How will the alternatives be evaluated?

The City Council adopted the below Criteria to be used to evaluate the alternatives.

- *Facilitate movement across the corridor for all modes of transportation*
- *Reduce delay and congestion for vehicular traffic at rail crossings*
- *Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles*
- *Support continued rail operations and Caltrain service improvements*
- *Finance with feasible funding sources (Order of magnitude cost)*
- *Reduce rail noise and vibration*
- *Minimize visual changes along the corridor*
- *Maintain access to neighborhoods, parks, and schools along the corridor, while reducing regional traffic on neighborhood streets*
- *Minimize right-of-way acquisition (Private property only)*
- *Minimize disruption and duration of construction*

Churchill Avenue and Caltrain Tracks

Meadow Drive and Caltrain Tracks

Who decides?

City Council is the final decision maker for this project for a preferred rail grade separation for Palo Alto's rail crossings. Council receives input from the community, from City staff, and from key stakeholders, and makes decisions based on this input. Council has already narrowed down the list of possible ideas from 37 to 7 alternatives. Council is expected to choose the preferred alternatives in Fall 2020.

Charleston Road and Caltrain Tracks

For an Evaluation Summary for each alternative based on the Criteria visit: https://connectingpaloalto.com/fact sheets/

RAIL FACT SHEETS

CITY OF PALO ALTO

Connecting Palo Alto

What is Connecting Palo Alto?

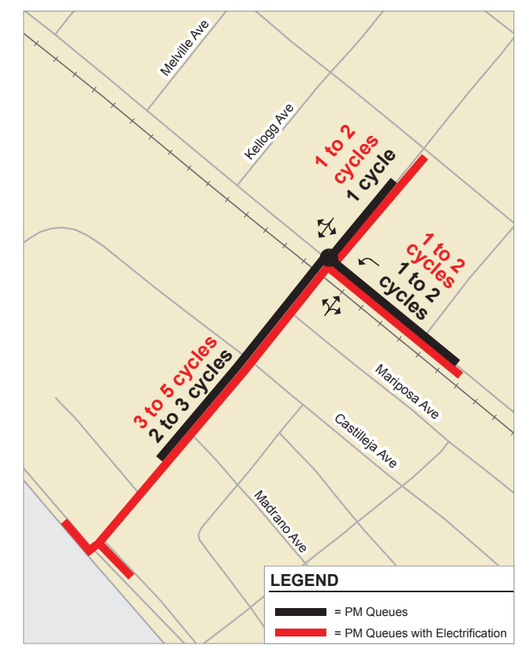
There are currently six streets where people and vehicles can cross the railroad tracks in Palo Alto. Two of these intersections, called grade crossings, are above the road and already grade separated, but the other four cross the tracks at the same level. The four at-grade crossings are Palo Alto Avenue, Churchill Avenue, Meadow Drive, and Charleston Road. Traffic congestion is expected to increase at all four of these locations as Caltrain begins to run electric trains on a more frequent schedule and implement their 2040 Business Plan. Not building any improvements is always being evaluated, however, the City is actively studying alternatives to improve traffic circulation and increase public safety.

Connecting Palo Alto is a community-based process to address the increased traffic congestion expected. Community feedback and collaboration are a vital part of this decision-making process that will affect future generations to come.

What happens if we do nothing?

A total gate down time of 9 minutes during peak hours is expected with electrification, which is 15% of the peak hour time. At the Alma Street/Churchill Avenue intersection, the average queue length of the northbound left-turn movement would be significantly impacted and extend to Rinconada Avenue during the AM Peak (7-9am). It would take approximately four to five signal cycles (10 to 12 minutes) for the northbound left-turn to clear. In the PM peak (4-6pm), eastbound Churchill Avenue is expected to back up onto El Camino Real. With implementation of the Caltrain's 2040 Business Plan and future growth of traffic, these queues will only get longer.

Alma Street and Churchill Avenue AM Peak Vehicular Queues



Alma Street and Churchill Avenue PM Peak Vehicular Queues

For more Rail Fact Sheets visit: https://connectingpaloalto.com/fact sheets/

What is Caltrain planning?

As Caltrain begins to modernize by electrifying the tracks, it is expected that the number of trains will increase from 8 trains to 12 trains during both the AM and PM peak hours. In addition, Caltrain has developed a long range vision for the growth of Caltrain and has considered three service scenarios: baseline growth, moderate growth, and high growth. The moderate growth scenario has been selected by the Joint Powers Board as the preferred scenario moving forward. For Palo Alto, this means that daily boarding of passengers at stations is projected to more than double and gate down times to increase by 137% from what they are today, which will further impact queue lengths at grade crossing intersections.

Service Concepts in Palo Alto

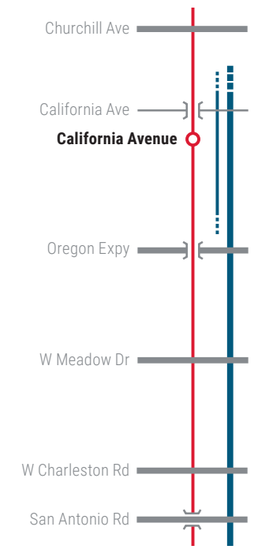
Station	Weekday Train Stops	Daily Boardings	Quickest Travel Time (min)
Palo Alto			
Existing	86 (57 PEAK, 29 OFF-PEAK)	WEEKDAY 7,410; 1,210 WEEKEND	Salesforce Transit Center N/A; Palo Alto N/A; Mountain View 0:07; San Jose 0:22
Baseline Growth	174 (120 PEAK, 54 OFF-PEAK)	WEEKDAY 14,950; 4,030 WEEKEND	Salesforce Transit Center 0:43; Palo Alto N/A; Mountain View 0:05; San Jose 0:23
Moderate Growth	268 (160 PEAK, 108 OFF-PEAK)	WEEKDAY 15,720; 5,530 WEEKEND	Salesforce Transit Center 0:39; Palo Alto N/A; Mountain View 0:05; San Jose 0:21
High Growth	348 (240 PEAK, 108 OFF-PEAK)	WEEKDAY 18,020; 5,580 WEEKEND	Salesforce Transit Center 0:39; Palo Alto N/A; Mountain View 0:05; San Jose 0:20

Source: CALTRAIN BUSINESS PLAN DEVELOPING A LONG-RANGE VISION FOR CALTRAIN CITY OF PALO ALTO BOOKLET, May 2019.

Crossing the Tracks - Gate Down Times

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.

Existing Crossings	Peak Hour Auto Crossings	Collisions (2008-2018)	Crossing Gate Downtime (Assuming No Improvements) (min/peak hr)			
	Existing	Existing	Existing	Baseline Growth	Moderate Growth	High Growth
Churchill Ave	800	5	0:06	+85%	+137%	+212%
California Ave (California Avenue)						
Oregon Expy						
W Meadow Dr	970	6	0:07	+89%	+95%	N/A - grade separation required due to 4 track segment
W Charleston Rd	1,080	10	0:07	+90%	+129%	N/A - grade separation required due to 4 track segment
San Antonio Rd						



Caltrain line; Road at-grade crossing; Road overpass; Road underpass; Bike/pedestrian path overpass; Bike/pedestrian path underpass; Passing Track; Baseline Growth; Moderate Growth; High Growth

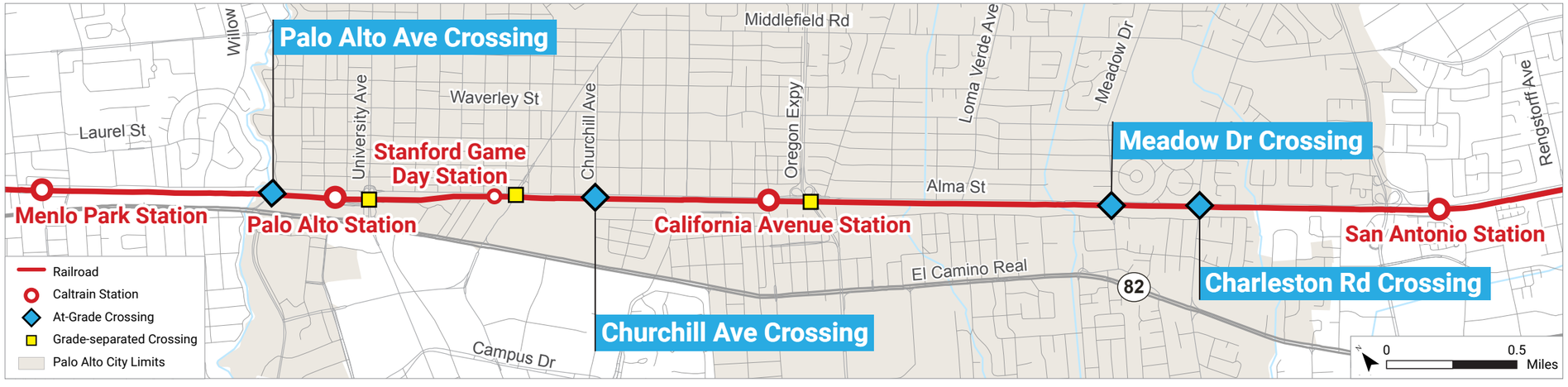
Note: Conceptual 4 Track Segment to be refined through further analysis and community engagement.

Source: CALTRAIN BUSINESS PLAN DEVELOPING A LONG-RANGE VISION FOR CALTRAIN CITY OF PALO ALTO BOOKLET, May 2019.

What alternatives are still being considered?

There are six alternatives being considering for Meadow Drive-Charleston Road and three alternatives for Churchill Avenue. Palo Alto Avenue, however, is going through a separate planning effort. As of January 22, 2019, the alternatives on the table are:

- Meadow-Charleston Trench
- Meadow-Charleston Viaduct
- Meadow-Charleston Hybrid
- Meadow-Charleston Underpass
- South Palo Alto Tunnel – Passenger and Freight
- South Palo Alto Tunnel with At-Grade Freight
- Churchill Closure
- Viaduct in the Vicinity of Churchill
- Churchill Partial Underpass

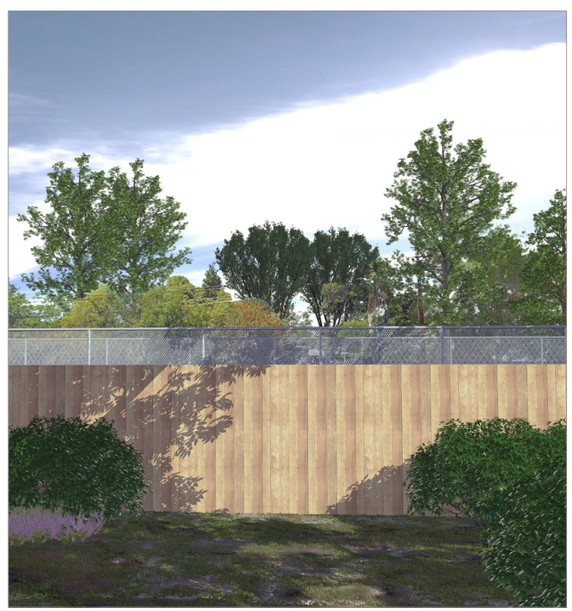


CITY OF PALO ALTO

Meadow-Charleston Trench

Proposed Ground Level View - Looking South
Charleston Road Intersection

Proposed Trench Aerial View - Looking South
Meadow Drive Intersection



Proposed Backyard View - Looking East
Typical Property West of Tracks

About the Trench

For the trench alternative, the railroad tracks will be lowered in an U-shaped box below Meadow Drive and Charleston Road. The new electrified railroad tracks will be built at the same location as the existing railroad tracks and will begin lowering south of Loma Verde Avenue, remain lowered under Meadow Drive and Charleston Road, and return to the existing elevation north of the San Antonio Station.

The roadways at Meadow Drive and Charleston Road will remain at their existing grade on a bridge over the railroad tracks. The roadway will have a similar configuration to what exists today with the addition of Class II buffered bike lanes on Charleston Road. This will require expanding the width of the road to maintain bike lanes through the overpass of the railroad.

By the numbers

- Railroad track is designed for 110 mph.
- Meadow Drive and Charleston Road are designed for 25 mph.
- Maximum grade on railroad is 2%.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.
- Construction period is approximately 6 years.

Engineering Challenges

- A non-standard grade of 2% will be required on the tracks. Caltrain's preferred maximum grade is 1%.
- Lowering of the tracks will require diversion of Adobe and Barron creeks, resulting in the need for lift station/siphons and numerous regulatory agency permits/approvals. Negotiations with the regulatory agencies will be lengthy and difficult since there are other "least impacting" alternatives that could be considered.
- Pump stations will also be needed for dewatering because the trench will be below the ground water level.
- Increased long-term maintenance costs and risk of flooding due to pump stations.
- Major utility relocations are required for the lowered railroad.

Cost Breakdown

Roadway & Railroad Items	$450M to $540M
Structure Items	$8M to $10M
Right-of-way & Utilities	$26M to $28M
Support Costs	$166M to $194M
Escalation to 2025 dollars	$150M to $178M
TOTAL PROJECT COSTS	**$800M to $950M**

Preliminary and subject to change. Maintenance costs and relocation of fiber optic lines not included.

Neighborhood Considerations

- During construction, Meadow Drive will be closed while the Charleston Road bridge is constructed and vice versa; right turn lanes on Alma Street at Meadow Drive and Charleston Road will be removed.
- Vertical clearance of Meadow Drive and Charleston Road over the railroad will be 24.5 feet.
- Subsurface acquisitions will be required for ground anchors for the trench retaining walls and only vegetation with shallow root vegetation will be allowed.
- The railroad tracks will be approximately 30 feet below the existing street between Meadow Drive and Charleston Road. A high fence will be required along trench walls.
- With grade separations at Meadow Drive and Charleston Road the traffic at nearby intersections is expected to improve.

Trench in Reno, Nevada

For more Rail Fact Sheets visit: https://connectingpaloalto.com/fact sheets/

Evaluation with City Council-Adopted Criteria

Facilitate movement across the corridor for all modes of transportation

Meadow Drive and Charleston Road will be grade separated from the railroad for all modes and will remain open.

Reduce delay and congestion for vehicular traffic at rail crossings

With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Drive and Charleston Road will be removed. Thus, the traffic will not be interrupted by the railroad crossing gates.

Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles

Pedestrians/cyclists will be separated from train traffic only. Bike lanes will be added to Meadow Drive and Charleston Road intersections. Additional pedestrian/cyclist separations routes can be explore on the next phase of design..

Support continued rail operations and Caltrain service improvements

A temporary railroad track will be required, and a crossover track located north of the San Antonio Caltrain Station will be relocated. With the pump stations, there will be potential risks to train operations from flooding.

Finance with feasible funding sources (Order of magnitude cost)

The trench will require greater levels of local funding in the form of fees, taxes or special assessments, the feasibility of which are still being studied in the context of overall citywide infrastructure funding needs.

Reduce rail noise and vibration

Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing EMU trains instead of diesel locomotives will also reduce noise. Trains operating in trench will reduce noise in neighborhoods. Acoustically treated trench walls will eliminate acoustical reflections. There would be a slight reduction to vibration levels at nearby receptors.

Minimize visual changes along the corridor

Railroad tracks will be below grade with high fencing at grade. Landscaping options will be limited to plants with shallow roots in areas where ground anchors are required for the trench retaining walls.

Maintain access to neighborhoods, parks, and schools along the corridor, while reducing regional traffic on neighborhood streets

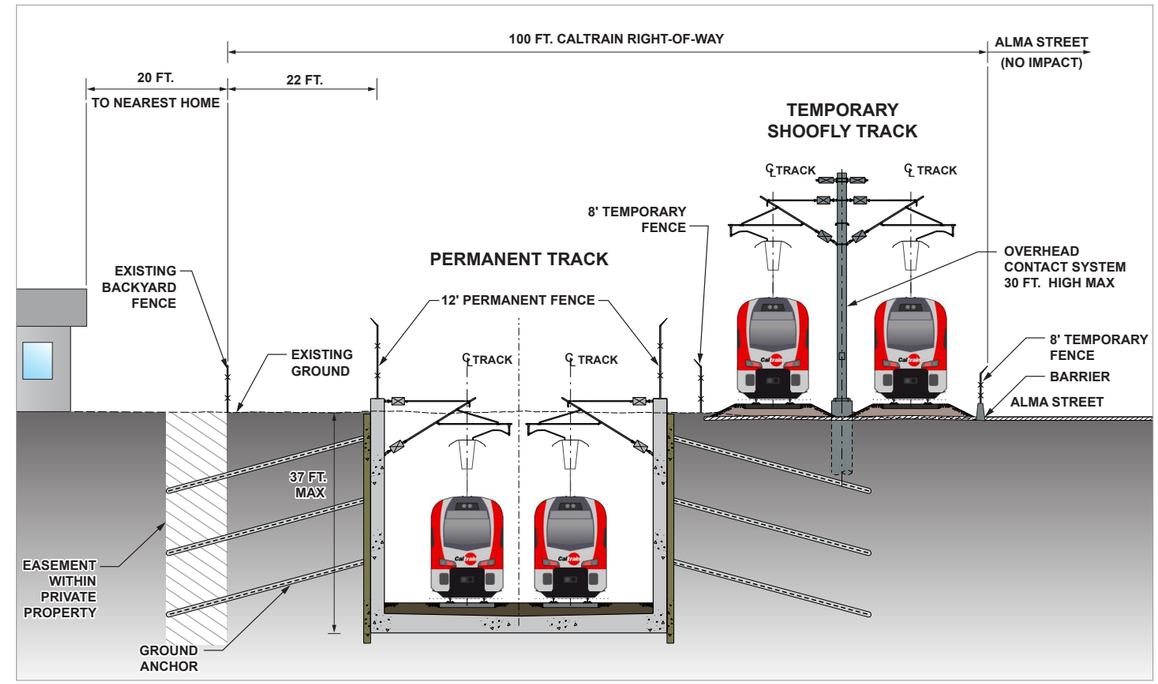
No diversion of regional traffic with construction of grade separations.

Minimize right-of-way acquisition (Private property only)

Subsurface acquisition will be required for the ground anchors for the trench retaining walls and private properties will be required for creek diversion pump station.

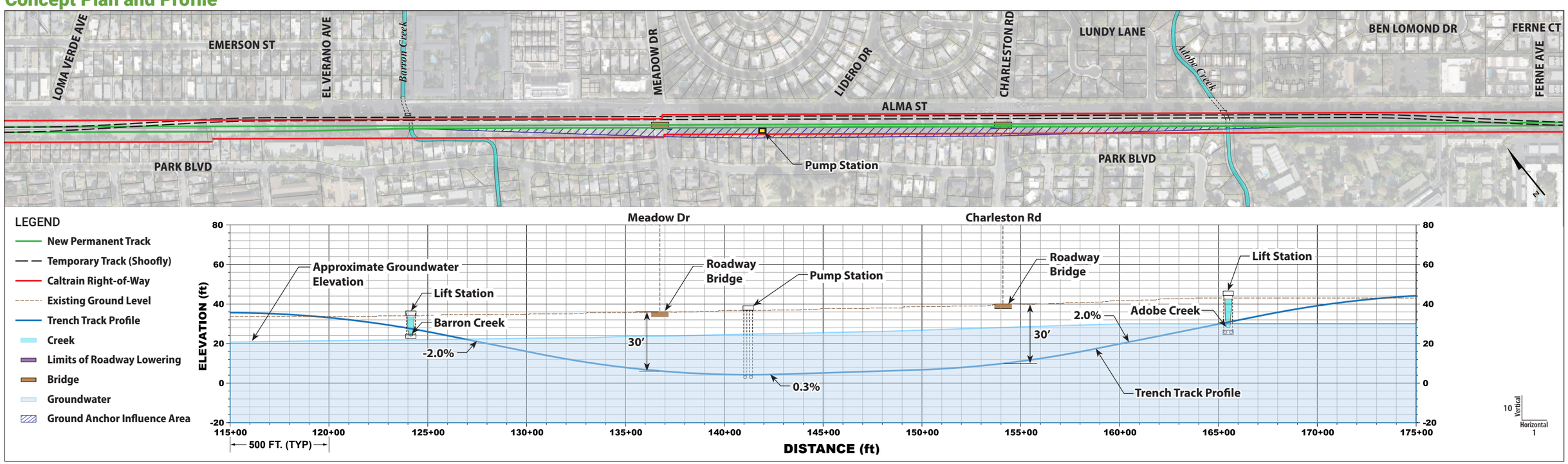
Minimize disruption and duration of construction

Extended road closures at Meadow Drive and Charleston Road are required. Construction would last for approximately 6 years.



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

Concept Plan and Profile



Proposed Ground Level View - Looking East
Charleston Road Intersection

Proposed Hybrid Aerial View - Looking South
Meadow Drive Intersection

Proposed Backyard View - Looking East
Typical Property West of Tracks

RAIL FACT SHEETS

CITY OF PALO ALTO

Meadow-Charleston Hybrid

About the Hybrid

For the hybrid alternative, the railroad tracks will be raised above Meadow Drive and Charleston Road. The new electrified railroad tracks will be built at the same location as the existing railroad tracks and will begin rising near El Verano Avenue, remain raised above Meadow Drive and Charleston Road, and return to the existing elevation north of the Ferne Avenue.

Between Park Boulevard and Alma Street, the roadways at Meadow Drive and Charleston Road will be lowered and will have a similar configuration that exists today, with the addition of Class II buffered bike lanes on Charleston Road. This will require expanding the width of the road to maintain bike lanes through the underpass of the railroad and to accommodate the new column supporting the railroad structure.

By the numbers

- Railroad track is designed for 110 mph.
- Meadow Drive and Charleston Road are designed for 25 mph.
- Maximum grade on roadway is 5%.
- Caltrain's preferred maximum grade is 1%.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.
- Construction period is approximately 4 years.

Engineering Challenges

- A non-standard temporary vertical clearance of 12 feet will be required on tracks. Caltrain's minimum allowable clearance is 15.5 feet.
- Lowering of the roadways will require a pump station.
- Increased long-term maintenance costs and risk of flooding due to pump stations.
- Major utility relocations will be required for the lowered roadways.

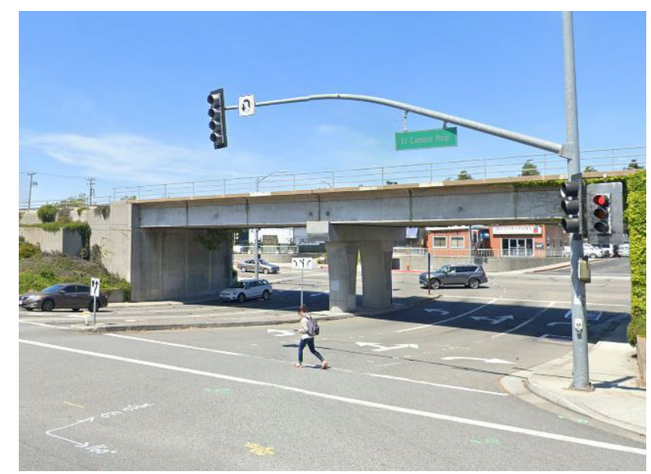
Cost Breakdown

Roadway & Railroad Items	$84M to $102M
Structure Items	$10M to $12M
Right-of-way & Utilities	$26M to $32M
Support Costs	$35M to $42M
Escalation to 2025 dollars	$35M to $42M
TOTAL PROJECT COSTS	**$190M to $230M**

Preliminary and subject to change. Maintenance costs and relocation of fiber optic lines not included.

Neighborhood Considerations

- During construction, Alma Street, Meadow Drive, and Charleston Road will be reduced to two lanes, and right turn lanes on Alma Street at Meadow Drive and Charleston Road will be removed.
- Vertical clearance of Meadow Drive and Charleston Road under the railroad will be 15.5 feet.
- The railroad tracks will be approximately 15 feet above the existing street between Meadow Drive and Charleston Road.
- With grade separations at Meadow Drive and Charleston Road the traffic at nearby intersections is expected to improve.



42nd Ave, San Mateo

For more Rail Fact Sheets visit:
https://connectingpaloalto.com/fact sheets/

Evaluation with City Council-Adopted Criteria

Facilitate movement across the corridor for all modes of transportation

Meadow Drive and Charleston Road will be grade separated from the railroad for all modes and will remain open.

Reduce delay and congestion for vehicular traffic at rail crossings

With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Drive and Charleston Road will be removed. Thus, the traffic will not be interrupted by the railroad crossing gates.

Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles

Pedestrians/cyclists will be separated from train traffic only. Bike lanes will be added to Meadow Drive and Charleston Road intersections. Additional pedestrian/cyclist separations routes can be explore on the next phase of design.

Support continued rail operations and Caltrain service improvements

A temporary railroad track will be required, and a crossover track located north of the San Antonio Caltrain Station will be relocated.

Finance with feasible funding sources (Order of magnitude cost)

The hybrid would require lower levels of local funding, with a substantial portion of capital costs covered by Regional, State and Federal sources.

Reduce rail noise and vibration

Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing EMU trains instead of diesel engines will also reduce noise. Six-foot high parapet sound barriers will help reduce propulsion and wheel/rail noise. There would be a slight reduction to vibration levels at nearby receptors.

Minimize visual changes along the corridor

Railroad tracks will be approximately 15 feet above grade. Landscaping with trees will be incorporated for screening where feasible.

Maintain access to neighborhoods, parks, and schools along the corridor, while reducing regional traffic on neighborhood streets

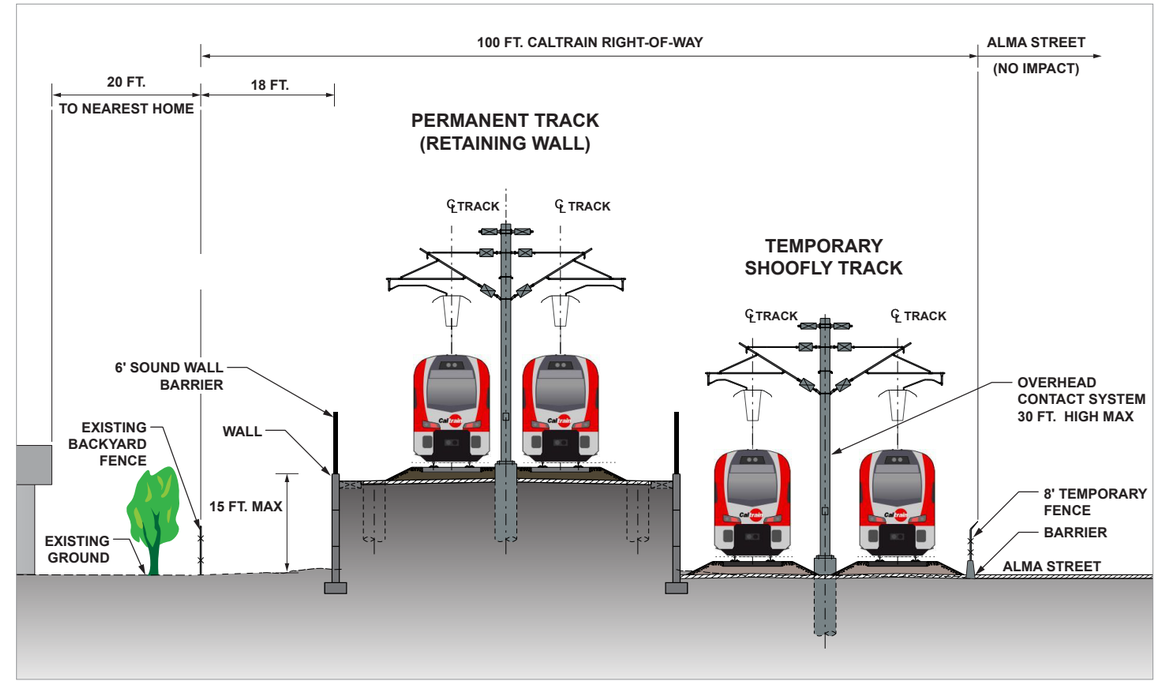
No diversion of regional traffic with construction of grade separations.

Minimize right-of-way acquisition (Private property only)

No acquisition of private properties is required; however, driveway modifications will be required.

