety.

⁵⁸ The Embarcadero Underpass: Accident Before Action: <http://www.paloaltohistory.org/embarcadero-underpass.php>

⁵⁹ Epi-Aid on Youth Suicide in Santa Clara County: <https://www.sccgov.org/sites/phd/hi/hd/epi-aid/Pages/epi-aid.aspx>

In collaboration with Caltrain and the City of Palo Alto's Emergency Response Department, several lethal means restriction methods were implemented, including:

- Professional track watch program with monthly incident reports.
- Removal of vegetation to enhance vision along the Caltrain rail corridor.
- Uniform eight-foot-tall fencing with 18-inch anti-climbing winglets on the East side of Alma Street.
- Intrusion Detection System (IDS) with nine cameras at the East Meadow Drive crossing.
- Warning system to prevent trespassing on the rail corridor.
- Signage for the assistance; crisis/suicide emergency hotline.

6.2. Safety Considerations for all Alternatives

Public safety must be a significant consideration in the implementation of any grade separation alternative. Regardless of what grade separation alternatives are eventually chosen, important safety considerations should be applied corridor-wide — not just at the location of new separations.

The XCAP recommends that the City Council adopt standardized safety protocols for the entire corridor as part of Caltrain's Corridor-wide grade separation project.

6.3. The Importance of Means Restriction

According to Harvard School of Public Health's Means Matter campaign⁶⁰, restriction to lethal means is one of the most effective ways to prevent a suicidal person's access to mechanisms that cause injuries and fatalities. Although this campaign focuses on firearm-related deaths, the train is also considered a lethal means for intentional harm.

In 2014, Scott Gabree, PhD, made a presentation titled "Potential Countermeasures to Mitigate Suicides on the Railroad Right-of-Way."⁶¹ This document shared several prevention efforts, including the use of blue lights,⁶² gatekeeper training, public awareness campaigns, signage for crisis center hotlines, media guidelines, means restrictions such as fencing, and track surveillance. XCAP recommends the incorporation of this document into discussions with Caltrain related to corridor wide safety improvements.

⁶⁰ Means Matter Campaign: <https://www.hsph.harvard.edu/means-matter/>

⁶¹ *Potential countermeasures to mitigate suicides on the railroad rights-of-way*. From <https://www.sprc.org/resources-programs/potential-countermeasures-mitigate-suicides-railroad-rights-way>

⁶² Some studies suggest that installing blue lighting on train platforms can reduce suicides. For example, this study from 2014: <https://pubmed.ncbi.nlm.nih.gov/25151192/>

According to Frank Frey, general engineer with track safety expertise for the Federal Railroad Administration,⁶³ the safest option for preventing injuries and fatalities at a dangerous crossing is closure. He also recommended tall fencing around “hot spot” areas where illegal trespass has occurred.

6.4. Safe Construction Recommendations

This section includes recommendations based mostly on the research and experience of former XCAP member Pat Lau, who had previously worked on Project Safety Net.⁶⁴ These suggestions are for the Council’s consideration for future design development as they go beyond the level of design detail available for XCAP at this time.

6.4.1. Fencing

Good fencing is an essential part of means restriction. The City should work to install uniform eight-foot-tall uniform fencing with an 18-inch anti-climbing winglet along the West side of the right-of-way to ensure access to the tracks is restricted. In addition, any sound barriers constructed as part of the grade separations, including for at-grade alternatives, can be considered an additional safety measure.

When adding fencing, it is also important to consider the “no-person’s land” in between fences, in case a new fence is installed in parallel to an existing fence — such areas can lead to their own set of challenges.

6.4.2. Considerations for Trenching and Tunneling

Illegal access to the tracks may be easier in places where the rail line enters a trench or tunnel, or anywhere near an open trench. Fences and sound barriers at the entrance to any potential trench or tunnel must be installed at these known “hot spots.” In addition, an Intruder Detection System (IDS) with multiple cameras and a warning system may be needed to monitor the rail corridor and identify at-risk behavior for intentional and unintentional injuries and fatalities.

6.4.3. Station Areas

Since grade separations still allow access to the tracks at station areas, additional safety measures may be necessary for stations to prevent pedestrians from trespassing there. For example, it will be important to make it clear which agency is responsible for responding to emergencies at or near stations.

⁶³ Frank Frey, General Engineer, Federal Railroad Administration, interviewed by former XCAP member Pat Lau.

⁶⁴ Lau's original safety recommendations submitted at XCAP meeting https://connectingpaloalto.com/wp-content/uploads/2020/07/2020-07-29_Item-4C_Draft-of-Chapter-6-Rail-Corridor-Safety-Measures.pdf.

6.4.4. Considerations for Passing Tracks

Finally, as Caltrain has indicated the potential need for passing tracks in Palo Alto (bringing the total number of tracks at a given spot from two to three or four), it is important to design and locate such segments so that they do not make it easier for trespassers to gain access to the tracks.

6.5. Additional Recommendations

Upon selection of final designs, XCAP recommends that egress and access safety protocols should be outlined and negotiated with Caltrain to ensure uniform protection across the corridor.

If the City must fund improvements, it should consider the cost of installation and maintenance of countermeasures to prevent illegal access to the Caltrain rail corridor as part of its budget process. The injury and fatality prevention efforts may include means restriction equipment such as standardized eight feet tall fencing with 18-inch winglets, Intruder Detection Systems (IDS) for track surveillance, flashing lights, warning systems, gatekeeper training, public awareness campaigns, signage for crisis center hotlines, and media guidelines.

XCAP also recommends that the City/School Liaison Committee, the City/School Traffic Committee, Safe Routes to School representatives, PABAC, PTAC, and PAUSD be consulted regarding the safety and efficacy of the recommended redesign alternatives. Mental health resources should be shared with key stakeholders including schools and community-based organizations, in an effort to prevent intentional injuries and fatalities on the Caltrain rail corridor.

7. Recommendations and Lessons Learned

The XCAP has three key sections for future considerations: Policymaker Recommendations, Technical Recommendations and Lessons Learned.

7.1. Recommendations for Policymakers

The following is a list of general recommendations for policymakers. The goal of these recommendations is to provide policymakers some alternatives for areas of on-going work.

7.1.1. Review Existing Reports and Policies to Inform Future Study and Consider Future Additional Criteria

The 2030 Comprehensive Plan (adopted Nov 2017), the City of Palo Alto Bicycle + Pedestrian Transportation Plan (2012) and the Rail Corridor Report (2013) all provide guiding principles and foundations which can be reviewed to guide future work.

2030 Comprehensive Plan

Relevant Comprehensive Plan Policies and Goals should be fully incorporated into the grade separation guidelines and criteria.

The 2030 Comprehensive Plan indicates that the primary sustainable transportation goal (Goal T-1) is to emphasize walking and bicycling to reduce GHG emissions and the use of single-occupancy motor vehicles. **Future grade separation design iterations should incorporate this goal as part of the primary focus.**

The Comp Plan also calls for prioritizing investments for “enhanced pedestrian access and bicycle use within Palo Alto” by incorporating improvements from related City plans like the 2012 Palo Alto Bicycle + Pedestrian Transportation Plan (Policy T-1.19). It also calls to “**increase the number of east-west pedestrian and bicycle crossings across Alma Street and the Caltrain corridor, particularly south of Oregon Expressway**” (Program T1.19.3). It also seeks to “enhance connections to, from and between parks, community centers, recreation facilities, libraries and schools for all users” (Policy T-3.2). In addition, to “avoid major increases in single-occupant vehicle capacity when constructing or modifying roadways unless needed to remedy severe congestion or critical neighborhood traffic” - but also that “when capacity is increased, designs must balance the needs of motor vehicles with those of pedestrians and bicyclists.” (Policy T-3.3)

The Comprehensive Plan also calls for a study to evaluate the implications of grade separation on bicycle and pedestrian circulation (Program T3.15.2). And that “until grade separation is completed, improve existing at-grade rail crossings to ensure the highest feasible level of safety along the corridor and provide additional safe,

convenient crossings (Policy T-3.17). The plan also calls for improving safety and minimizing adverse noise, vibrations and visual impacts of operations in the Caltrain rail corridor on adjoining districts, public facilities, schools and neighborhoods with or without the addition of High-Speed Rail Policy (T-3.18)

Additional Comp Plan visions, goals and policies that might be relevant for future planning are available in the Appendix B-12 Palo Alto Comprehensive Plan Excerpts.

