Hexagon Transportation Consultants, Inc.

Memorandum

Date: January 16, 2024

To: Mr. Ripon Bhatia, City of Palo Alto

From: Gary Black, Trisha Dudala

Subject: Intersection, Bicycle, and Pedestrian Delay Analysis for the Palo Alto Grade Separation Project

Hexagon Transportation Consultants, Inc. completed an evaluation of east/west connectivity across Alma Street and the Caltrain tracks. The study evaluated travel time/delay for motor vehicles and travel time/safety for bicycles and pedestrians. Grade separations were evaluated at Churchill Avenue, Meadow Drive, and Charleston Road.

The two alternatives that are being considered for the Churchill crossing are closure and a partial underpass. The partial underpass would allow turns from Alma to Churchill under the railroad but would not allow through traffic on Churchill Avenue. Both alternatives would include a bike/pedestrian underpass. Either alternative would improve bicycle and pedestrian safety. Motor vehicle delays would be reduced for the movements that would be allowed, but some existing movements would be cut off.

Three alternatives are being considered for the Meadow and Charleston railroad crossings: Trench, Hybrid and Underpass. The trench and hybrid alternatives would depress the railroad, and Meadow and Charleston would pass over. The traffic signals at Alma Street would remain, so there would be delays for motor vehicles, bicycles, and pedestrians at red lights. However, delays at the railroad crossings would be eliminated. In the Underpass alternative, Meadow and Charleston would pass under both Alma Street and the railroad. Overall, the Underpass alternative would result in lower vehicular delays compared to the Trench/Hybrid alternatives. However, some vehicular movements would have increased delays. The increased delays are due to the circuitous nature of the movements, as vehicles would need to use the Alma Village Circle signal or the Charleston roundabout to complete their maneuver.

Pedestrians and bicyclists on Meadow and Charleston would not need to interface with motor vehicles with the Underpass option. However, the proposed bike/pedestrian paths would be on only one side of the street, so, depending on the travel direction, they would need to cross Meadow or Charleston twice to complete their journey.

The analysis is presented in detail below.

The following grade separation alternatives were analyzed. A rendering of these alternatives is included in the appendix.

Churchill Alternatives

- Churchill Grade Separation *
- Churchill Partial Underpass
- Churchill Closure (Option 1)

- Churchill Closure (Option 2)

*The “Grade Separation” alternative, shown as Viaduct in the tables is not being considered by the city but was analyzed for comparison purposes with the other alternatives still being considered by the City.

Meadow - Charleston Alternatives

- Meadow – Charleston Trench
- Meadow – Charleston Hybrid
- Meadow – Charleson Viaduct *
- Meadow – Charleston Underpass

*The “Viaduct” option is no longer under consideration.

Intersection Delays

Intersection delays for the grade separation alternatives were analyzed using future year 2030 intersection turning movement volumes at Churchill Avenue, Meadow Drive and Charleston Road with Alma Street. The 2030 intersection delays are based on the *Churchill, Meadow, and Charleston Grade Separation Traffic Analysis* memorandum dated August 13, 2020 prepared by Hexagon. These volumes were based on the 2030 forecasts presented in the *Draft Churchill Closure* report by TJKM. The intersection turning movement delays are based on the Synchro/SimTraffic analysis that was conducted for the Churchill, Meadow, and Charleston Grade Separation Traffic Analysis.

Tables 1 – 3 provide a comparison of the 2030 intersection delays for the grade separation alternatives for each of the twelve turning movements at the Alma/Churchill, Alma/Meadow, and Alma/Charleston intersections. In the tables, green indicates reduced delays and orange indicates increased delays compared to the Viaduct alternative.

At the Alma/Churchill intersection, the Churchill Closure and Partial Underpass alternatives show reduced delays compared to the Viaduct alternative for nearly all movements (see Table 1). However, many turning movements would no longer be possible with Churchill closure, and some movements would be precluded with the Partial Underpass.

At the Alma/Meadow intersection, the Underpass alternative shows reduced delays compared to the Hybrid/Trench alternative for most movements (see Table 2). However, some movements would not be possible with the Underpass (eastbound to southbound right turn and westbound to southbound left turn), and that traffic would need to use the Charleston intersection instead. The northbound rights from Alma to Meadow Drive would be facilitated via the signal at Alma/Alma Village Circle intersection. This traffic would make a U-turn at the Alma Village Circle signal and then make a left-turn at the Alma southbound off-ramp to Meadow signal to travel eastbound on Meadow Drive, resulting in slightly longer delays due to the circuitous nature of this movement.