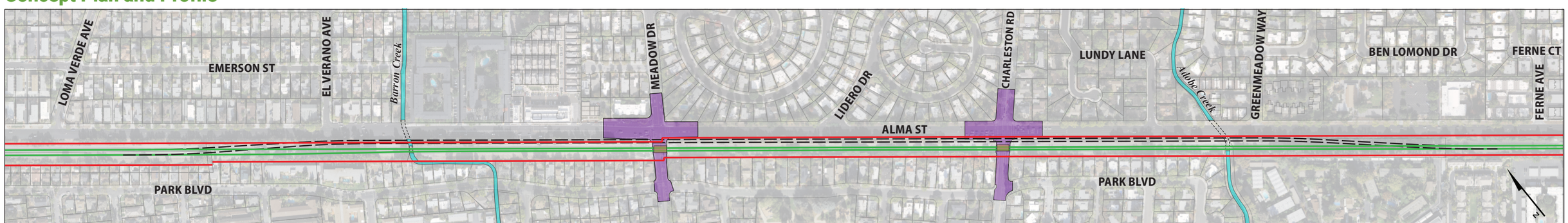
Minimize disruption and duration of construction

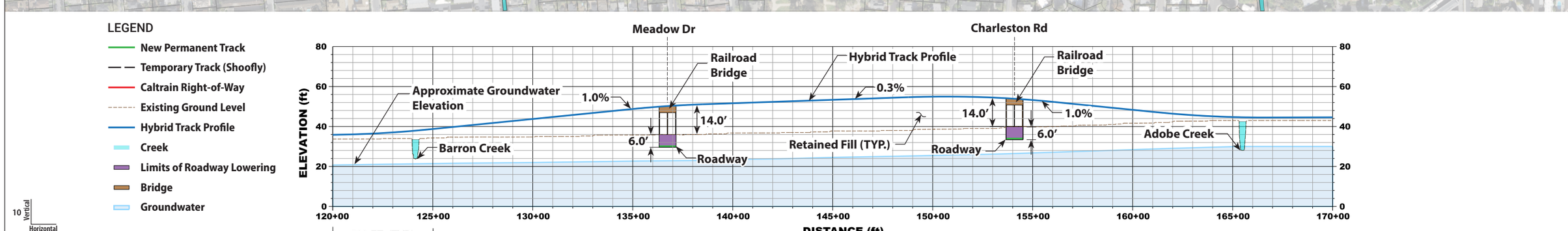
Extended lane reductions at Alma Street, Meadow Drive, and Charleston Road will be required. Construction would last for approximately 4 years.



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

Concept Plan and Profile



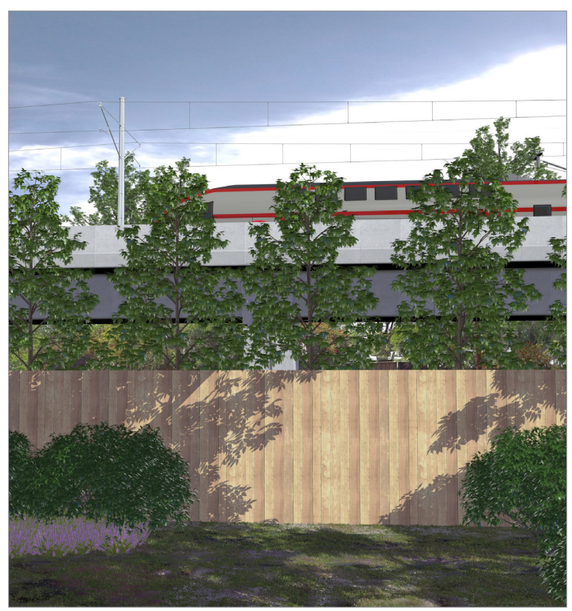


CITY OF PALO ALTO

Meadow-Charleston Viaduct

Proposed Ground Level View - Looking East
Charleston Road Intersection

Proposed Viaduct Aerial View - Looking South
Meadow Drive Intersection



Proposed Backyard View - Looking East
Typical Property West of Tracks

About the Viaduct

For the viaduct alternative, the railroad tracks will be elevated on a structure over Meadow Drive and Charleston Road. The new electrified railroad tracks will be built between the existing railroad tracks and Alma Street (east side) and will begin rising north of Loma Verde Avenue, remain elevated over Meadow Drive and Charleston Road, and return to the existing elevation south of Ferne Avenue.

The roadways at Meadow Drive and Charleston Road will remain at their existing grade and have a similar configuration to what exists today, with the addition of Class II buffered bike lanes on Charleston Road. This addition will require expanding the width of the road to maintain bike lanes through the underpass of the railroad and to accommodate the new column supporting the railroad structure.

By the numbers

- Railroad track is designed for 110 mph.
- Meadow Drive and Charleston Road are designed for 25 mph.
- Maximum grade on railroad is 1.4%.
- Maximum grade on roadway is 5%.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.
- Construction period is approximately 2 years.

Engineering Challenges

- A non-standard grade of 1.4% will be required on the tracks. Caltrain's preferred grade maximum is 1%.

Cost Breakdown

Roadway & Railroad Items	$72M to $90M
Structure Items	$155M to $194M
Right-of-way & Utilities	$18M to $22M
Support Costs	$80M to $100M
Escalation to 2025 dollars	$75M to $94M
TOTAL PROJECT COSTS	**$400M to $500M**

Preliminary and subject to change. Maintenance costs and relocation of fiber optic lines not included.

For more Rail Fact Sheets visit: https://connectingpaloalto.com/fact sheets/

Neighborhood Considerations

- During construction, Meadow Drive and Charleston Road will be closed intermittently at night and on weekends.
- During construction, Alma Street will have narrow lanes for the portions north of Meadow Drive and south of Charleston Road.
- Vertical clearance of the railroad over Meadow Drive and Charleston Road will be 15.5 feet.
- The railroad tracks will be approximately 20 feet above the existing street between Meadow Drive and Charleston Road.
- With grade separations at Meadow Drive and Charleston Road the traffic at nearby intersections is expected to improve.

Caulfield to Dandenong Viaduct - Australia

Evaluation with City Council-Adopted Criteria

Facilitate movement across the corridor for all modes of transportation

Meadow Drive and Charleston Road will be grade separated from the railroad for all modes and will remain open. Viaduct provides opportunities for additional crossings for all modes.

Reduce delay and congestion for vehicular traffic at rail crossings

With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Drive and Charleston Road will be removed. Thus, the traffic will not be interrupted by the railroad crossing gates.

Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles

Pedestrians/cyclists will be separated from train traffic only. Bike lanes will be added to Meadow Drive and Charleston Road intersections. Additional pedestrian/cyclist separations routes can be explore on the next phase of design.

Support continued rail operations and Caltrain service improvements

New railroad tracks can be built without a temporary track, and a crossover track located north of the San Antonio Caltrain Station will be relocated.

Finance with feasible funding sources (Order of magnitude cost)

The viaduct would require substantial local funding resources more than the hybrid alternative, but less than the trench and tunnel alternatives.

Reduce rail noise and vibration

Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing EMU trains instead of diesel engines will also reduce noise. Six-foot high parapet sound barriers will help reduce propulsion and wheel/rail noise. There would be significant reduction to vibration levels at nearby receptors.

Minimize visual changes along the corridor

Railroad tracks will be approximately 20 feet above grade. Landscaping with trees will be incorporated for screening where feasible.

Maintain access to neighborhoods, parks, and schools along the corridor, while reducing regional traffic on neighborhood streets

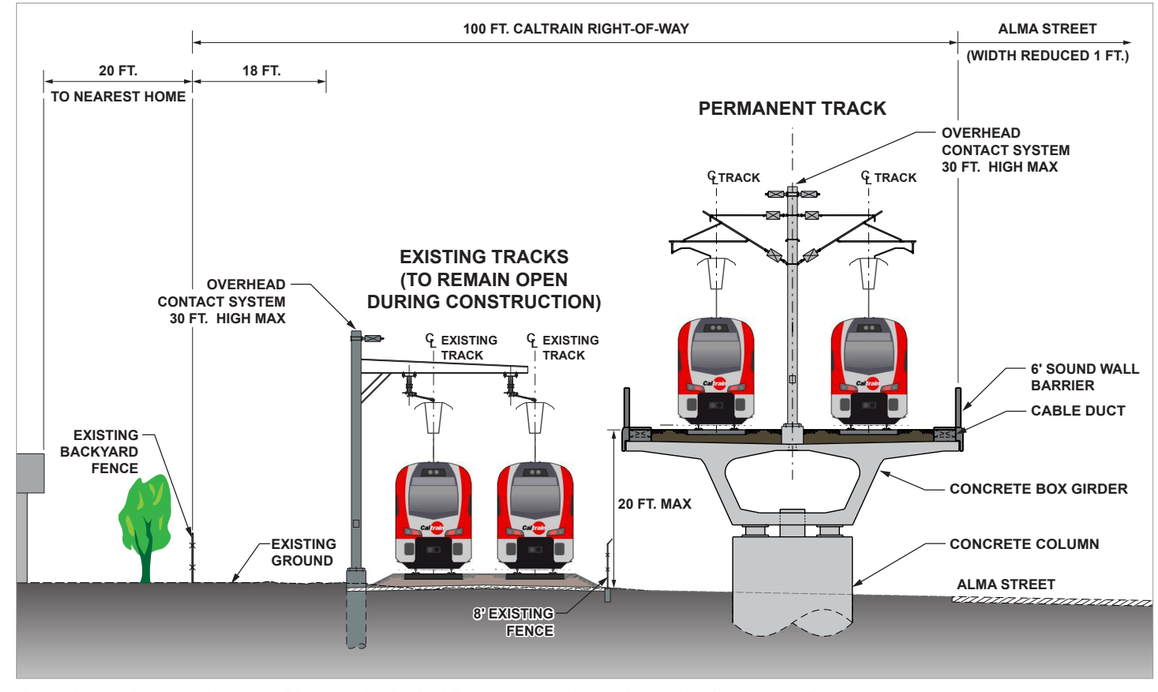
No diversion of regional traffic with construction of grade separations.

Minimize right-of-way acquisition (Private property only)

No acquisition of private properties is required.

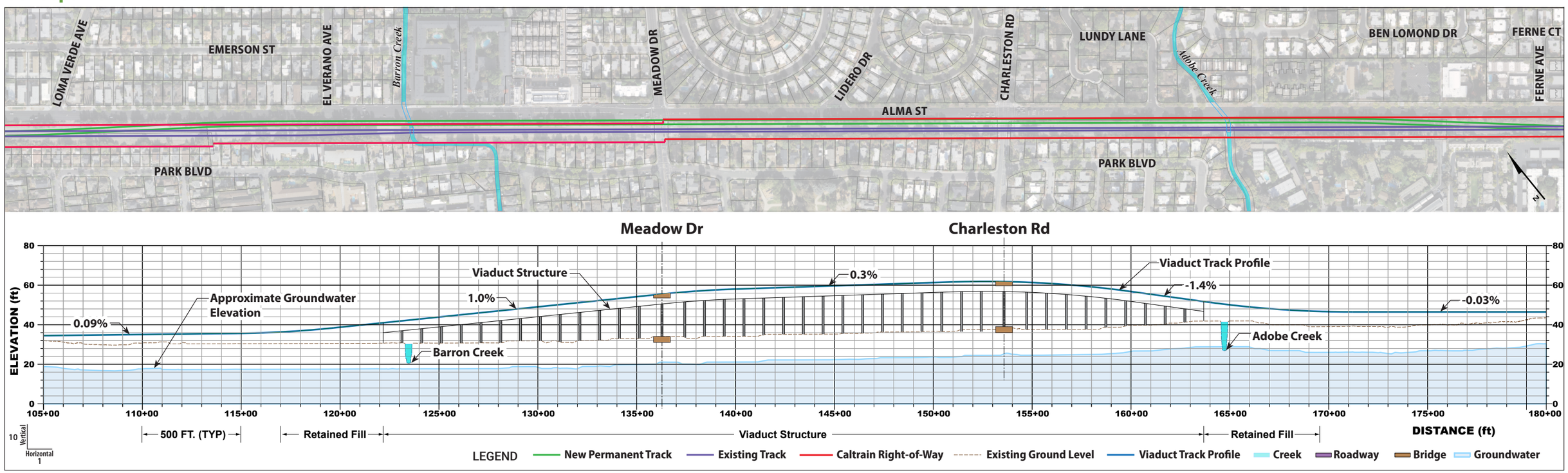
Minimize disruption and duration of construction

The viaduct will have minimal road closures (nights/weekends only). Construction would last for approximately 2 years.



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

Concept Plan and Profile

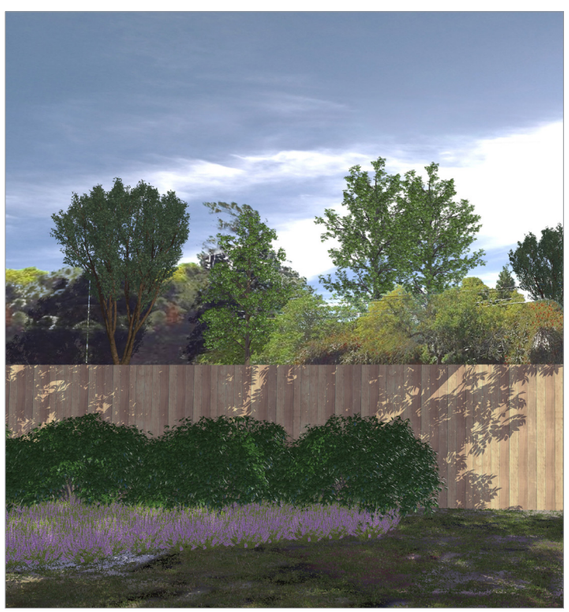


CITY OF PALO ALTO

South Palo Alto Tunnel – Passenger & Freight

Proposed Ground Level View - Looking Southwest
Charleston Road Intersection

Proposed Tunnel Aerial View - Looking South



Proposed Backyard View - Looking East
Typical Property West of Tracks

About the Tunnel with Passenger and Freight

For the tunnel alternative, the railroad tracks will be lowered in a trench south of Oregon Expressway to approximately Loma Verde Avenue. The twin bore tunnel will begin near Loma Verde Avenue and extend to just south of Charleston Road. The railroad tracks will then be raised in trench to approximately Ferne Avenue. The new electrified southbound railroad tracks will be built at the same horizontal location as the existing railroad track, however, the northbound track will be moved to the east within the limits of the tunnel to accommodate the spacing required between the twin bores. The railroad tracks will carry both passenger and freight trains as it does today.