City of Palo Alto Bicycle + Pedestrian Transportation Plan (2012)

The 2012 Bike Plan discusses several projects that form part of the bike/pedestrian network across the Caltrain ROW, including suggested new bike/pedestrian only crossings that have been recommended for study. (see New Bike/Pedestrian Connection beyond Meadow/Charleston for Interim Mitigations section below for more details).

Palo Alto Rail Corridor Study 2013

The 2013 Rail Corridor Study⁶⁵ identified opportunities to create more East/West connectivity across the Caltrain corridor for cars, bikes and pedestrians. XCAP recommends the Council and Staff consider the principles of that report when refining design concepts for ALL the grade separation alternatives.

The report explored opportunities to improve the circulation framework and connections while specifically highlighted the following:

- Provide additional rail crossings in the southern section of the study area.
- Strengthen the pedestrian and bicycle circulation framework and make connections to citywide facilities and amenities.
- Create a walkable, pedestrian and bicycle-friendly community with convenient and safe access to goods and services.
- Implement a Layered Street Framework.

The existing policies along with the now more developed possible grade separations alternatives could be used to update the City Council criteria and provide a framework for future work. More information is also available in Appendix B 13 - Rail Corridor Study – 2012 Excerpts.

7.1.2. Formalizing Bike/Pedestrian Input

Given the importance placed on bikes and pedestrians in the Comprehensive Plan, it is critical that more formalized, targeted feedback is sought for any additional work on grade separations. XCAP's understanding was that Staff would be liaising with the appropriate groups to garner feedback regarding bike/pedestrian design but that did not occur. Therefore, as part of future

⁶⁵ <https://www.cityofpaloalto.org/civicax/filebank/documents/38025>

work, **XCAP recommends the Council and City Staff develop a formal series of feedback from groups including:**

- Palo Alto Unified School District (PAUSD)
- Palo Alto Bicycle Advisory Committee
- Safe Routes to School (SRTS)
- Palo Alto Council of Parent Teacher Associations (PTAC)
- School Facilities personnel
- City/School Traffic Safety Committee

7.1.3. Geotechnical and Groundwater Analysis

The hybrid, trench and underpass alternatives (both Churchill Partial Underpass and Meadow/Charleston Underpass) all require significant excavation. The XCAP recommends that the council authorize a preliminary geotechnical and ground water analysis. This information is needed to help refine the cost estimates and provide insight about alternative construction methods (such as Jacked Box). (See Construction Methodology section.)

7.1.4. Passing Tracks and their impact on Design

Caltrain has made it clear that when presenting designs for consideration, Palo Alto must be able to show whether the design “precludes” the ability to add two additional passing tracks to accommodate High Speed Rail in the future. If HSR decides it needs four tracks, Caltrain and the City of Palo Alto have indicated HSR should bear the additional cost.

7.1.5. Caltrain Advocacy

The City should prioritize working on the Caltrain Corridor Wide Study and be active participants in scoping future areas of study - concentrating on the issue of potential passing tracks in Palo Alto, design standards that might impact Palo Alto’s design alternatives and construction methodologies that could cut costs.

7.1.6. New Bike/Pedestrian Connections as Key Infrastructure and Interim Mitigations

The 2012 Palo Alto Bicycle Plan, the 2013 Rail Corridor Study and the 2030 Comprehensive Plan (2017) all highlight two key additional crossings that should be studied: Seale Avenue/Peers Park in North Palo Alto and the vicinity of Loma Verde/Alma and Matadero Creek in South Palo Alto. Each of these projects provides stand-alone improvements that will help develop Palo Alto’s bike and pedestrian network but, in addition, these projects could be constructed ahead of any grade separation projects to provide a safe crossing for bikes/pedestrians during the long construction periods expected for grade separations (2-6 years). In addition, these projects could be completed regardless of whether or not passing tracks are needed.

The Loma Verde/Matadero Creek crossing would close a 1.3 mile bike/pedestrian crossing gap between the existing California Avenue bike/pedestrian tunnel and the surface crossing on Meadow Drive. It would provide a path connecting to Hoover Park to the east and beyond. In addition, it would also bridge a missing link between the South of Midtown neighborhood and the California/Ventura Mixed Use District and the Ventura neighborhood, then further connecting to the Bol Park Bike path that leads to Gunn High School and the Stanford Research Park employment center. And it would also provide a link between the El Carmelo School and Hoover Park for residents of the Ventura neighborhood.

7.1.7. Safety

Regardless of which grade separation is chosen, important safety considerations should be applied corridor-wide, not just at the location of new separations. The City Council should consider adopting standardized safety protocols for means restrictions the entire corridor as part of Caltrain's corridor-wide grade separation project.

Policymakers should also consider the cost of installation and maintenance of counter measures to prevent illegal access to the Caltrain corridor as part of the budget process for alternatives.

More information about Safety considerations is in Chapter 6.

7.2. General Technical Recommendations

The following are recommendations are technical in nature and relate to all the alternatives:

7.2.1. Noise and Vibration Study Addendum

XCAP received a number of concerns related to the Noise and Vibration Study. This report is one of the most technical received by XCAP and, while it was likely completed in accordance with industry standards, would benefit from additional work to explain impacts (or lack thereof) in relation to specific areas of concerns raised by the public. For example, the diagrams included impacts to homes in the first and second rows adjacent to the tracks but did not explain what happens beyond that distance. That should be addressed, particularly because there was concern that a "typical" noise study considers dwellings that might be two stories, but that the area in South Palo Alto is primarily a single-story overlay (mostly low slung Eichler homes) and that sound might carry farther. Any additional information to further contextualize the data for Palo Alto would be helpful to inform the public.

7.2.2. Urban Designer

XCAP recommends the City consider hiring an Urban Designer who can use all of the information gathered to date and see if there are ways to make the engineering requirements into comfortable environments for all modes of movement.

7.2.3. Safe Construction Recommendations

Uniform 8-foot-tall fencing with an 18-inch anti-climbing winglet should be considered for the entire west side of the ROW given that current fencing is inconsistent.

If a trench or tunnel is considered, designs should include special fencing or other barriers to address critical “hot spots” and deter any potential intrusion.

Intruder Detection Systems (IDS) with multiple cameras and a warning system should also be considered.

More information about Safety is also available in Chapter 6 Rail Safety in Palo Alto.