At the Alma/Charleston intersection, the Underpass alternative shows increased delays compared to the Hybrid/Trench alternatives for some movements, including eastbound left turns, westbound left turns, westbound right turns, and southbound right turns during the AM peak hour and the northbound through movement during the PM peak hour (see Table 3). The increased delays are due to the circuitous nature of the movements, as vehicles would need to use the neighboring roundabout and return to the intersection in order to complete certain turning movements.

Table 1
Intersection Movement Delays at Alma/Churchill

			2030 Delays (seconds / vehicle)		
Intersection	Movement	Peak Hour	Viaduct	Churchill Closure	Partial Underpass
Alma/Churchill	EBL	AM	64.6	N/A	18.8
		PM	115.4	N/A	31
	EBT	AM	62.6	N/A	N/A
		PM	117.2	N/A	N/A
	EBR	AM	12.2	N/A	6.2
		PM	64.9	N/A	17.3
	WBL	AM	63.0	40.8	N/A
		PM	72.0	69.3	N/A
	WBT	AM	N/A	N/A	N/A
		PM	69.0	N/A	N/A
	WBR	AM	47.0	24.0	21.2
		PM	53.0	45.3	10.6
	NBL	AM	114.7	N/A	24
		PM	99.2	N/A	44.9
	NBT	AM	35.3	27.3	0.7
		PM	35.2	34.6	3.5
	NBR	AM	42.4	38.1	1.6
		PM	35.0	35.0	0.7
	SBL	AM	84.5	70.7	N/A
		PM	154.7	124.0	N/A
	SBT	AM	47.0	13.4	14.4
		PM	63.1	22.9	26.4
	SBR	AM	26.4	N/A	10
		PM	50.3	N/A	22.6

Notes:-
indicates reduced delays compared to the Viaduct alternative.
N/A - Movement not allowed.

Table 2
Intersection Movement Delays at Alma/Meadow

Intersection	Movement	Peak Hour	2030 Delays (seconds / vehicle)	
			Hybrid/ Trench/ Viaduct	Underpass
Alma/Meadow	EBL	AM	64.1	8.1
		PM	43.4	8.3
	EBT	AM	73.7	14.1
		PM	45.5	16.5
	EBR	AM	18.0	N/A
		PM	29.2	N/A
	WBL	AM	85.6	N/A
		PM	43.5	N/A
	WBT	AM	89.7	15.3
		PM	46.6	13.6
	WBR	AM	15.9	6.5
		PM	27.8	7.6
	NBL	AM	118.7	41.3
		PM	126.1	51.8
	NBT	AM	50.0	0.0
		PM	78.9	0.0
	NBR	AM	53.8	55.3
		PM	78.5	80.9
	SBL	AM	109.6	8.8
		PM	443.9	10.0
	SBT	AM	37.4	0.0
		PM	463.7	0.0
	SBR	AM	19.3	6.1
		PM	463.1	7.4

Notes:-
indicates reduced delays compared to the Hybrid/Trench alternatives.
indicates increased delays compared to the Hybrid/Trench alternatives.
N/A - Movement not allowed.

Table 3
Intersection Movement Delays at Alma/Charleston

Intersection	Movement	Peak Hour	2030 Delays (seconds / vehicle)	
			Hybrid/ Trench/ Viaduct	Underpass (With Roundabout)
Alma/Charleston	EBL	AM	47.1	149.1
		PM	437.3	110.0
	EBT	AM	52.7	2.0
		PM	420.1	5.9
	EBR	AM	45.6	0.9
		PM	494.8	3.6
	WBL	AM	55.5	98.6
		PM	74.8	54.5
	WBT	AM	51.1	0.9
		PM	75.9	1.0
	WBR	AM	33.5	78.7
		PM	61.3	39.6
	NBL	AM	179.4	80.8
		PM	111.2	78.7
	NBT	AM	195.1	37.5
		PM	47.8	50.5
	NBR	AM	177.3	9.7
		PM	47.8	7.6
	SBL	AM	91.9	11.9
		PM	303.4	17.6
	SBT	AM	52.3	17.2
		PM	264.5	27.5
	SBR	AM	35.7	84.8
		PM	235.1	90.5

Notes:-
indicates reduced delays compared to the Hybrid/Trench alternatives.
indicates increased delays compared to the Hybrid/Trench alternatives.