The roadways at Meadow Drive and Charleston Road remain at their existing grade and will have a similar configuration that exists today with the addition of Class II buffered bike lanes on Charleston Road. This will require expanding the width of the road to maintain bike lanes through the overpass of the railroad.

By the numbers

- Diameter of twin bores is 34 feet.
- Railroad track is designed for 110 mph.
- Meadow Drive and Charleston Road are designed for 25 mph.
- Maximum grade on railroad is 2%.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.
- Construction period is approximately 6 years.

Engineering Challenges

- A non-standard grade of 2% will be required on tracks. Caltrain's preferred maximum grade is 1%.
- Lowering of the tracks will require diversion of Adobe and Matadero creeks, resulting in the need for lift stations/siphons and numerous regulatory agency permits/approvals. Negotiations with the regulatory agencies will be lengthy and difficult since there are other "least impacting" alternatives that could be considered.
- Pump stations will also be needed for dewatering since the tunnel will be below the ground water level.
- Increased long term maintenance costs and risk of flooding due to pump stations.
- Major utility relocations are required for the lowered railroad.

For more Rail Fact Sheets visit: https://connectingpaloalto.com/fact sheets/

Neighborhood Considerations

- During construction, Alma Street will be reduced to one lane in each direction from south of Oregon Expressway to Ventura Avenue. From Charleston Road to Ferne Avenue, there will only be one southbound lane.
- The train tracks will be approximately 60 feet below the existing grade in the tunnel section. A high fence will be required along trench walls.
- With grade separations at Meadow Drive and Charleston Road the traffic at nearby intersections is expected to improve.

Cost Breakdown

Roadway & Railroad Items	$764M to $1,146M
Right-of-way & Utilities	$6M to $10M
Support Costs	$236M to $353M
Escalation to 2025 dollars	$212M to $318M
TOTAL PROJECT COSTS	**$1,218M to $1,827M**

Preliminary and subject to change. Maintenance costs and relocation of fiber optic lines not included.

Milan Metro Line, Italy

Evaluation with City Council-Adopted Criteria

Facilitate movement across the corridor for all modes of transportation

Meadow Drive and Charleston Road will be grade separated from the railroad for all modes and will remain open.

Reduce delay and congestion for vehicular traffic at rail crossings

With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Drive and Charleston Road will be removed. Thus, the traffic will not be interrupted by the railroad crossing gates.

Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles

Pedestrians/cyclists will be separated from train traffic only. Bike lanes will be added to Meadow Drive and Charleston Road intersections. Additional pedestrian/cyclist separations routes can be explore on the next phase of design.

Support continued rail operations and Caltrain service improvements

A temporary railroad track will be required at the boring pit areas to the north and south. A siding track will be relocated north of the California Avenue Caltrain Station. Due to the pump stations, there will be potential risks to train operations due to flooding.

Finance with feasible funding sources (Order of magnitude cost)

The tunnel will require the greatest levels of local funding in the form of fees, taxes or special assessments, the feasibility of which are still being studied in the context of overall citywide infrastructure funding needs.

Reduce rail noise and vibration

Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing EMU trains instead of diesel engines will also reduce noise. In the trench section, train noise would be partially reduced with acoustically absorptive materials. In the tunnel section, train noise will be contained. There would likely be a slight reduction to vibration levels at nearby receptors.

Minimize visual changes along the corridor

Railroad tracks will be below grade with high fencing at grade in the trench section. Landscaping options will be limited to plants with shallow roots in areas where ground anchors are required for the trench section.

Maintain access to neighborhoods, parks, and schools along the corridor, while reducing regional traffic on neighborhood streets

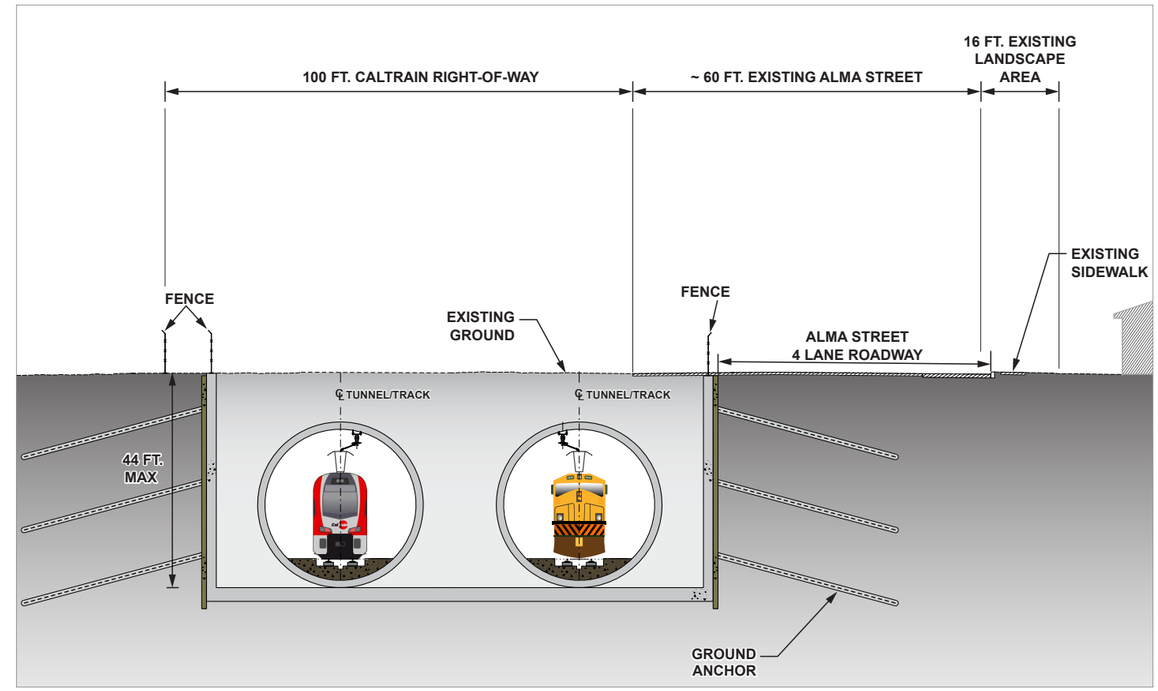
No diversion of regional traffic with construction of grade separations.

Minimize right-of-way acquisition (Private property only)

Subsurface acquisition will be required for the ground anchors for the trench retaining walls and private properties will be required for creek diversion pump station.

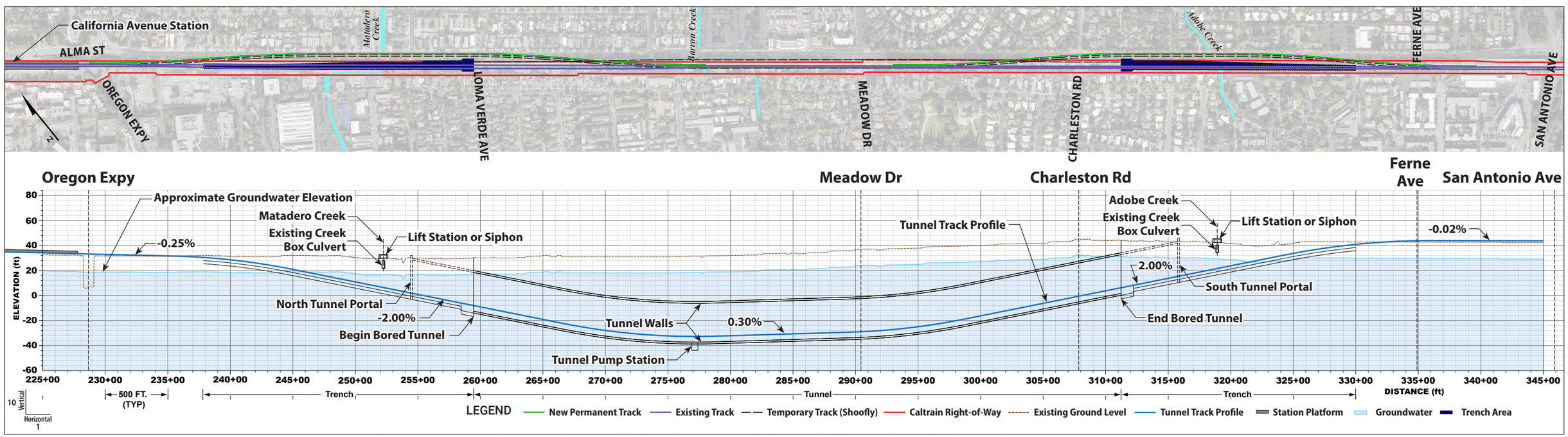
Minimize disruption and duration of construction

Extended lane reductions on Alma Street are required. Construction would last for approximately 6 years.



Example Section - South Portal Tunnel - Looking North

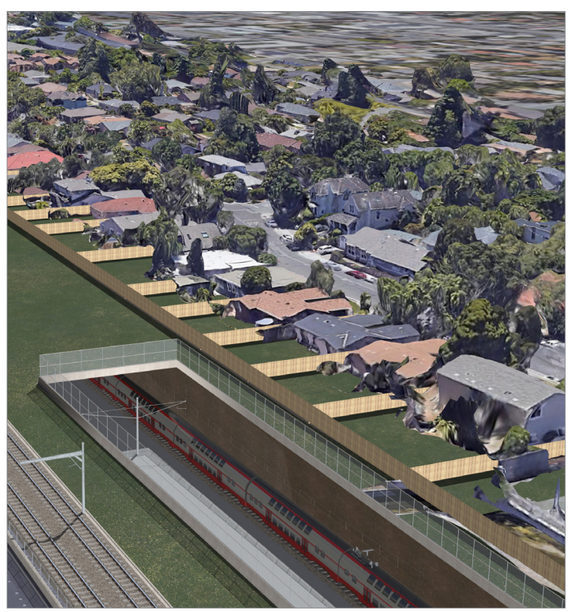
Concept Plan and Profile



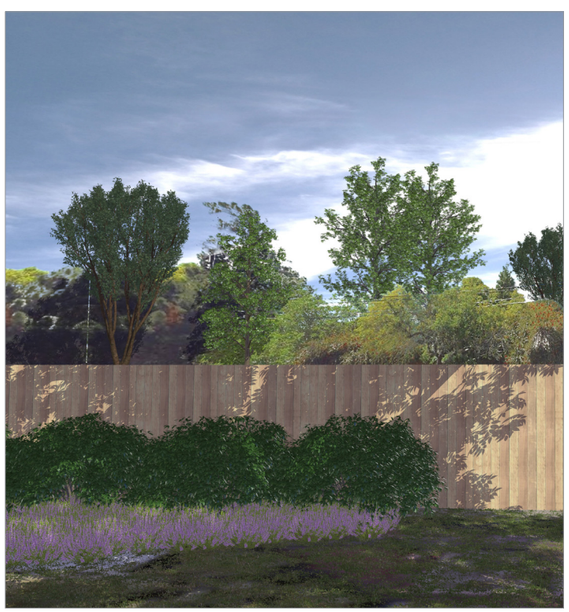
CITY OF PALO ALTO

South Palo Alto Tunnel with At-Grade Freight

Proposed Ground Level View - Looking Southwest
Charleston Road Intersection



Proposed Tunnel Aerial View - Looking South



Proposed Backyard View - Looking East
Typical Property West of Tracks

About the Tunnel with At-Grade Freight

For the tunnel alternative, the railroad tracks will be lowered in a trench south of Oregon Expressway to approximately Loma Verde Avenue. The twin bore tunnel will begin near Loma Verde Avenue and extend to just south of Charleston Road. The railroad tracks will then be raised in trench to approximately Ferne Avenue. The new electrified southbound railroad tracks will be built at the same horizontal location as the existing railroad track, however, the northbound track will be moved to the east within the limits of the tunnel to accommodate the spacing required between the twin bores. The railroad tracks in the trench and tunnel will carry only passenger trains. The freight trains will remain at-grade.

The roadways at Meadow Drive and Charleston Road remain at their existing grade and will have a similar configuration that exists today with the addition of Class II buffered bike lanes on Charleston Road. This will require expanding the width of the road to maintain bike lanes through the overpass of the railroad.

By the numbers

- Diameter of twin bores is 30 feet.
- Railroad track is designed for 110 mph.
- Meadow Drive and Charleston Road are designed for 25 mph.
- Maximum grade on railroad is 2%.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.
- Construction period is approximately 6 years.

Engineering Challenges

- A non-standard grade of 2% will be required on tracks. Caltrain's preferred maximum grade is 1%.
- Lowering of the tracks will require diversion of Adobe and Matadero creeks, resulting in the need for lift stations/siphons and numerous regulatory agency permits/approvals. Negotiations with the regulatory agencies will be lengthy and difficult since there are other "least impacting" alternatives that could be considered.
- Pump stations will also be needed for dewatering since the tunnel will be below the ground water level.
- Increased long term maintenance costs and risk of flooding due to pump stations.
- Major utility relocations are required for the lowered railroad.

For more Rail Fact Sheets visit: https://connectingpaloalto.com/fact sheets/

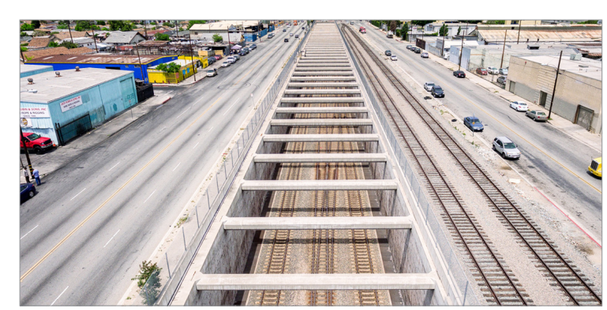
Neighborhood Considerations

- Alma Street will permanently be reduced to one lane in each direction from south of Oregon Expressway to Ventura Avenue and from Charleston Road to Ferne Avenue.
- The train tracks will be approximately 70 feet below the existing grade in the tunnel section. A high fence will be required along trench walls.
- With grade separations at Meadow Drive and Charleston Road the traffic at nearby intersections is expected to improve.