7.3. Technical Recommendations by Alternative

The following recommendations are specific to each alternative:

7.3.1. Churchill Closure with Mitigations

1. The following suggestions were made:
 - a. Mitigations should include the 2016 Bike Project and evaluate impacts to El Camino and Embarcadero and Embarcadero/Emerson/High Street and along both sides of Embarcadero (see: <https://www.cityofpaloalto.org/civicax/filebank/documents/53341>) (approved but removed from the Capital Improvement Program due to COVID - has been pushed out past the 5-year timeline).
 - b. Unofficial student pick-up/drop off locations along Embarcadero slip road and possible safety mitigations needed if more cars travel on that road.
 - c. Embarcadero intersection should be revisited when alternatives for Palo Alto Avenue and Downtown are selected.
 - d. Lincoln/Kingsley/High/Embarcadero multi-way intersection issue needs to be addressed to reduce neighborhood through traffic.
 - e. Consider working with Town & Country on reducing congestion on Embarcadero/El Camino.
 - f. Review proposed Pedestrian overpass over Embarcadero for safety issues.
 - g. Consider creating a comprehensive bike/pedestrian connection plan.
 - h. Bike/Pedestrian path at Seale before building the Churchill bike/pedestrian to allow safe crossing during construction. (and how that might be used for phasing a closure) (Note: bike/pedestrian path is consistent with park use and can be done on dedicated park land).
 - i. Study whether Park Blvd should be reopened between Southgate and Evergreen Park. Consider testing an opening. Neighborhood outreach is critical.

- j. Consider mitigations (ex. stairs) for the northwest corner of the Embarcadero grade separation, where westbound foot traffic (represented by the red arrow) on the north side of Embarcadero Road travels under the grade separation and then up through landscaping on the northwest embankment towards Town & Country, with many continuing to Palo Alto High School by looping across Embarcadero using the Embarcadero bike/pedestrian bridge adjacent to the railroad tracks (represented by the yellow arrow).
 - k. Consider a traffic signal at North California/Alma to have fewer cars along Churchill and to provide a signalized left out of Old Palo Alto.
2. Additional bike/pedestrian crossing mitigation future study areas:
- a. Add Bike/Pedestrian Crossing at Seale**
 - i. Recommended in Rail Corridor Plan
 - ii. Adds a Bike/Pedestrian crossing that can be built while mitigations are being built.
 - iii. Would provide a more direct Safe Route to School for Greene and Walter Hays from West of Alma and for Palo Alto High School from students West of Alma and South of Churchill.
 - iv. Reduces bike traffic on congested California Avenue bike/pedestrian tunnel and on Churchill tunnel.
 - v. Bikes on the west side of tracks end up on Park Blvd which is a bike path.
 - vi. Alternatives for Seale design could be center of the road or property acquisition to create bike/pedestrian ramps to separate from Alma and tracks.
 - b. Bike Option 2**
 - i. Explore closing Churchill to cars on the East side between Alma and Emerson - only homeowners and their guests would use the road. Residents would enter/exit Churchill from Emerson Street. Explore need and possibility for a turn-around at the end of resulting cul-de-sac.
 - ii. Consider the effect of changes on moving trucks, garbage trucks, emergency vehicles, etc. on an altered Churchill Ave block. Consider any traffic implications including any additional traffic onto Embarcadero.
 - iii. Explore use of the area from curb and landscaping between curb and sidewalk on both sides of Churchill Ave to enable an increase in width of ramp.
 - iv. Explore flatter, wider, taller and fully lit crossing with increased sightlines. Consider moving the entry to ramp further back from Alma to decrease ramp grade.
3. Analyze the impacts of widening the Alma Street bridge on the overall traffic network and any necessary mitigations.

4. Consider a cost-benefit analysis of whether the Embarcadero grade separation might eventually need replacement, whether opportunities exist to improve all turn movements if replaced, and what impact that has on other east/west arterials and their planned improvements since closure of Churchill could impact network resiliency.
5. Consider impacts of any roadway modifications to east/west travel, particularly regarding decisions made on the future Downtown coordinated Area Plan and the Palo Alto Avenue crossing.
6. Given the impacts to the overall project timelines from COVID, it is expected that an updated Traffic study eventually will be needed. The following suggestions are areas of future study that could be included:
 - Expand Traffic Study to include impacts beyond 2030 - Analysis describing network impacts of the proposed mitigations beyond 2030 are needed. Given the uncertainty of long-range forecasts, analysis with certain confidence bands and future scenario analysis should test how sensitive the LOS forecast predictions are to changes in the input assumptions.
 - Perform network LOS analysis of proposed mitigations and improvements to understand the queuing effects of these mitigations and whether they create capacity constraints at other intersections.
 - Consider potential delays to public transit or/and school buses that may result from concentrating more traffic on fewer roadways.

7.3.2. Churchill Partial Underpass

If the Council would like to pursue the Partial Underpass, further design review should seek to reduce the underpass cost, size and encroachment within the Caltrain ROW. Some ideas include:

- Explore whether raising the rail tracks by a few feet, which would reduce both the underpass depth and length along both Churchill and Embarcadero, potentially reducing property impacts and cost and improving visual appearances.
- Explore ideas to reduce the width of Churchill's lanes/shoulders to reduce the underpass width, further reducing excavation and construction costs.
- Explore whether it is possible to design a bike/pedestrian crossing closer to Churchill itself to address circuitousness created by having the bike/pedestrian crossing at either Kellogg or Seale.
- Work with Caltrain to address encroachment on their ROW.
- Model whether the building of a Partial Underpass could cause auto traffic inducement.

7.3.3. Churchill Viaduct

If the Council would like to pursue the Viaduct, some ideas for areas of further study include:

- Consider the exploration into a viaduct over Embarcadero, but with a reduced and diminishing height at the Churchill intersection to allow for a Homer-like bike/pedestrian underpass.
- Model whether building a Viaduct at Churchill would induce auto traffic.

7.3.4. Meadow/Charleston Viaduct

- Provide more detailed plans regarding dimensions, shape and structure to ascertain visual impacts in order to help communicate to the community what is being proposed.
- Provide more renderings to show the visual impact of the proposed viaduct.
- Provide a plan showing where the viaduct would be placed to one foot of accuracy to help understand light planes.
- Provide cross sections every 100'-200' from east of Alma Street to the first property on Park Avenue, shown with potential screening and sound mitigations.
- Provide a formal accounting of how many properties are affected by the viaduct showing a longitudinal profile of the track elevation compared to the lots affected.
- Additional noise analysis, including a prediction for noise levels farther from the tracks. A large number of commenters are concerned that the viaduct, because of its height, will transmit sound farther than the other alternatives and they would like to understand what this will actually mean.
- Partner with a landscape architect and/or urban designer to ensure that the planned structure and any improvements to the land under the structure are compatible with the look and feel of the rest of the city.

Usable Space

Policymakers should consider the possibility that negotiating with Caltrain could provide the City with a new opportunity – space at ground level that would previously have been occupied by train tracks would now be vacant.

The XCAP recommends further study of potential uses of this space be considered as part of Caltrain's Corridor-wide grade separation study. Caltrain may have multiple places where cities would be asking for similar use permits, and they could consider acceptable public uses as part of their study.

Maintenance

If the viaduct concept is pursued further, XCAP recommends that Staff work with Caltrain to negotiate the long-term maintenance of this land after construction and in perpetuity to maintain

attractive landscaping. Standards related to this issue, including whether fencing will be needed should be clarified and included in formal agreements as discussed in the section on Safety.

Visual Design and Privacy

To improve the visual appeal of a viaduct, consider a variety of construction materials, shapes, and surface treatments that could enhance how a viaduct fits into the landscape. Any viaduct should be designed in close collaboration with the community, working with landscape and urban designers, to build community support. The use of noise barriers as a potential way to increase privacy for the homes along the tracks should be explored.