Induced Travel

Although the grade separation alternatives show reduced delays and improvements in travel times across the east/west streets, none of the grade separation alternatives are likely to induce travel demand. Induced travel is defined as the increase in vehicle travel that occurs because of capacity expansion, which enables more trips and longer distance trips in a given amount of time due to increased travel speed.

Alma/Churchill Grade Separation Alternatives

The two alternatives that are being considered are the Churchill Closure and Partial Underpass alternatives. The Viaduct alternative is not being considered for further evaluation so vehicular and cyclist/pedestrian delays under this alternative are provided only for comparison purposes. For the Churchill closure option, Churchill Avenue would be closed off, west of the Caltrain tracks, and Churchill Avenue would no longer provide an east-west connection for vehicles across Alma Street.

Under the partial grade separation alternative, access to Alma Street would be maintained by keeping Churchill Avenue partially open via a modified underpass. However, no through traffic would be possible on Churchill Avenue across Alma Street. Therefore, there would be no induced travel under either alternative.

Alma/Charleston and Alma/Meadow Grade Separation Alternatives

The alternatives that are being considered are the Hybrid/Trench alternatives and the Underpass Alternative.

Under the Hybrid/Trench alternatives, the railroad would be grade separated, which would eliminate the traffic signal at the railroad tracks. However, the analysis shows that with future traffic volumes, vehicular delays at the Alma/Charleston intersection and Alma/Meadow intersection under the Hybrid/Trench alternatives would be similar or higher compared to existing traffic delays at these intersections (based on the *Churchill, Meadow, and Charleson Grade Separation Traffic Analysis* memorandum dated August 13, 2020 prepared by Hexagon). Therefore, it is unlikely that the Hybrid/Trench alternatives would induce travel demand along Charleston Road or Meadow Drive.

For the Underpass alternative, east/west through traffic on Meadow Drive and Charleston Road would be separated from Alma Street and thus would have lower delays compared to existing conditions. However, the improvement in travel time generally would be one minute or less, which is negligible compared to typical trip lengths of 10 – 30 minutes. Also, as some movement connections would have increased travel times, the underpass alternative is not likely to induce vehicular travel.

However, the underpass alternative would cause some traffic on Meadow Drive to divert onto Charleston Road (less than 150 vehicles during the peak commute hours) as some vehicular turning movements would not be feasible at the Alma/Meadow intersection. The vehicular movement delays presented in Table 3 for the Alma/Charleston intersection reflect the diverted volume from Meadow Drive to Charleston Road.

Bicycle and Pedestrian Delays

Bicycle and pedestrian access across the Caltrain tracks and Alma Street were analyzed for all grade separation alternatives. Bike speed is assumed to be 10 miles per hour (mph), and pedestrian speed is assumed to be 3 feet per second. For alternatives where pedestrian/bicycle access is grade separated, the bike speed was assumed to be 8 mph to account for the change in

grade and the sharp turns to access the pedestrian/bicycle bridge. For alternatives where pedestrians and bicycles have to cross Alma Street at grade, the bicycle and pedestrian travel times include the wait time at the traffic signal on Alma. The following paths near the proposed grade separation were analyzed in coordination with the city.

- Alma/Churchill
  - East/west bicycle and pedestrian travel times along Churchill Avenue between Mariposa Avenue and Emerson Street.
- Alma/Meadow
  - East/west bicycle and pedestrian travel times along Meadow Drive between Wilkie Way and Ramona Street.
  - North/south bicycle and pedestrian travel times along Park Boulevard between Maclane Street and Davenport Way.
- Alma/Charleston
  - East/west bicycle and pedestrian travel times along Charleston Road between Ruthelma Avenue and Carlson Court.
  - North/south bicycle and pedestrian travel times along Park Boulevard between Carolina Lane and Darlington Court.

Alma/Churchill Avenue Intersection

Table 4 provides a comparison of bicycle and pedestrian travel times between the Viaduct, Churchill Closure and Partial Underpass alternatives at the Alma/Churchill intersection. It is noted that the Viaduct alternative is not being considered for further evaluation so vehicular and cyclist/pedestrian delays under this alternative are provided only for comparison purposes.

Under the Viaduct alternative, an elevated structure would carry the railroad tracks over Churchill Avenue, and the Alma/Churchill Avenue intersection would continue to provide a direct connection to all turning movements for pedestrians and bicycles. Pedestrians and cyclists would travel through the Alma/Churchill intersection, through which approximately 28,000 vehicles travel daily.