Cost Breakdown

Roadway & Railroad Items	$735M to $1,102M
Right-of-way & Utilities	$7M to $10M
Support Costs	$227M to $340M
Escalation to 2025 dollars	$204M to $307M
TOTAL PROJECT COSTS	**$1,173M to $1,759M**

Preliminary and subject to change. Maintenance costs and relocation of fiber optic lines not included.



Alameda Rail Corridor, Long Beach

Evaluation with City Council-Adopted Criteria

Facilitate movement across the corridor for all modes of transportation

Meadow Drive and Charleston Road will be grade separated from the passenger train traffic only for all modes and will remain open. Meadow Drive and Charleston Road will not be grade separated from the freight train traffic. Alma Street will be limited to one lane in each direction within the trench sections leading up to the tunnel entrance.

Reduce delay and congestion for vehicular traffic at rail crossings

With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Drive and Charleston Road will remain for the freight at-grade crossing. Freight train service is limited to just a few trains at night.

Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles

Pedestrians/cyclists will be separated from train traffic only. Bike lanes will be added to Meadow Drive and Charleston Road intersections. Additional pedestrian/cyclist separations routes can be explore on the next phase of design.

Support continued rail operations and Caltrain service improvements

A temporary railroad track will be required at the boring pit areas to the north and south. A siding track will be relocated north of the California Avenue Caltrain Station. Due to the pump stations, there will be potential risks to train operations due to flooding.

Finance with feasible funding sources (Order of magnitude cost)

The tunnel will require the greatest levels of local funding in the form of fees, taxes or special assessments, the feasibility of which are still being studied in the context of overall citywide infrastructure funding needs. However, this alternative would not be eligible for grade separation funding as the at-grade crossing for freight would remain.

Reduce rail noise and vibration

Train horn noise and warning bells will remain for the at-grade crossings to accommodate a limited number of freight trains. Utilizing EMU trains instead of diesel engines will also reduce noise. In the trench section, train noise would be partially reduced with acoustically absorptive materials. In the tunnel section, train noise will be contained. Reduced traffic lanes on Alma would also reduce noise levels in the community. There would be slight reduction to vibration levels at nearby receptors.

Minimize visual changes along the corridor

Passenger tracks will be below grade and freight tracks will be at-grade with high fencing. Landscaping options will be limited to plants with shallow roots in areas where ground anchors are required for the trench section.

Maintain access to neighborhoods, parks, and schools along the corridor, while reducing regional traffic on neighborhood streets

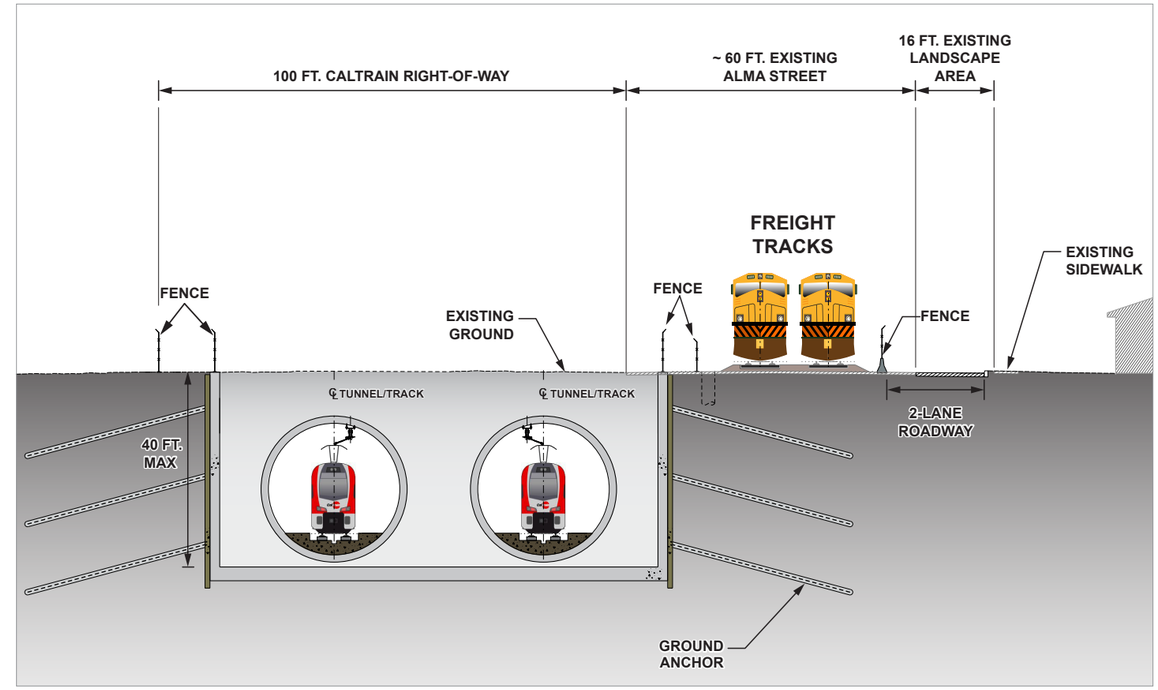
Diversion of regional traffic with the permanent lane reduction on Alma Street will impact residential streets.

Minimize right-of-way acquisition (Private property only)

Subsurface acquisition will be required for the ground anchors for the trench retaining walls and private properties will be required for creek diversion pump station.

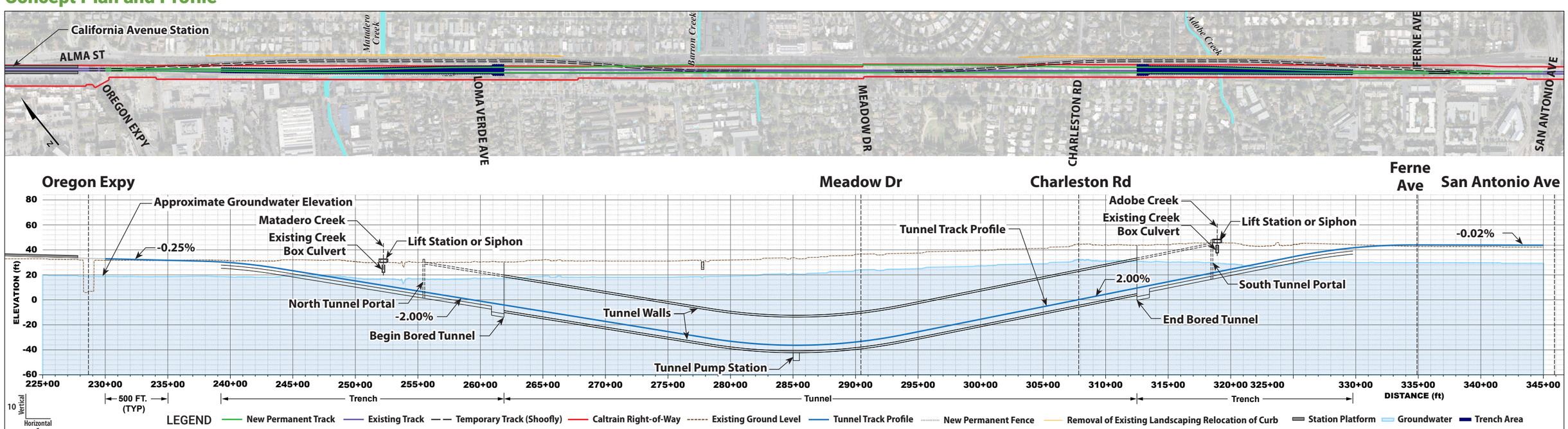
Minimize disruption and duration of construction

Extended lane reductions on Alma Street are required. Construction would last for approximately 6 years.



Example Section - South Portal Tunnel - Looking North

Concept Plan and Profile



CITY OF PALO ALTO

Meadow-Charleston Underpass

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

Charleston Road Underpass Overview - Looking South

About the Underpass

The underpass alternative retains the Caltrain tracks at the current grade and lowers Meadow Drive and Charleston Road under the tracks and under Alma Street for through traffic. Alma Street will retain four lanes of traffic, two northbound and two southbound, supported on a new road bridge spanning the intersecting road. Turning movements to and from Alma Street will be facilitated by ramps for key traffic flow directions and controlled by traffic signals. On the east side of Alma Street, the new road profile will begin descending just west of the Emerson Street for Meadow Drive, and just west of Wright Place on Charleston Road and will return to grade on the west side of the tracks, just west of Park Boulevard. Turning movements from various side streets will be limited.

Charleston Road Roundabout - Looking West

The Caltrain tracks will be supported on a new rail bridge that spans the width of the intersecting road and the pedestrian/bike ramp while remaining on its current alignment.

The pedestrian/bike ramp will provide a crossing for cyclists and foot traffic of both Alma Street and the railroad. This pedestrian/bike crossing is separate and at a different grade from both the rail and the road, providing both the benefits of a safer route and less traffic interference resulting in better traffic flow.

The on-ramp and off-ramp connecting Meadow Drive to Alma Street will be limited to northbound and southbound traffic, respectively. Through traffic on Park Boulevard will no longer be possible. The connection from the south side of Park Boulevard to Meadow Drive will no longer possible and will end in a cul-de-sac, while the north side of Park Boulevard will have driveway modifications but turning movements will be retained.

With connection ramps only to East Charleston Road, movement to and from Alma Street will be facilitated via a roundabout on East Charleston Road just west of Mumford Place. Right of way acquisition from private property will be required to accommodate this alternative. As with Meadow Drive, through traffic on Park Boulevard will no longer be possible, however, a bridge will be constructed just west of the tracks to provide north/south pedestrian/bike connectivity at Park Boulevard. Ely Place intersection with Alma Street will only facilitate an exit onto northbound Alma Street. Entrance from southbound Alma Street into Ely Place will be prohibited.

For Rail Fact Sheets for each alternative visit: https://connectingpaloalto.com/fact-sheets/

By the numbers

- Meadow Drive and Charleston Road are designed for 25 miles per hour.
- Alma Street is designed for 35 miles per hour.
- Maximum grade for Meadow Drive, Charleston Road and Park Boulevard is 12%
- Travel lanes are 10 to 12 feet wide.
- Meadow Drive pedestrian/bike path has a maximum grade of 5% for a length of approximately 310 feet west of the tracks and 190 feet east of the tracks. Path is 20 feet wide. Dimensions are subject to change in the next phase of design.
- Charleston Road pedestrian/bike paths have a width of 20 feet and a maximum grade of 5% for a length of approximately 190 feet west of tracks and 4% grade for a length of approximately 215 feet east of the tracks. The pedestrian/bike ramp at the northeast has a grade of 5% and is approximately 230 feet long. All dimensions are subject to change in the next phase of design.
- Construction period is approximately 3.5 to 4 years.

Engineering Challenges

- For access to the construction site, construction traffic will be diverted to other areas.
- Lowering of the roadways will require a pump station.
- Increased cost of long-term maintenance and risk of flooding due to pump station.
- Major utility relocations will be required for the lowered roadways.
- Dewatering of the excavation during construction will be required.

Neighborhood Considerations

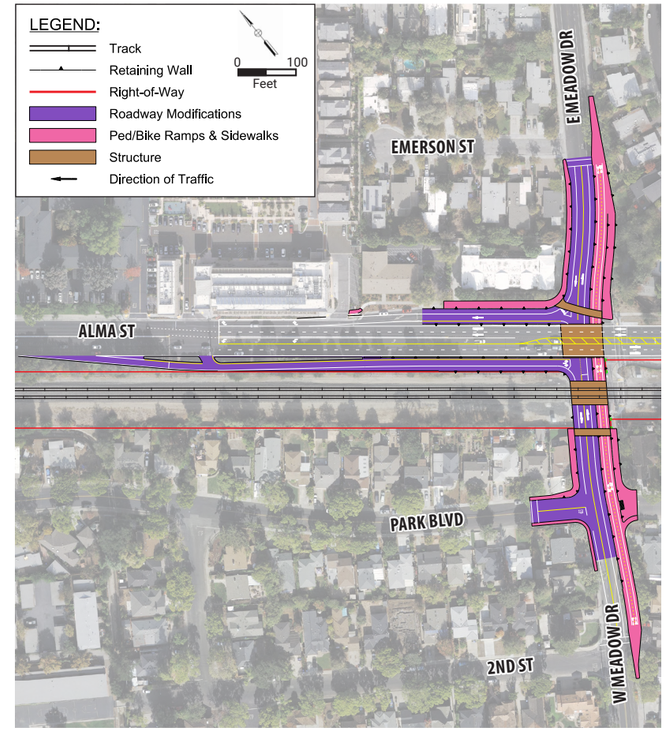
- The rail crossing at Meadow Drive and Charleston Road will need to be closed for most of the construction period.
- Excavation work and construction of the new road bridge will require or reduction of the number of lanes on Alma Street for a significant portion of the construction period.
- Vertical clearance of Meadow Drive and Charleston Road under the railroad will be 15.5 feet.
- With the grade separation at Meadow Drive and Charleston Road and restricted turning movements, traffic at nearby intersections is expected to improve.
- Significant excavation and construction work will take place adjacent to residences.
- Property impact is required for both Meadow Drive and Charleston Road underpasses.

Cost Breakdown - Both Underpasses

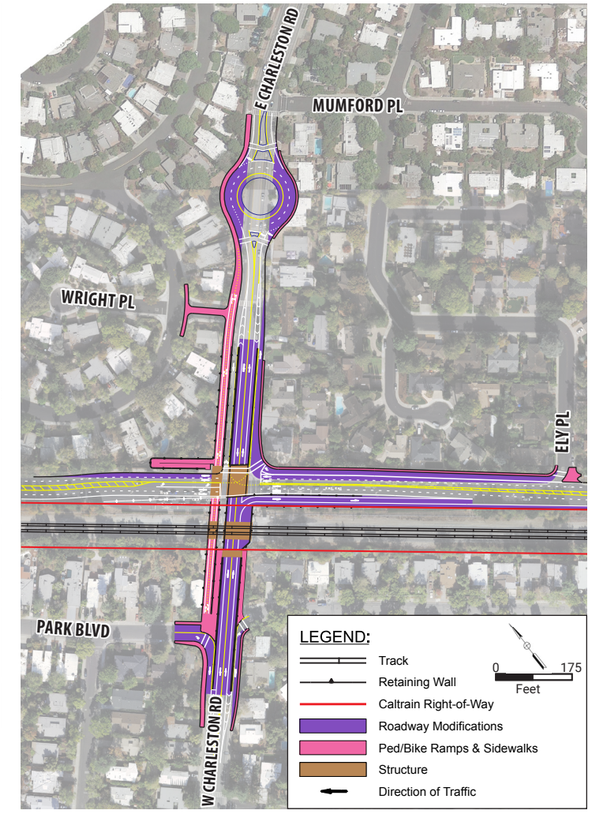
Roadway & Railroad Items	$124M to $152M
Structure Items	$18M to $22M
Right-of-Way & Utilities	$80M to $98M
Support Costs	$54M to $70M
Escalation to 2025 dollars	$64M to $78M
TOTAL PROJECT COSTS	**$340M to $420M**

Preliminary and subject to change. Maintenance costs and relocation of fiber optic lines not included. Both Meadow Drive and Charleston Road Intersection improvements included.