7.3.5. Meadow/Charleston Hybrid

- Explore whether the maximum track height can be lowered to less than 15 feet with minimal impact to properties.
- Consider if there might be some partial acquisitions that could enable giving us some advantage in height and identify which properties could require driveway modifications.
- Consider sound mitigations and explain what they would look like.
- Provide more detail on what the bike and pedestrian pathways would look like.
- Explore whether the maximum grade on the bike and pedestrian ramps can be lowered to 5% or less and what is the impact on total ramp length (and possibly properties).
- Explore mitigations for eastbound bikes traveling downhill that may have limited sight and limited stopping distance approaching the Alma intersection.
- Study whether new grade separation designs may increase capacity and induce more traffic and what additional protections will be necessary to mitigate more bikes sharing the road. (Ex: Will we need protected bike lanes and how far would they need to extend?)
- Identify how new grade separation designs will impact Charleston/Arastradero's design needs beyond 2030.
- Confirm whether this design precludes the ability to add two additional tracks for HSR if required?
- Ensure there is enough queuing space for cyclists traveling eastbound towards each intersection to accommodate those waiting for a traffic signal.

7.3.6. Meadow/Charleston Trench

- Explore whether the trench depth could be reduced by designing bridges with thin decks and providing minimal clearances under the bridges to reduce construction costs and potentially reducing trench/creek interference.
- Furthermore, identify designs (such as trusses) that minimize road bridge-deck thickness. Also quantify the required height of such designs. In particular, explore

whether a bow-string arch or tied-arch designs could produce an attractive design that the community might embrace.

- The current AECOM trench design does not completely seal the trench, requiring pumps to continually remove the slow trickle of groundwater that enters the trench. Explore whether sealing the trench to avoid groundwater leakage is possible and more desirable.
- Analysis should be done to predict groundwater impacts for any trench design considered, and design alternatives that provide different mitigations for groundwater impacts should be identified.
- Explore other methods of trench wall supports (such as overhead struts) not considered by AECOM to explore alternatives that could reduce vegetation restrictions from the proposed tiebacks.
- Work with Caltrain to identify any designs that could improve the vertical curve constraints that impact design flexibility for the trench.
- Explore with Caltrain whether trench lids would be possible between Charleston/ Meadow and how long could the lid sections be while still allowing adequate spacing for emergency access.
- Explore with Caltrain (and potentially Mt. View) whether the crossover track section located north of the San Antonio station can be relocated (perhaps south of San Antonio Station) to provide greater design flexibility.
- Identify the cross-sectional dimensions of the Adobe Creek culvert currently under Alma.
- Explore if a rail trench reduces the vertical clearance of Adobe Creek, whether the vertical interference could be mitigated by widening and/or deepening the creek as it passes under the rail trench. If it is possible, identify how wide the creek can be made and the corresponding vertical clearance that is required to maintain sufficient creek throughput under the trench.
- Identify what maintenance must be performed to keep sediment from reducing the siphon performance if a passive siphon is used to pass the water under the rail trench. Consider whether a sediment trap be constructed upstream (e.g., near Miller Ave) to reduce the sediment that reaches the siphon.
- Consider if a powered siphon is used to pass water under the rail trench, what would be the impacts of a power outage on the siphon and whether the unpowered siphons still allow sufficient passive flow to avoid flooding.
- Explore whether during dry periods, would siphons (either passive or powered) allow standing water to accumulate and lead to mosquito breeding.
- Barron Creek is relatively shallow, so it may be preferable to have it pass over the trench instead of under the trench. Since Barron Creek currently takes two 90 degree turns on the west side of Alma, consider whether Barron Creek instead can take its two 90 degree turns on the east of Alma (or under Alma). Put differently, explore if Barron Creek could be straightened so it crosses the trench at the same point that it crosses Park Blvd.

- Perform ground water analysis to determine whether construction techniques (such as Secant Pile Wall, Slurry-Diaphragm Wall, Deep Soil Mixing Wall, and Cantilever Wall with Sheetpile Shoring) will meet criteria for Groundwater Control. Identify if these construction techniques could similarly seal a Charleston/Meadow trench.
- Evaluate the groundwater in the area surrounding a Charleston/Meadow rail trench and identify at what depths does groundwater flow occur.
- Identify how a rail trench with a depth of 30-40 feet could interfere with the groundwater flow. Identify if the groundwater might rise to approximately the same height on both sides of the trench and whether design techniques (such as permeable fill adjacent to the trench) can mitigate groundwater impacts of a trench.
- Identify how current/future developments along El Camino that have deep basements or foundations, might have similar impacts on groundwater flow as the trench or whether the space between buildings would reduce groundwater impacts.
- Consider obtaining an independent cost estimate and project comparison delineating the differences between the Charleston/Meadow trench and the Reno, San Gabriel, and Carlsbad trench projects (with publicly available data if possible, to minimize cost).
- Consider obtaining an independent construction duration estimate and project comparison delineating the differences between the Charleston/Meadow trench and the Reno, San Gabriel, and Carlsbad trench projects (with publicly available data if possible, to minimize cost).

7.3.7. Meadow/Charleston Underpass

7.3.7.1. Bike Design

In the Meadow/Charleston designs, bikes and peds are grade separated from the train and cars along Alma - which is seen as a potentially significant safety upgrade by providing dedicated bikeways. As stated in the Comprehensive Plan, safer and more direct bike/pedestrian routes also help achieve the goal of reducing reliance on single occupancy vehicles, including traffic levels in the corridor. Additional design review should focus on the necessary elements to make safety and access to a bike/pedestrian separated corridor.

Issues to address in design:

1. Ensure that the bike and pedestrian crossing over Meadow near Park Blvd would be designed in such a way to provide convenient and safe access for bikers along Park Blvd attempting to gain access to the bikeway, as well as for bicyclists exiting the bikeway and turning onto Park Blvd or continuing in a westward direction along Meadow but now on the right-hand side of the street.
2. Ensure bike paths are designed to have turning radii that are appropriate for cargo bikes or bikes pulling trailers.
3. Need to optimize design for flatter slopes to make it for safer bike/pedestrian connections, especially for young children.

4. A thinner bridge deck reduces the depth of the bike/pedestrian underpass, reducing the required slope of the bike/pedestrian path. Work with Caltrain to select a thinner rail bridge.
5. Reducing the needed vertical clearance (height) of the bike/pedestrian path under the tracks would reduce its required slope.

The volume of bikers (LOS) and their overall speed may have impacts for widths needed on the path. A good reference is the Evaluation of Safety, Design, and Operation of Shared-Use Paths-Final Report created by FHWA (available at: http://www.pedbikeinfo.org/cms/downloads/Eval_SharedUsePaths_Final.pdf)

7.3.7.2. Reduction of Eminent Domain

Design refinement should seek to reduce or eliminate (if possible) the need for eminent domain. XCAP received significant community feedback about this issue, especially from those potentially impacted by early conceptual designs. (See correspondence received in the appendix.)

Design modification to consider:

1. To reduce property impacts, consider reducing the road speeds thereby increasing permissible road grade and shortening the underpass length. (Example: Jefferson Ave in Redwood City has a 20-mph speed limit to allow a steep grade to go from El Camino, under the tracks to Broadway in a short distance. Palo Alto designs were conceived using “traditional” design speeds, but are those flexible?
2. Can the Charleston roundabout diameter be decreased in order to reduce the amount of property acquisition?

7.3.7.3. Noise and Vibration

While the train remains where it is today in the Underpass design, an at-grade noise parapet could reduce noise from passing trains and should be considered as part of the future design.