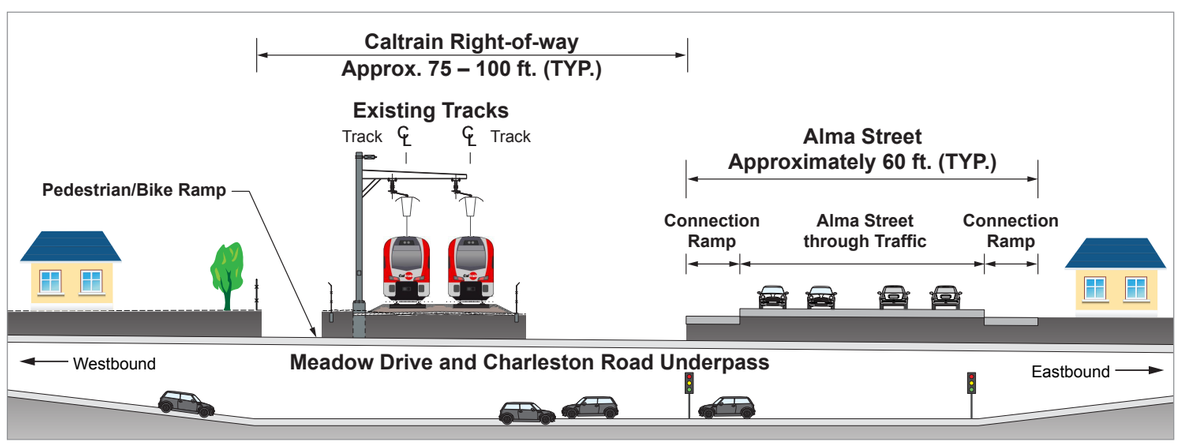
Concept Plan View



Meadow Drive Underpass Aerial (Plan)

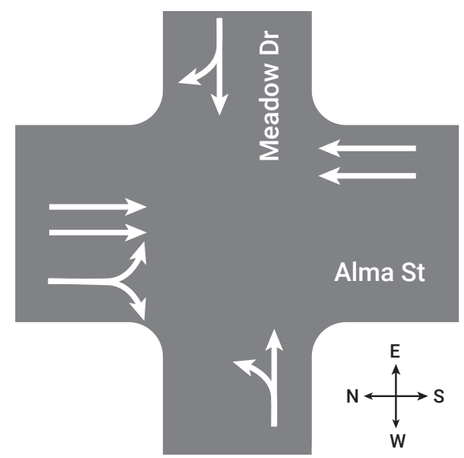


Charleston Road Underpass Aerial (Plan)

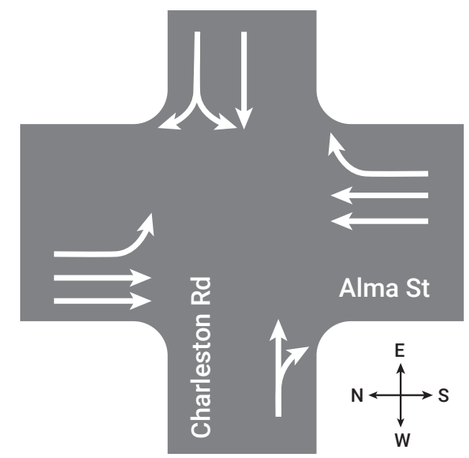


Example Section - Underpass at Meadow Drive and Charleston Road

Intersection Turning Movement Diagrams



Meadow Drive Underpass



Charleston Road Underpass

Evaluation with City Council-Adopted Criteria:

Facilitate movements across the corridor for all modes of transportation

East/West (through) traffic on Meadow Drive and Charleston Road will be grade separated from the railroad and Alma Street for all modes.

Some turning movements on Meadow Drive to/from Alma Street will be prohibited. All turning movements on Charleston Road to/from Alma Street will be permitted; however, some movements will be facilitated via a roundabout approximately 600 feet west of Alma Street, resulting in longer routes for all modes.

Reduce delay and congestion for vehicular traffic at rail crossings

With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Drive and Charleston Road will be removed. Thus, the traffic will not be interrupted by the railroad crossing gates. Pedestrian and cyclist mode separation will also help reduce intersection congestion.

Provide clear, safe routes that are separated from vehicles for pedestrians and cyclists crossing the rail corridor.

Pedestrians and cyclists traveling east/west will be completely separated from train and vehicular traffic on Alma Street. Full pedestrian and cyclist movement is maintained.

Pedestrians and cyclists will have more circuitous routes traveling east/west across the corridor because the pedestrain/bike path is located on one side of the street only: on the south side of Meadow Drive and on the north side of Charleston Road. For example, cyclists traveling eastbound on Charleston Road near Ruthelma Street will have to cross Charleston Road to get onto the north side of the road, then cross Charleston Road again at the roundabout near Mumford Place to get back onto the right/south side of the road.

Support continued rail operation and Caltrain service improvements

A temporary railroad track is likely to be required unless an alternate construction methodology and sequencing is acceptable to Caltrain.

Finance with feasible funding sources (Order of magnitude cost)

The underpass will require substantial local funding resources more than the hybrid alternative, but less than the trench and tunnel alternatives.

Reduce rail noise and vibration

Train horn noise and warning bells will be eliminated by the replacement of the at-grade crossings with grade separations. Utilizing EMU trains rather than diesel engines will also reduce noise. Modern rail bridge design will reduce excess structural noise. Sound barriers will also help to reduce propulsion and wheel/rail noise. There would be little to no change to vibration levels at nearby receptors. An optional 6-foot high noise barrier near the tracks and on the overpass structure could significantly reduce wheel/rail and propulsion noise.

Minimize visual change along the corridor

Railroad tracks will remain at-grade. On Charleston Road, removal of the planting strip on both sides of the road will be required along with the planting strip on the east side of Alma Street between Charleston Road and Ely Place.

Maintain access to neighborhoods, parks, and schools along the corridor while reducing regional traffic on neighborhood streets

Regional traffic will be diverted due to the restricted turning movements; however, travel in all directions will be possible, but may require a longer route and take more time. Turning movements at Ely Place will be limited to right turns on northbound Alma Street only. Pedestrian and cyclist access will improve due to mode separation.

Minimize right-of-way acquisition (Private property)

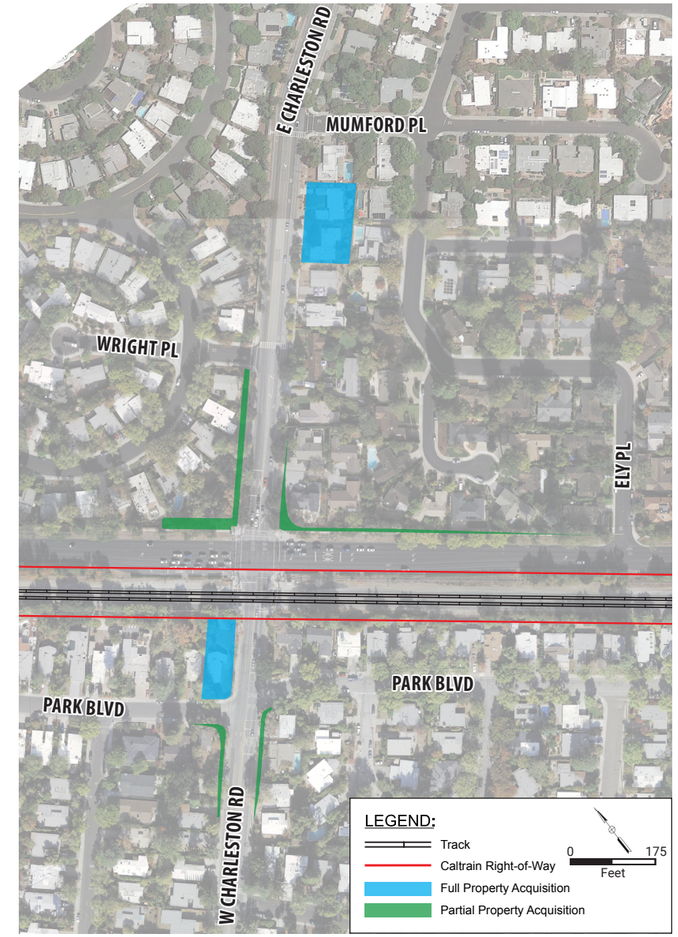
Multiple private property acquisitions are required, and driveway modifications will be required. Some (sliver) acquisition of residential properties immediately adjacent Alma Street, Meadow Drive and Charleston Road will be required.

Minimize disruption and duration of construction

Lane reductions and temporary closures (nights/weekends only) on Alma Street, a closure of Meadow Drive between Emerson Street and Park Boulevard, and a closure of Charleston Road between Alma Street and Park Boulevard will be required for the majority of construction. The total duration of construction will be approximately 3.5 to 4 years; however the durations are subject to change depending on the construction methodologies used.

Conceptual Private Property Impacts

Meadow Drive Private Property Impacts
(Subject to changes during design development)



Charleston Road Private Property Impacts
(Subject to changes during design development)

Meadow Drive Underpass - Looking West

CITY OF PALO ALTO

Churchill Closure with Mitigations

Undercrossing at San Antonio Station

About the Closure

For the Churchill closure alternative, the railroad tracks will remain at their existing location and elevation (as is). Churchill Avenue will become a T-intersection with Alma Street on the east side and will end at Mariposa Avenue on the west side. A pedestrian/bike only undercrossing will be constructed. Two options are proposed: one crosses under the railroad tracks only (Option 1) and the other crosses under both the railroad tracks and Alma Street (Option 2). Ramps and stairs in varying configurations will provide access to the undercrossing for pedestrians and cyclists.

There are several intersection improvements associated with the Churchill Avenue closure to mitigate the anticipated diversion in traffic. These improvements will include:

- **Embarcadero Road/Alma Street:** constructing a pedestrian/bike overcrossing at Embarcadero Road, widening Alma Street on the Embarcadero underpass, adding a right turn lane from eastbound Embarcadero Road and left turn lane from southbound Alma Street, and installing a new signal at Embarcadero Road/Kingsley Avenue/High Street. Two options are proposed: one that provides full connectivity to/from High Street (Option A) and the other that keeps the movements to/from High Street as they are today (Option B).
- **El Camino Real/Embarcadero Road:** optimizing signal timing and installing an additional westbound left turn lane and northbound right turn lane.
- **Alma Street/Oregon Expressway:** signalizing both on/off ramps.
- **El Camino Real/Oregon Expressway-Page Mill Road:** optimizing signal timing and installing a westbound right turn lane and northbound right turn lane from Oregon Expressway to El Camino Real Road.

Proposed Churchill Avenue Undercrossing Concept - Option 1 - Looking North

Proposed Churchill Avenue Undercrossing Concept - Option 2 - Looking West

Proposed Churchill Avenue Undercrossing Concept Overview - Option 1

For more Rail Fact Sheets visit: https://connectingpaloalto.com/fact sheets/

By the numbers

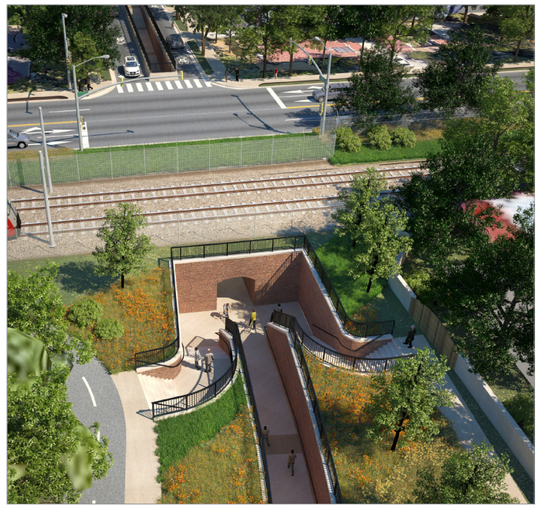
- Churchill Avenue is designed for 25 mph.
- Maximum grade on pedestrian/bike ramp is 8% with 5-foot landings.
- The pedestrian/bike ramp is 8-10 feet wide and approximately 230ft long with a maximum grade of 8%. 5-foot landings are spaced 35 feet apart. Dimensions are subject to change in the next phase of design.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.
- Construction period is approximately 2 years.

Engineering Challenges

- Pedestrian/bike undercrossing will require a sump pump.
- Relocation of pump house at Embarcadero Road will be required to widen Alma Street.
- Utility relocations will be required for pedestrian/bike undercrossing.
- Additional environmental review may be required for the Embarcadero Road underpass, which has been identified as eligible as a historic resource.

Neighborhood Considerations

- During construction, Embarcadero Road, Alma Street, and Churchill Avenue will be closed intermittently at night and on weekends.
- Vertical clearance of the pedestrian undercrossing will be 8-10 feet.
- The railroad tracks will remain at the existing grade at Churchill Avenue.
- Traffic mitigations will be implemented to improve traffic at nearby intersections and reduce traffic on residential streets.