7.3.7.4. Construction Methods

A technology referred to as Box Jacking (where a precast box is pushed into place) was identified early on as a potential construction method that could be used to avoid needing electrified shoofly tracks which are expensive, disruptive and add significantly to construction time. This method was most recently used in Florida⁶⁶ and Long Island, NY, resulting in significantly shorter construction time.

A design goal of the XCAP Underpass Concept was to avoid moving the tracks at all (to reduce cost, construction time and complexity), but without further geotechnical studies, it is not possible to determine whether this is feasible. Caltrain has indicated interest in understanding

⁶⁶ <https://www.orlandosentinel.com/news/transportation/os-ne-brightline-tunnel-construction-20200917-cj66ylrgafah7dlb6iuekatye-story.html>

more about construction methods that could avoid the need to construct electrified shoofly tracks through its Corridor Wide study, but the City should continue to advocate for this.

XCAP recommends that Staff provide Caltrain the materials gathered through XCAP and through public comment related to Box Jacking construction for incorporation into Caltrain's Corridor-Wide Grade Separation Study.

7.3.7.5. Bridge-Deck Thickness

Reducing the thickness of the bridge deck reduces the depth of the underpass; this reduced elevation change reduces the underpass length, lowering costs and mitigating neighborhood impacts. Identify designs (such as trusses) that minimize road bridge-deck thickness. Also quantify the required height of such designs. In particular, explore whether bow-string arch or tied-arch designs with a short height could produce an attractive design that the community might embrace.

7.3.7.6. Passing Tracks and their impact on Design

Caltrain has made it clear that when presenting designs for consideration, Palo Alto must be able to show whether the design "precludes" the ability to add two additional passing tracks to accommodate High Speed Rail in the future. Of all the alternatives, the Underpass design does not appear to preclude that possibility, but this should be confirmed.

7.3.7.7. Public Outreach

Overall, the XCAP process has made it clear there are no alternatives that stand out as clear winners that easily achieve consensus community support. All the alternatives have pros and cons that must be weighed or resolved. The Underpass alternative has the highest possibility of property acquisition or eminent domain, thus the design refinements and public outreach on this alternative likely needs to be extensive so the community can understand the trade-offs and mitigations being considered. This point is especially important if the alternative requires additional funding from the community.

The Meadow/Charleston Underpass alternatives did not receive the benefit of a live Town Hall with the ability to explain the concept. The Virtual Town Hall explained the existing AECOM design, but did not present it as a preliminary concept that needed more iterations to address the significant issues identified. And the inconsistencies between the drawings and the videos led to some confusion, further impacting the public's ability to understand the initial concept. In the future, it is critical to ensure all work is consistent across all modes of communication, particularly on bike/pedestrian design.

7.4. Lessons Learned

The following are lessons learned that XCAP thinks are useful for anyone considering grade separations in the future.

1. Very few vehicles actually go straight across the Caltrain tracks at Churchill (East/West), and instead Churchill is mainly used for cars wishing to turn North/South onto Alma.
2. When cyclists are forced to use a call button to cross an intersection, that causes a large group of bikes to gather at peak times. This large group then impacts design concepts for creating bike/pedestrian crossings because the design must focus on accommodating these large bunches, rather than a more typical flow of cyclists. When bikes and pedestrians can be put on a dedicated path that does not interface with vehicles, this problem is mitigated.
3. Similarly, grade separating bikes/pedestrians from Alma and train creates safer environment and greater intersection efficiency.
4. The maximum desirable grade for bikes/pedestrians is 5%, preferably 4%.
5. Intersections that allow all 12 movements generally decrease the amount of cut-through traffic in neighborhoods.
6. Eliminating at-grade crossings eliminates train horns - giving biggest overall noise reduction.
7. Trip time in town is driven more by traffic signal interruption than traffic speed. (If trying to improve safety, slowing traffic isn't a showstopper, but adding lights is).
8. Since smoothly flowing traffic has about two-second spacing between vehicles, reducing the speed limit has little effect on traffic capacity. As a result, traffic flow is improved by encouraging steady speeds, not necessarily fast speeds.
9. The closure of Churchill moves cars to more intersections than expected.
10. Consultants should put extra emphasis on bike/pedestrian traffic and be familiar with the large number of bikes at peak times (that don't necessarily match up with peak car traffic times) and needs of the Safe Routes to School program.
11. Future traffic studies need to evaluate Bike and Pedestrian Level of Service in subsequent phases.

8. Rail Corridor Timeline 2008 - 2021

The following timeline summarizes key local, regional, and state decisions and milestones which have shaped Palo Alto's rail corridor planning efforts to date.⁶⁷

2008

Nov	California voters pass Proposition 1A, the Safe, Reliable High-Speed Passenger Train Bond Act for the 21st Century, authorizing issuance of \$9.95 billion of general obligation bonds to partially fund a statewide high-speed rail system.
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2009

Oct	California High Speed Rail Authority begins the scoping process as part of the project-level environmental review for the San Jose-San Francisco project section. The number of tracks, vertical alignment, and horizontal alignment, among other factors were major issues raised by the City of Palo Alto and other communities along the project section.
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2010

Jul	City Council authorizes appointment of a 17-member task force to generate a community vision for land use, transportation, and urban design opportunities along the Caltrain corridor, particularly in response to improvements to fixed rail services along the tracks through Palo Alto.
Nov	Palo Alto Rail Corridor Study is initiated as a component of the city's response to planned rail investments along the Caltrain rail corridor, specifically the California High Speed Rail project, and potential modifications to Caltrain operations.

2011

Apr	U.S. Rep. Anna Eshoo, State Sen. Joe Simitian, and State Assemblyman Rich Gordon officially propose the "blended system" approach for the Caltrain corridor consisting of a primarily two-track system shared between Caltrain and future California High Speed Rail trains.
Aug	California High Speed Rail Authority technical peer review group supports principles identified in the blended system proposal.

2012

Apr	California High Speed Rail releases the Revised 2012 Business Plan proposing Silicon Valley to Merced as the initial operations segment for high-speed trains and adopting the blended systems and operations approach for the San Jose-San Francisco segment along the Caltrain corridor. The blended system along the Caltrain corridor was described as "primarily a two-track system that will be shared by Caltrain, high-speed rail service, and current rail tenants."
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⁶⁷ <https://www.cityofpaloalto.org/civicax/filebank/documents/58463>

May	Peninsula Corridor Joint Powers Board (Caltrain) approves the Peninsula Corridor Electrification Project.
Jul	State Legislature passes Senate Bill SB1029, providing high speed rail funding for construction of the “blended system” as defined in the Revised 2012 Business Plan.

2013

Jan	State, regional, and local agencies establish a regional funding memorandum of understanding to support the blended system, which was further defined as “remaining substantially within the existing Caltrain right-of-way and will accommodate future high-speed rail and modernized Caltrain service along the Peninsula corridor by primarily utilizing the existing track configuration on the Peninsula.”
	Palo Alto Rail Corridor Study presented to and approved by Palo Alto City Council.
May	Memorandum of Understanding (MOU) signed between the California High Speed Rail Authority and Caltrain regarding “blended system”
Nov	City Council authorizes Hatch Mott McDonald to proceed with an analysis delivering a conceptual cost estimate for a range of preliminary grade separation alternatives south of the California Ave Caltrain Station. This work would become the 2014 Palo Alto Grade Separation and Trenching Study

2015

Oct	As part of a study session, the Palo Alto City Council reviews Palo Alto Grade Separation and Trenching Study and discusses the report findings.
	Palo Alto Rail Committee (a subset of City Council) reconstituted to discuss grade separations and high-speed rail

2016

Jan	Staff presents to Rail Committee proposed scope of work for Rail Program Management Services
	Caltrain awards contract to begin construction on electrification.
Oct	City Council approved a two-year professional services contract with Mott MacDonald Group for Rail Program Management Services
Nov	Measure B is approved by Santa Clara County voters, which includes \$700 million for grade separations along the Caltrain Corridor in Santa Clara County.

2017

Mar	City Council directs Staff to move forward with Context Sensitive Solution alternative analysis ⁶⁸
Apr	City of Palo Alto signs a contract with AECOM to replace Hatch Mott McDonald for Rail Program Management Services
May	Connecting Palo Alto Community Workshop #1 - Reviewed Circulation challenges caused by trains crossing at-grade
	Community survey completed
	Caltrain electrification federal funding agreement signed by US Secretary of Transportation
Sep	Connecting Palo Alto Community Workshop #2 - Reviewed types of grade separations and Traffic Study using travel demand model showing impacts of Churchill Closure
	Community Questionnaire #2 distributed
	City Council adopts Connecting Palo Alto Problem Statement, Goals and Evaluation Criteria
	Connecting Palo Alto Community Workshop #2
	Palo Alto hosts a series of 3 community roundtables to engage the public to help evaluate potential grade separation ideas

2018

Mar	Community Roundtable Discussions held by City and Summary Report Released
	The Rail Team (City Departments and Manager's office) implement a project reset to accelerate planning, design and construction of rail grade separation in Palo Alto
May	<p>City Council voted⁶⁹ to reduce the alternatives from 34 possible alternatives to:</p> <p>Churchill Ave hybrid;</p> <p>Churchill Ave roadway over railroad</p> <p>Churchill Ave crossing closed; improvement options include: widen existing Embarcadero Road undercrossing, add new traffic signals at Embarcadero Road ramps, build bike/pedestrian crossing at Churchill Ave, and/or build Seale Ave bike/pedestrian crossing to connect to Peers Park and Stanford Ave bicycle boulevard;</p> <p>Meadow Dr and Charleston Road hybrid and build Loma Verde Ave bike/pedestrian crossing to connect to Margarita Ave bike boulevard;</p> <p>Meadow Dr and Charleston Road roadway over railroad reverse hybrid and build Loma Verde Ave bike/pedestrian crossing to connect to Margarita Ave bicycle boulevard;</p>

⁶⁸ <https://www.cityofpaloalto.org/civicax/filebank/documents/56546>

⁶⁹ <https://www.cityofpaloalto.org/civicax/filebank/documents/65124>

	<p>Meadow Dr and Charleston Road roadway over railroad trench or tunnel; Alma St would not be within trench or tunnel (maintains Alma St connections to Meadow Dr and Charleston Rd) with Alma St in its existing alignment or a new alignment;</p> <p>Meadow Dr and Charleston Road railroad over roadway (viaduct);</p> <p>Palo Alto Ave Hybrid - Continue proposed Menlo Park railroad over roadway hybrid and/or viaduct across San Francisquito Creek and Palo Alto Ave;</p> <p>Palo Alto Ave crossing closed; improvement options include: build an Everett Ave bike/pedestrian undercrossing and widen University Ave;</p> <p>City-wide deep-bore railroad under roadway tunnel within Palo Alto city limits with two new underground rail stations with or without freight;</p>
Jun	City Council removes Churchill Reverse Hybrid and Hybrid options ⁷⁰
Aug	Community Meeting held by City discussing: Meadow / Charleston Hybrid, Shallow Trench and Full Trench, and Viaduct, Palo Alto Ave Hybrid and Citywide* Tunnel
	Community Advisory Panel is formed and has its first meeting
Nov	City held Community Meeting with videos of: Meadow/Charleston Hybrid, Trench, and Viaduct

2019

Jan	City Council votes to separate from study all alternatives for the Palo Alto Ave Crossing (Closure and Hybrid) and include Palo Alto Ave in a separate future coordinated area plan study for downtown Palo Alto. ⁷¹
	City Council votes to remove from study the bike/pedestrian crossing of the Caltrain corridor in the vicinity of Loma Verde Ave and assess feasibility in a future study ⁷²
	City Council votes for Staff to return with info on South Palo Alto tunnel with/without freight ⁷³
	City Council decides to change from Rail Committee (subset of the Council) to Committee of the Whole (entire Council) ⁷⁴
Mar	CAP sees Citywide* Tunnel video (*From Palo Alto Station to San Antonio Road)
	City held Community Meeting: included overview of Citywide Tunnel, Churchill Ave Closure and Churchill Ave Ped/Bike Undercrossing Options 1 & 2 and TJKM Traffic Study
	CAP is disbanded

⁷⁰ <http://cityofpaloalto.org/civicax/filebank/blobdload.aspx?t=41995.87&BlobID=65507>

⁷¹ <https://cityofpaloalto.org/civicax/filebank/blobdload.aspx?t=78937.16&BlobID=68858>

⁷² ibid

⁷³ ibid

⁷⁴ <https://cityofpaloalto.org/gov/agendas/hsrs/>

Apr	City Council adds viaduct option to Churchill ⁷⁵
May	City Council votes to remove Citywide* Tunnel from consideration (*From Palo Alto Station to San Antonio Road)
Jun	Newly formed XCAP has its first meeting
Oct	XCAP adopts guiding principles for their group
	XCAP Reviews Fact Sheets for Alternatives
Nov	XCAP Seeks new ideas - three are selected to proceed for further evaluation (Embarcadero/Churchill Roundabout concept, Churchill Partial Underpass, Meadow/Charleston Underpass) ⁷⁶
	XCAP's TAC and Volunteer Retired Civil engineers review concepts
Dec	XCAP votes present new alternatives to City Council (Embarcadero/Churchill Roundabout concept, Churchill Partial Underpass, Meadow/Charleston Underpass) ⁷⁷

2020

Jan	XCAP confirms report for City Council presenting new alternatives
	City Council votes to proceed with two alternatives (Churchill Partial Underpass and Meadow/Charleston underpass)
	XCAP develops questions for Traffic Study based on new alternatives
	XCAP received presentation related to Eminent Domain from attorney
Feb	XCAP votes to eliminate from their deliberations the two South Palo Alto tunnels (with and without freight)
	Two Town Halls are held which includes preliminary information on Churchill partial underpass but does NOT include information on Meadow/Charleston Underpass in the formal presentation. Informally, a table is set up in the back with maps showing property impacts even though designs have not yet been developed.
	Third town Hall cancelled due to COVID
Mar	All meetings cancelled due to COVID Shelter in Place orders
Apr	XCAP presented updated Churchill Partial Underpass information and phasing video

⁷⁵ <https://www.cityofpaloalto.org/civicax/filebank/blobdload.aspx?t=67695.84&BlobID=70530>

⁷⁶ https://connectingpaloalto.com/wp-content/uploads/2020/04/2019-11-13_XCAP-Meeting-Summary_CCG.pdf

⁷⁷ https://connectingpaloalto.com/wp-content/uploads/2020/04/2019-12-18_XCAP-Meeting-Summary_CCG.pdf