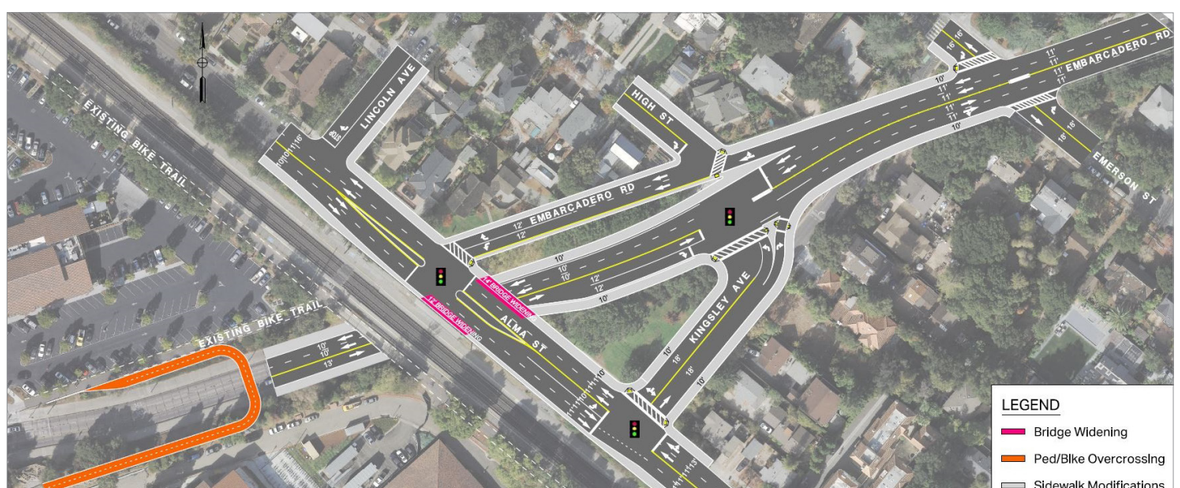


Proposed Churchill Avenue Undercrossing Concept - Option 2 - Looking East

Cost Breakdown

Roadway & Railroad Items	$22M to $24M
Structure Items	$4M to $9M
Right-of-way & Utilities	$4M to $7M
Support Costs	$11M to $14M
Escalation to 2025 dollars	$9M to $11M
TOTAL PROJECT COSTS	**$50M to $65M**

Preliminary and subject to change. Maintenance costs and relocation of fiber optic lines not included. Intersection improvements included.



Proposed Embarcadero Road/High Street/Kingsley Avenue Plan View (Option B without High Street connection)

Evaluation with City Council-Adopted Criteria

Facilitate movement across the corridor for all modes of transportation

Churchill Avenue will be closed to vehicles at the railroad tracks. Pedestrians and cyclists will be grade separated from the railroad in Option 1. For Option 2, pedestrians and cyclists will be grade separated from the railroad and vehicle traffic on Alma Street.

Reduce delay and congestion for vehicular traffic at rail crossings

With closure of Churchill Avenue, the traffic at nearby intersections will be impacted; however, this can be mitigated.

Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles

Pedestrians/cyclists will be separated from train traffic and vehicles.

Support continued rail operations and Caltrain service improvements

A temporary railroad track will not be required.

Finance with feasible funding sources (Order of magnitude cost)

The closure would require the lowest levels of local funding, with a substantial portion of capital costs covered by Regional, State and Federal sources.

Reduce rail noise and vibration

Train horn noise and warning bells will be eliminated with the removal of the at-grade crossings with roadway closure. Utilizing EMU trains instead of diesel engines will also reduce noise. There would be no change to vibration levels at nearby receptors.

Minimize visual changes along the corridor

Railroad tracks remain at existing grade. Residual roadway areas from closure provide opportunities for landscaping.

Maintain access to neighborhoods, parks, and schools along the corridor, while reducing regional traffic on neighborhood streets

Vehicle access will be diverted and resultant regional traffic will be mitigated. Pedestrian and cyclist access will improve to mode separation.

Minimize right-of-way acquisition (Private property only)

No acquisition of private properties is required; however, there will be impacts to Palo Alto High School property. There also may be some parking loss on the east side of Churchill Avenue for the pedestrian/bike undercrossing (Option 2 only).

Minimize disruption and duration of construction

The closure will have minimal road closures (nights/weekends only). Construction would last for approximately 2 years.

Proposed Churchill Avenue Undercrossing Concept Overview - Option 2

CITY OF PALO ALTO

Churchill Viaduct

Proposed Ground Level View - Looking East
Churchill Avenue Intersection

Proposed Viaduct Aerial View - Looking South
Chuchill Avenue Intersection

Proposed Backyard View - Looking East
Typical Property West of Tracks

About the Viaduct

For the viaduct alternative, the railroad tracks will be elevated on a structure over Churchill Avenue. The new electrified railroad tracks will be built at the same location as the existing railroad tracks and will begin rising near Homer Avenue, remain elevated over Churchill Avenue, and return to the existing track elevation near the California Avenue Station. Stanford game day station will be eliminated.

The roadway at Churchill Avenue will remain at its existing grade and have a similar configuration to what exists today. This will require expanding the width of the road through the underpass of the railroad to accommodate the new column supporting the railroad structure.

By the numbers

- Railroad track is designed for 110 mph.
- Churchill Avenue is designed for 25 mph.
- Maximum grade on railroad is 1.6%.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.
- Construction period is approximately 2 years.

Engineering Challenges

- A non-standard grade of 1.6% will be required on the tracks. Caltrain's preferred maximum grade is 1%.

Cost Breakdown

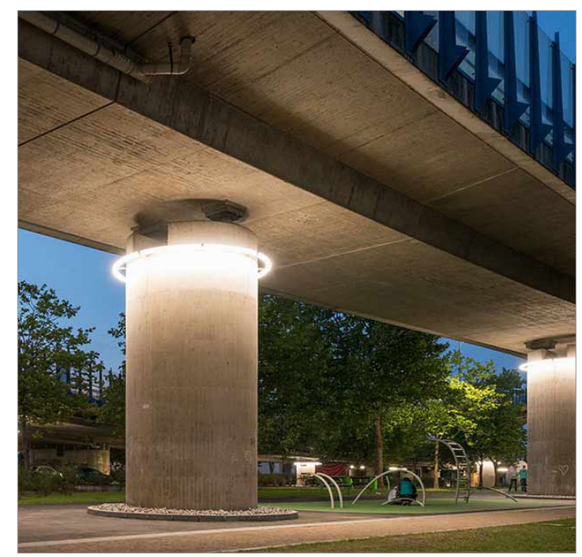
Roadway & Railroad Items	$55M to $73M
Structure Items	$115M to $152M
Right-of-way & Utilities	$16M to $20M
Support Costs	$60M to $80M
Escalation to 2025 dollars	$54M to $75M
TOTAL PROJECT COSTS	**$300M to $400M**

Preliminary and subject to change. Maintenance costs and relocation of fiber optic lines not included.

For more Rail Fact Sheets visit: https://connectingpaloalto.com/fact sheets/

Neighborhood Considerations

- During construction, Alma Street and Churchill Avenue will be closed intermittently at night and on weekends.
- During construction, Alma Street will be reduced to two lanes and right turn lanes on Alma Street at Churchill Avenue will be removed.
- Vertical clearance of the railroad over Churchill Avenue will be 15.5 feet.
- The railroad tracks will be approximately 20 feet above the existing street at Churchill Avenue.
- With grade separations at Churchill Avenue the traffic at nearby intersections is expected to improve.
- Stanford game day station will be eliminated.



Viaduct with linear park and lighting - Germany

Evaluation with City Council-Adopted Criteria

Facilitate movement across the corridor for all modes of transportation

Churchill Avenue will be grade separated from the railroad for all modes and will remain open. Viaduct provides opportunities for additional crossings for all modes.

Reduce delay and congestion for vehicular traffic at rail crossings

With construction of the grade separation, the railroad crossing gates and warning lights at Churchill Avenue will be removed. Thus, the traffic will not be interrupted by railroad crossing gates.

Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles

Pedestrians/cyclists will be separated from train traffic only. Bike lanes will be added to Churchill intersections. Additional pedestrian/cyclist separations routes can be explore on the next phase of design.

Support continued rail operations and Caltrain service improvements

A temporary railroad track will be required. Stanford game day station will be eliminated due to grade issues.

Finance with feasible funding sources (Order of magnitude cost)

The viaduct would require substantial local funding resources significantly above the closure alternative.

Reduce rail noise and vibration

Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing EMU trains instead of diesel engines will also reduce noise. There would be significant reduction in vibration levels at nearby receptors.

Minimize visual changes along the corridor

Railroad tracks will be approximately 20 feet above grade. Landscaping with trees will be incorporated for screening where feasible.

Maintain access to neighborhoods, parks, and schools along the corridor, while reducing regional traffic on neighborhood streets

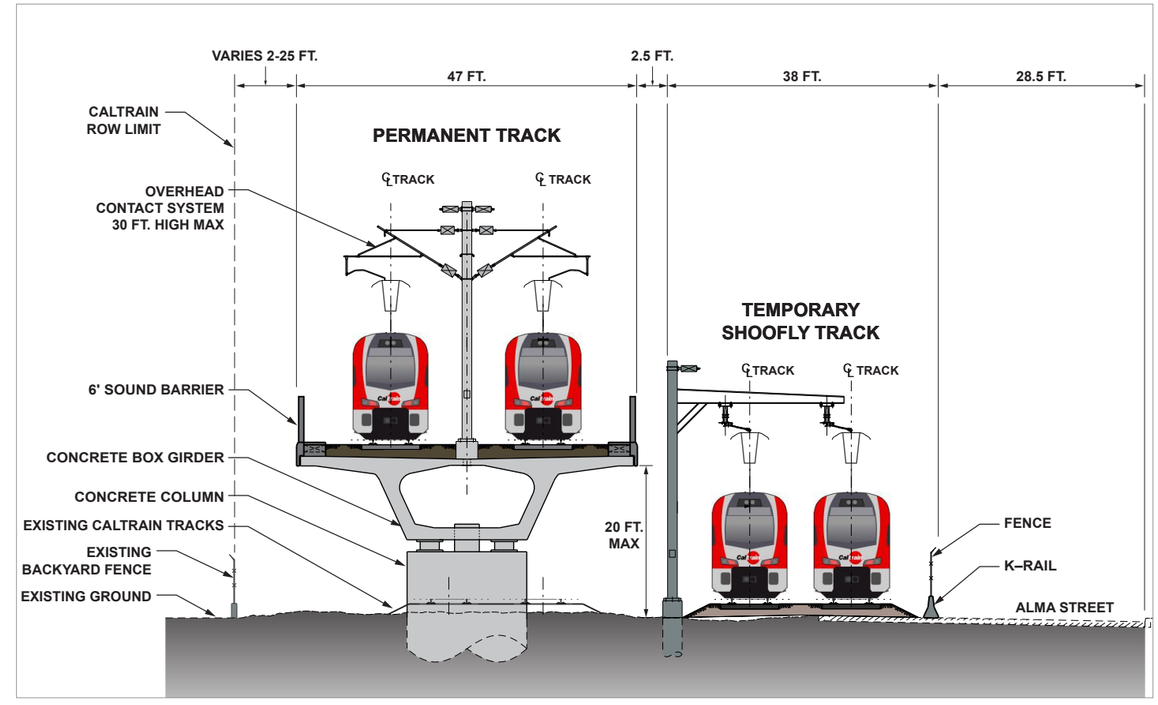
No diversion of regional traffic with construction of a grade separations.

Minimize right-of-way acquisition (Private property only)

No acquisition of private properties will be required.

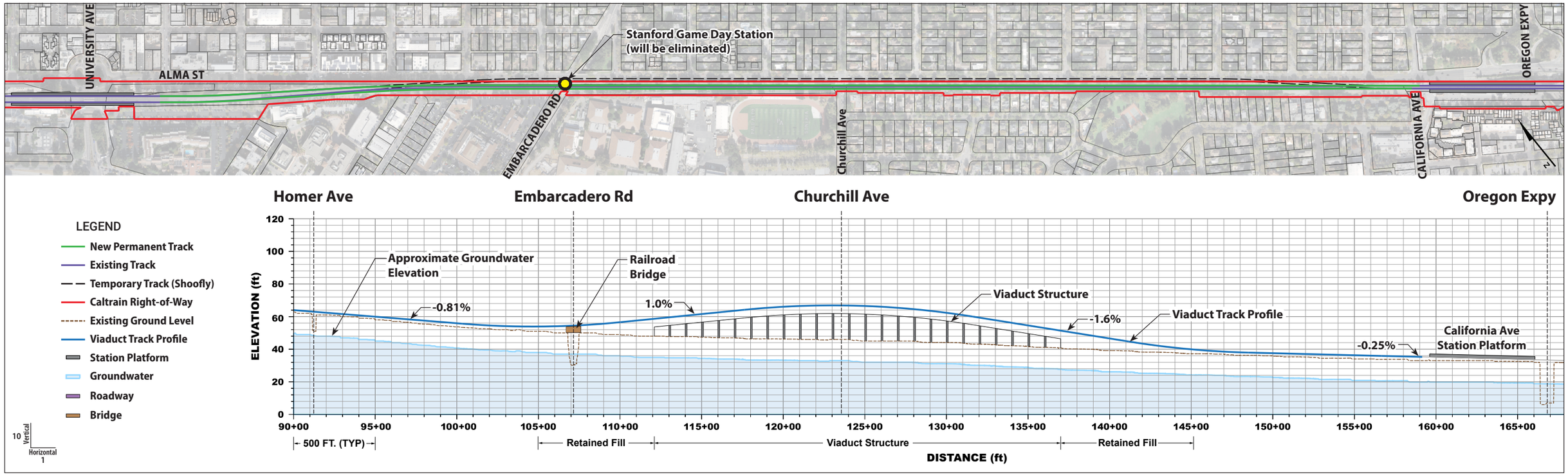
Minimize disruption and duration of construction

Extended lane reductions at Alma Street (one lane in each direction) will be required. Construction would last for approximately 2 years.



Example Section - Viaduct - Looking North

Concept Plan and Profile



CITY OF PALO ALTO

Churchill Partial Underpass

Churchill Avenue Partial Underpass Overview - Looking Northwest

Kellogg Avenue Pedestrian/Bike Underpass - Looking Southeast

About the Partial Underpass

The partial underpass alternative will grade separate Churchill Avenue from the current Caltrain tracks via an underpass; however, there will no longer be through traffic on Churchill Avenue at the intersection with Alma Street.