	Staff/XCAP receive emails from Caltrain re: Board's Rail Corridor Use Policy decision and its impacts on grade separations in PA (designs must not preclude 4 tracks in all of PA, limits encroachments).
May	TAC presented updated Churchill Partial Underpass info and initial Meadow/Charleston designs
	XCAP receives updated designs for Churchill and initial designs for Meadow/Charleston
	City Council receives updated City Budget information forecasting revenue shortfalls
Jun	XCAP Chair invited to speak at PABAC meeting to present latest designs of all alternatives
	XCAP Received Noise and Vibration study
	XCAP received updated layouts, renderings and fact sheets for Meadow/Charleston Underpass
Jul	XCAP Received updated Matrix for Meadow/Charleston Underpass
	XCAP received presentation from Caltrain regarding the beginning of the Corridor Wide Grade Separation Study scheduled to begin Fall of 2020
	XCAP received updated renderings and fact sheets for Meadow/Charleston Underpass related to clarifying bike/ped infrastructure
	XCAP received new draft Hexagon Traffic Report with updated information related to the new alternatives (Churchill Partial Underpass, Meadow/Charleston Underpass)
	XCAP reviewed all updated final materials for Virtual Town Hall
Aug	City has Virtual Town Hall online from August 19 through September 14, 2020
	XCAP Received Final Traffic Report from Hexagon
	XCAP began deliberations on Churchill alternatives
Sep	XCAP votes 6-3 to support Churchill Closure with mitigations ⁷⁸
	Deliberated on Meadow/Charleston alternatives
Oct	XCAP votes 7-2 that it can't make a decision on Meadow/Charleston with current information ⁷⁹
Nov	XCAP focused efforts on report writing
2021	
Mar	XCAP submits report to City Council

⁷⁸https://connectingpaloalto.com/wp-content/uploads/2020/09/2020-09-02_XCAP-Meeting-Summary_Cybertary.pdf

⁷⁹https://connectingpaloalto.com/wp-content/uploads/2020/10/2020-10-14_XCAP-Meeting-Summary_Cybertary.pdf

The Appendix files are available on the City website at:
<https://connectingpaloalto.com/presentations-and-reports/>

Appendix A – Fact Sheets, Matrix, Renderings and Plans (created by AECOM)

Note: Appendix A contains engineering drawings that are very large, so files have been broken up into four parts due to size limitations.

Part 1: A-1 thru A-2-1
Part 2: A-2-2 (01-04)
Part 3: A-2-2 (05-08)
Part 4: A-2-3 thru A-6

A-1. Fact Sheets and Matrix

- A. Connecting Palo Alto
- B. Churchill Closure with Mitigations
- C. Churchill Partial Underpass
- D. Churchill Viaduct
- E. Meadow-Charleston Viaduct
- F. Meadow-Charleston Hybrid
- G. Meadow-Charleston Trench
- H. Meadow-Charleston Underpass
- I. South Palo Alto Tunnel – Passenger & Freight
- J. South Palo Alto Tunnel with At-Grade Freight
- K. Matrix – Summaries of Evaluations with City Council Adopted Criteria

A-2. Renderings and Plans

1. Churchill Alternatives

Churchill Closure with Mitigations

- 1. Rendering – Option 1
- 2. Rendering – Option 2
- 3. Plan and Section – Option 1
- 4. Plan and Section – Option 2
- 5. Churchill Closure - Traffic Improvements and Mitigation Measures

Churchill Viaduct

- 6. Rendering
- 7. Plan & Profile
- 8. Section

Churchill Partial Underpass

9. Rendering
10. Plan & Profile

2. Meadow-Charleston Alternatives

Meadow-Charleston Viaduct

1. Rendering
2. Plan & Profile (205 MB) Meadow-Charleston Hybrid
3. Rendering
4. Plan & Profile (306 MB)

Meadow-Charleston Trench

5. Rendering
6. Plan & Profile (143 MB)

Meadow-Charleston Underpass

7. Rendering
8. Plan & Profile

3. South Palo Alto Tunnels

South Palo Alto Tunnel – Passenger & Freight

1. Rendering
2. Freight Plan & Profile
3. Section

South Palo Alto Tunnel with At-Grade Freight

4. Rendering
5. Freight Plan & Profile
6. Section

A-3. AECOM DRAFT Cost Estimates

1. Churchill Alternatives

Churchill Closure

1. Closure of Churchill Avenue Cost Summary
2. Alt 3A Cost Estimate Alma Br Replaced
3. Alt 3A Cost Estimate Alma Br Widened
4. Churchill Ave PRC Concept 1_ 6-Page Cost Estimate
5. Churchill Ave PRC Concept 2_ 6-Page Cost Estimate
6. Traffic Mitigation Cost Estimate - Alma Oregon
7. Traffic Mitigation Cost Estimate - ECR Embarcadero
8. Traffic Mitigation Cost Estimate - ECR Oregon

Churchill Partial Underpass

9. Churchill Partial Underpass Cost Estimate

Churchill Viaduct

10. Churchill Viaduct 6-Page Cost Estimate

2. Meadow-Charleston Alternatives

1. Viaduct – Meadow/Charleston Cost Estimate
2. Hybrid – Meadow/Charleston Cost Estimate
3. Trench – Meadow/Charleston Cost Estimate
4. Underpass – Charleston Cost Estimate
5. Underpass - Meadow Cost Estimate

3. South Palo Alto Tunnel Alternatives

6. South Palo Alto Tunnel Estimate - Freight at Grade
7. South Palo Alto Tunnel Estimate - Freight in Tunnel

A-4. Additional Information Provided by City Staff

1. Queue lengths at Churchill 10-16-19
2. Follow up to Questions related to Criteria 01-15-2020
3. Staff Update: Follow Up to XCAP Criteria Questions 4-22-20
4. Memo from Office of Transportation - Re: Mixing of Underpass and Hybrid Grade Separation Alternatives at Charleston Road and Meadow Drive
5. Churchill Bike/Pedestrian Tunnel Info presented by Staff to XCAP 9-9-20
6. Additional Trench Information for XCAP Meeting 10-7-2020
7. Draft Virtual Town Hall Information 10-7-2020
8. Staff Presentation Re-Carlsbad-Trench-Project 10-14-20
9. Response to XCAP Questions 12-16-20

A-5. Links to Animations and Virtual Town Hall

A-6. Discarded Alternatives - Citywide Tunnel

Appendix B – General Information

B-1. Community Generated Ideas as presented to XCAP

- A. Churchill Ave Partial Underpass Proposal - Michael Price
- B. South Palo Alto Tunnel Proposal - Roland LeBrun
- C. Viaduct with Roundabout at Embarcadero Proposal - Tony Carrasco
- D. Meadow-Charleston Underpass Proposal (Part 1) - Elizabeth Alexis
- E. Meadow-Charleston Underpass Proposal (Part 2) - Elizabeth Alexis

B-2. AECOM's Technical Review of Community Generated Ideas and Notes from XCAP Technical Advisory Committee

- A. AECOM Technical Review of Community Ideas (part 1)
- B. AECOM Technical Review of Community Ideas (part 2)
- C. 12-18-2019 Update from Technical Working Group Regarding Review of New Ideas with Volunteer Civil Engineers and AECOM

B-3. Traffic Studies and Presentations

- 1. Final Traffic Study - Hexagon Traffic Consultants - Analysis of Churchill, Meadow and Charleston Grade Separation (Final Aug 2020)
- 2. DRAFT Traffic Study- TJKM - Draft Traffic Impact Study Report - Churchill Ave Closure (Aug 2019)
- 3. 1-8-2020- Presentation to XCAP: Review of Traffic Study and Discussion of Submitted Questions
- 4. 2-12-20 XCAP Traffic Questions and Hexagon Responses

B-4. Noise and Vibration Comparative Analysis Report

B-5. Frequently Asked Questions from Connecting Palo Alto website

B-6. Eminent Domain Information

- 1. Eminent Domain Transcript Feb 5 2020 - Presentation by Norm Matteoni - Land Use Attorney
- 2. Eminent Domain handout - Feb 5 2020 - Information from Norm Matteoni
- 3. 2020-2-05 XCAP Meeting Minutes Verbatim

B-7. Palo Alto Police and Fire Departments Letters

- 1. Palo Alto Fire Department Memo regarding Churchill Closure
- 2. Palo Alto Police Department Memo regarding Churchill Closure

B-8. Caltrain Communications/Presentations

- A. Caltrain Response to City of Palo Alto Council Letter 12-18-2018
- B. Caltrain Business Plan Update to Local Policy Maker Group 4-19-2019
- C. Caltrain Letter to High-Speed Rail - Re: Preferred Alternatives 8-22-19
- D. City of Palo Alto letter to Caltrain re: Business Plan 9-30-2019
- E. Caltrain Presentation to XCAP Verbatim Meeting Minutes 1-29-20
- F. Caltrain presentation to XCAP 1-29-20
- G. Caltrain Rail Corridor Use Policy 2-6-20
- H. Caltrain Booklet for City of Palo Alto
- I. Caltrain Pandemic Rider Survey Topline Report Fall 2020
- J. Caltrain Email Regarding Encroachment 2020-04-22
- K. Caltrain Follow Up Email Regarding Shoofly Discussed at XCAP Meeting 05-20-20

B-9. Palo Alto Unified School District (PAUSD)

- 1. PAUSD Letter#1 to XCAP 2-20-20
- 2. PAUSD Letter #2 to XCAP 12-7-20

B-10. Safe Routes to Schools

B-11. PTA Council (PTAC)

- 1. PTAC Letter to City Council re Bike-Ped improvements 1-22-2020
- 2. PTAC Letter to City Council 1-18-2021

B-12. Palo Alto Comprehensive Plan Excerpts

B-13. Rail Corridor Study – 2012 Excerpts

B-14. Embarcadero Road and El Camino Real Corridor Improvement Study Aug 2016

Appendix C – XCAP

C-1. History of Meadow-Charleston Underpass Alternative

1. History of Meadow-Charleston Underpass Alternative
2. Email - Discrepancies between the Town Hall Renderings and the Video

C-2. History of Grade Separation Funding Sources

C-3. Concerns with Meadow-Charleston Trench Design (by member Keith Reckdahl)

1. Concerns with Meadow-Charleston Trench Design (by member Keith Reckdahl)
2. Trench Presentation by Member Reckdahl 9-23-20
3. Revisiting Trench Costs (Presentation by K. Reckdahl) 10-3-2020

Supporting Documents:

- A. Concerns Trench Design Supporting Doc 1 - Carlsbad Village Railroad Trench Economic Analysis and Feasibility Study January 2017
- B. Concerns Trench Design Supporting Doc 2 - Economic Study: LOSSAN Corridor Improvement (Jan 2017)
- C. Concerns Trench Design Supporting Doc 3 - Carlsbad Village Railroad Trench Final Alternative Analysis Report April 2020

C-4. XCAP Updates to City Council

1. Update #1 10-28-19
2. Update #2 12-9-19
3. Update #3 01-21-20
4. Update #4 03-16-20
5. Update #5 06-03-20
6. Update #6 09-09-20

C-5. XCAP Meeting Materials and Public Comment Received:

The Agenda, key meeting materials and summary for all XCAP meetings are listed below, with the corresponding Public Comment in the next section. Note that Public comment received between September 2019 and March 2020 are all contained in one file.

- 2021-02-03 XCAP Regular Meeting (Virtual) Summary
 - 2021-02-03 Public Comment

- 2021-01-27 XCAP Special Meeting (Virtual) Summary
 - 2021-01-27 Public Comment
- 2021-01-20 XCAP Regular Meeting (Virtual) Summary
 - 2021-01-20 Public Comment
- 2021-01-13 XCAP Special Meeting (Virtual) Summary
 - 2021-01-13 Public Comment
- 2021-01-06 XCAP Regular Meeting (Virtual) Summary
 - 2021-01-06 Public Comment
- 2020-12-16 XCAP Regular Meeting (Virtual) Summary
 - 2020-12-16 Public Comment
- 2020-12-09 XCAP Special Meeting (Virtual) Summary
 - 2020-12-09 Public Comment
- 2020-12-02 XCAP Regular Meeting (Virtual) Summary
 - 2020-12-02 Public Comment
- 2020-11-18 XCAP Regular Meeting (Virtual) Summary
 - 2020-11-18 Public Comment
- 2020-11-10 XCAP Special Meeting (Virtual) Summary
 - 2020-11-10 Public Comment
- 2020-10-14 XCAP Special Meeting (Virtual) Summary
 - 2020-10-14 Public Comment
- 2020-10-07 XCAP Regular Meeting (Virtual) Summary
 - 2020-10-07 Public Comment
- 2020-09-30 XCAP Special Meeting (Virtual) Summary
 - 2020-09-30 Public Comment
- 2020-09-23 XCAP Special Meeting (Virtual) Summary
 - 2020-09-23 Public Comment
- 2020-09-16 XCAP Regular Meeting (Virtual) Summary
 - 2020-09-16 Public Comment
- 2020-09-09 XCAP Special Meeting (Virtual) Summary
 - 2020-09-09 Public Comment
- 2020-09-02 XCAP Regular Meeting (Virtual) Summary
 - 2020-09-02 Public Comment
- 2020-08-26 XCAP Special Meeting (Virtual) Summary
 - 2020-08-26 Public Comment
- 2020-08-22 XCAP Special Meeting (Virtual) Summary
 - 2020-08-22 Public Comment
- 2020-07-29 XCAP Special Meeting (Virtual) Summary
 - 2020-07-29 Public Comment
- 2020-07-22 XCAP Special Meeting (Virtual) Summary
 - 2020-07-22 Public Comment
- 2020-07-15 XCAP Regular Meeting (Virtual) Summary
 - 2020-07-15 Public Comment

- 2020-07-08 XCAP Special Meeting (Virtual) Summary
 - 2020-07-08 Public Comment
- 2020-07-01 XCAP Regular Meeting (Virtual) Summary
 - 2020-07-01 Public Comment
- 2020-06-17 XCAP Regular Meeting (Virtual) Summary
 - 2020-06-17 Public Comment
- 2020-06-03 XCAP Regular Meeting (Virtual) Summary
 - 2020-06-03 Public Comment
- 2020-05-20 XCAP Regular Meeting (Virtual) Summary
 - 2020-05-20 Public Comment
- 2020-05-06 XCAP Regular Meeting (Virtual) Summary
 - 2020-04-01 thru 04-30 Public Comment
 - 2020-05-01 thru 05-06 Public Comment
- 2020-04-22 XCAP Special Meeting (Virtual) Summary
 - 2019-09 thru 2020-03 Public Comment
- 2020-02-26 XCAP Special Meeting Summary
- 2020-02-12 XCAP Special Meeting Summary
- 2020-02-05 XCAP Regular Meeting Summary
- 2020-01-29 XCAP Special Meeting Summary
- 2020-01-22 XCAP Special Meeting Summary
- 2020-01-15 XCAP Special Meeting Summary
- 2020-01-08 XCAP Special Meeting Summary
- 2019-12-18 XCAP Regular Meeting Summary
- 2019-12-04 XCAP Regular Meeting Summary
- 2019-11-13 XCAP Special Meeting Summary
- 2019-10-30 XCAP Special Meeting Summary
- 2019-10-16 XCAP Special Meeting Summary
- 2019-10-10 XCAP Special Meeting Summary
- 2019-09-25 XCAP Meeting Summary
- 2019-09-05 XCAP Meeting Summary
- 2019-08-21 XCAP Meeting Summary
- 2019-06-19 XCAP Meeting Summary