Traffic on eastbound Churchill Avenue from the Paly Road/Castilleja Avenue intersection will descend and pass under the railroad and terminate at a lowered, signal-controlled, T-intersection at Alma Street where vehicles can make a left turn onto northbound Alma Street or a right turn onto southbound Alma Street; then ascend and return to grade along Alma Street.

Traffic on westbound Churchill Avenue from Emerson Street will terminate at Alma Street. Right turns only (onto northbound Alma Street) will be permitted. Similarly, westbound traffic on Kellogg Avenue and Coleridge Avenue approaching Alma Street will be permitted to make right turns only onto northbound Alma Street.

Traffic on northbound Alma Street will be split near Coleridge Avenue:

- Vehicles bearing right will remain at grade and continue on northbound Alma Street. This traffic will be permitted to make right turns onto all connecting streets (Coleridge Avenue, Churchill Avenue, Kellogg Avenue, etc.) approaching Emerson Street.
- Vehicles bearing left will descend to the T-intersection with Churchill Avenue and be permitted to make left turns (under the railroad) onto westbound Churchill Avenue approaching Paly Road/Castilleja Avenue and El Camino Real.

Traffic on southbound Alma Street will operate as it does today except left turns onto Kellogg Avenue, Churchill Avenue and Coleridge Avenue will not be permitted.

The Caltrain tracks will be supported on a new rail bridge spanning across a lowered Churchill Avenue at approximately its current location.

A separate pedestrian/bicycle crossing will be provided at Kellogg Avenue. From westbound Kellogg Avenue, a 10-foot wide path will descend at the center of the road, at which point widens to 20 feet and crosses under both Alma Street and the Caltrain tracks and conforms at the Embarcadero Bike Path adjacent to Palo Alto High School.

Lowered Intersection of Alma Street and Churchill Avenue - Looking Northwest

For Rail Fact Sheets for each alternative visit: https://connectingpaloalto.com/fact-sheets/

By the numbers

- Churchill Avenue is designed for 25 mph and Alma Street is designed for 35 mph.
- Maximum grade on the roadway is 11% for Churchill Avenue, and 7% for Alma Street.
- Travel lanes are 10 to 12 feet wide.
- Each pedestrian/bike ramp is approximately 220 to 250 feet long with width ranging from 10 to 20 feet, and a maximum grade of 8% with 5-foot landings spaced 35 feet apart. All dimensions are subject to change in the next phase of design.
- Construction period is approximately 2.5 to 3 years.

Engineering Challenges

- For access to the construction site, construction traffic will be diverted to other areas.
- Lowering of the roadway will require a pump station.
- Increased cost of long-term maintenance and risk of flooding due to pump stations.
- Major utility relocations will be required for the lowered roadways.
- Dewatering of the excavation during construction will be required.
- The southbound lane/shoulder on Alma Street and the pedestrian/bike ramps on the west side of the tracks for the underpass at Kellogg Avenue will require encroachment inside Caltrain's right-of-way.

Neighborhood Considerations

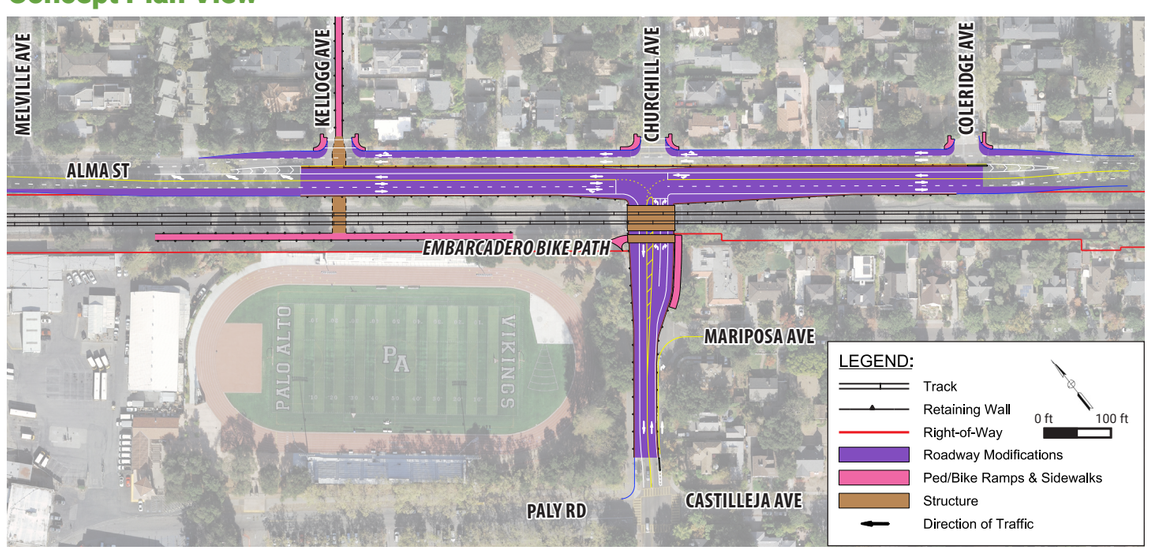
- Churchill Avenue between Alma Street and Mariposa Avenue will likely be closed for a majority of the construction period. In addition, Alma Street will be one-way northbound for approximately 6+ months. Local traffic will be diverted to other neighborhood roads during construction.
- Vertical clearance of Churchill Avenue under the railroad will be 15.5 feet.
- With the grade separation at Churchill Avenue and the restricted turning movements, traffic at nearby intersections is expected to improve.
- Significant excavation and construction work will take place adjacent to residences.
- Access to the Churchill Avenue crossing and the Embarcadero bike path will be limited during construction, which will impact pedestrian and bicycle routes heading to Palo Alto High School.
- Kellogg Avenue between Alma Street and Emerson Street will lose street parking.
- Minor property impacts are required.

Cost Breakdown

Roadway & Railroad Items	$70M to $86M
Structure Items	$8M to $10M
Right-of-Way & Utilities	$24M to $30M
Support Costs	$28M to $36M
Escalation to 2025 dollars	$30M to $38M
Total Project Cost	**$160M to $200M**

Preliminary and subject to change. Maintenance costs and relocation of fiber optic lines not included. Both Churchill and Kellogg Avenue improvements included.

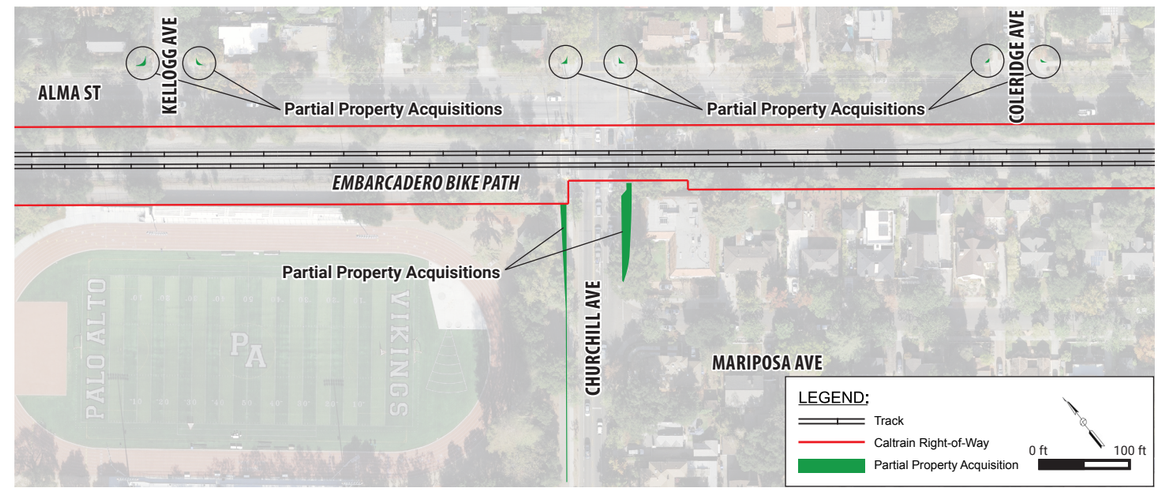
Concept Plan View



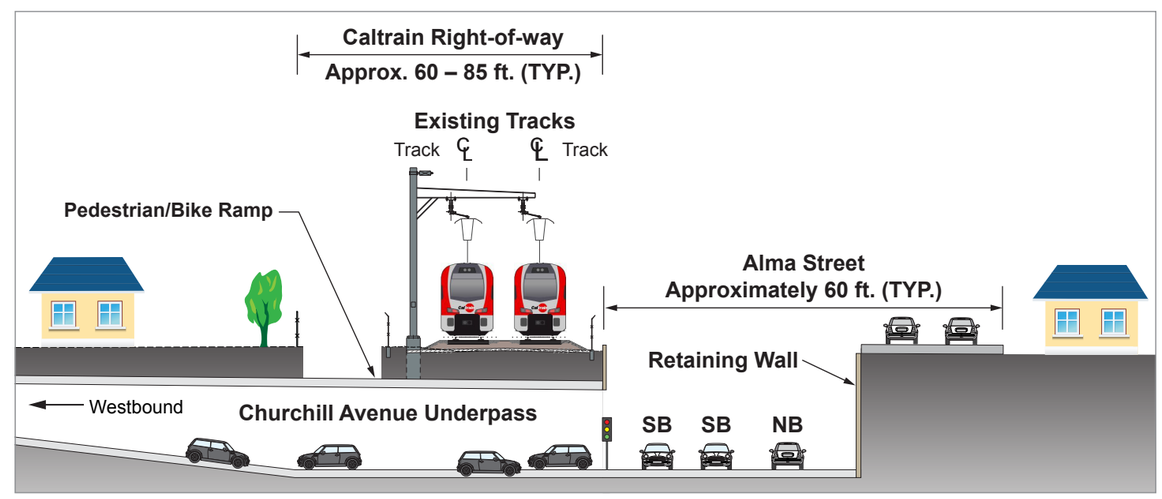
Churchill Avenue Partial Underpass Aerial (Plan)

Lowered portion of Alma Street - Looking South Towards Churchill Avenue

Conceptual Private Property Impacts



Churchill Avenue Private Property Impacts (Subject to changes during design development)
Note: See Engineering Challenges for impacts to Caltrain right-of-way.



Example Section - Underpass at Churchill Avenue

Evaluation with City Council-Adopted Criteria:

Facilitate movements across the corridor for all modes of transportation

Churchill Avenue will be grade separated from the Churchill Avenue will be grade separated from the railroad for all modes and will remain open. Through traffic on Churchill Avenue is no longer possible, and some traffic will have to take alternate routes. Pedestrian/bike (only) traffic will be grade separated from the railroad and vehicle traffic on Alma Street via an undercrossing at Kellogg Avenue.

Reduce delay and congestion for vehicular traffic at rail crossings

With construction of the grade separation, the railroad crossing gates and warning lights at Churchill Avenue will be removed. Thus, the traffic will not be interrupted by the railroad crossing gates. Pedestrian undercrossing at Kellogg Avenue will also help reduce intersection congestion.

Provide clear, safe routes that are separated from vehicles for pedestrians and cyclists crossing the rail corridor

Pedestrians and cyclists will be completely separated from train and vehicular traffic. Full pedestrian and cyclist movement is maintained with a new undercrossing at Kellogg Avenue.

Support continued rail operation and Caltrain service improvements

A temporary railroad track is likely to be required unless an alternate construction methodology and sequencing is acceptable to Caltrain.

Finance with feasible funding sources (Order of magnitude cost)

The underpasses would require lower levels of local funding, with a substantial portion of capital costs covered by Regional, State, and Federal sources.

Reduce rail noise and vibration

Train horn noise and warning bells will be eliminated by the replacement of the at-grade crossings with grade separations. Utilizing EMU trains rather than diesel engines will also reduce noise and some road noise would be reduced. Modern rail bridge design will reduce excess structural noise. There would be little to no change to vibration levels at nearby receptors. An optional 6-foot high noise barrier near the tracks and on the overpass structure could significantly reduce wheel/rail and propulsion noise.

Minimize visual changes along the corridor

The railroad tracks and the northbound lanes of Alma Street will remain at-grade, and the east side of Churchill Avenue will remain unchanged. Mature trees and overhead power poles within the Alma Street planting strip, from just north of Kellogg Avenue to just south of Coleridge Avenue, will be removed. Landscaping restoration is limited due to space constraints.

Maintain access to neighborhoods, parks, and schools along the corridor while reducing regional traffic on neighborhood streets

Regional traffic will be diverted due to the restricted turning movements. Pedestrian and cyclist access will improve due to mode separation.

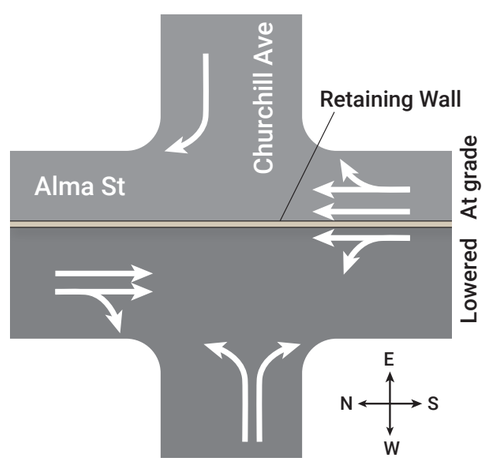
Minimize right-of-way acquisition (Private property)

Driveway modifications are likely to be required due to the removal of planter strips along Alma Street. Some (sliver) acquisition of the high school and/or residential property fronting Churchill Avenue on the west side of the tracks will be required. Street parking on both sides of Kellogg Avenue will be eliminated along the pedestrian/bike ramp (for approximately 250-300 feet from Alma Street).

Minimize disruption and duration of construction

Closure of Churchill Avenue between Alma Street and Mariposa Avenue will be required for the majority of construction. Alma Street will be one-way northbound for approximately 6+ months. Total duration of construction will be approximately 2.5 to 3 years; however the durations are subject to change depending on the construction methodologies used.

Intersection Turning Movement Diagram



Churchill Avenue Partial Underpass

Kellogg Avenue and Alma Street intersection - Looking North

Churchill Avenue and lowered Alma Street Intersection with rail bridge and pedestrian/bike crossing - Looking East