Under the Churchill Closure alternative, Churchill Avenue would be closed off to the west of the Caltrain tracks, and Churchill Avenue would no longer provide an east-west connection for vehicles across Alma Street. However, pedestrian and bicycle access across Churchill Avenue would be maintained. Two options are being considered under this alternative, which differ in design with respect to pedestrian/bicycle access across Alma Street (see Figures 1 and 2). Under Alternative 1, pedestrians and bicycles would cross under the Caltrain tracks but would still need to cross Churchill Avenue at grade at the signal. Under Alternative 2, pedestrian/bicycle access across Alma Street would be provided via an underground tunnel that begins on the west side of the Caltrain tracks where Churchill Avenue is closed, then goes under the tracks and Alma Street and rises to the street level approximately 220 feet east of Alma Street. Under this alternative, pedestrians and bicyclists would not need to cross Alma Street at grade.

Under the Partial Underpass alternative, access to Alma Street would be maintained by keeping Churchill Avenue partially open via a modified underpass. Pedestrian and bicycle access across Alma Street would be provided via a tunnel that traverses under the Caltrain tracks and Alma Street at Kellog Avenue (see Figure 3).

As shown in Table 4, pedestrian and bicycle access under Churchill Closure (Option 1) and the Partial Underpass would have longer delays compared to the viaduct alternative as pedestrians and bicyclists would have to travel farther north and make multiple sharp turns to access the tunnel under the railroad tracks.

Table 4
Bicycle and Pedestrian Delays at Alma/Churchill Road

Bike Route	Alma Street/ Churchill Avenue Grade-Separation Alternatives			
	Viaduct	Churchill Closure (Option 1) [6]	Churchill Closure (Option 2) [7]	Partial Underpass (Ped/Bike Tunnel) [8]
Daily # of Bicycles [1]				
Cyclists/Pedestrian navigate through a major signal?	Yes (28,500 daily Vehicles)	Yes (28,500 daily Vehicles)	No	No
East/west Bicycle - Travel Time (seconds) [2,3] (between Mariposa Avenue and Emerson Street)	143	212	53	157
East/west Pedestrian - Travel Time (seconds) [3,4] (between Mariposa Avenue and Emerson Street)	383	587	263	600
Distance along Travel Path (feet) [5]	790	1400	790	1800
# of Turns along the East/West Travel Path	0	4	0	2

Notes

[1] Based on traffic counts conducted on 4/11/2023 and 4/12/2023

[2] Bike speed is assumed to be 10 mph for the Viaduct alternative. Bike speed is assumed to be 8 mph for the Churchill Closure (Option 1) alternative and the Partial Underpass alternative to account for the change in grade and sharp turns along the travel path.

[3] Under the Viaduct alternative and the Churchill Closure (Option 1) alternative, the bike/ped travel time accounts for the wait time at the Alma/Churchill traffic signal. With the Churchill Closure (Option 2) alternative and the Underpass alternative, pedestrians and cyclists traveling east/west will be completely separated from train and vehicular traffic on Alma Street.

[4] Pedestrian speed is assumed to be 3 feet/second.

[5] Distance is measured from the midpoint at each intersection.

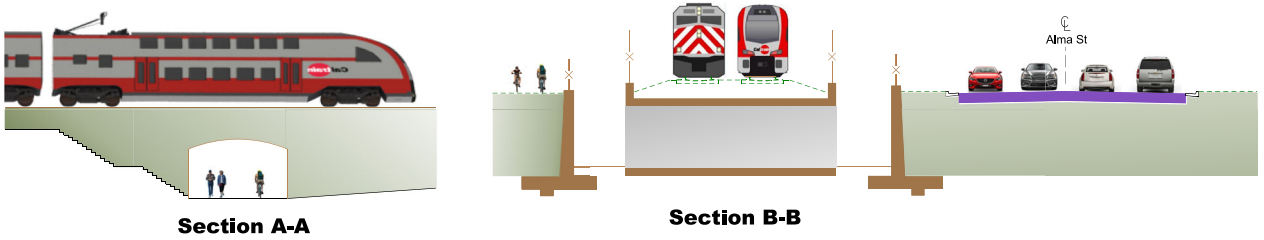
[6] See Figure 3

[7] See Figure 4

[8] See Figure 5

indicates reduced delays compared to the Hybrid/Trench/Viaduct alternatives.

indicates increased delays compared to the Hybrid/Trench/Viaduct alternatives.



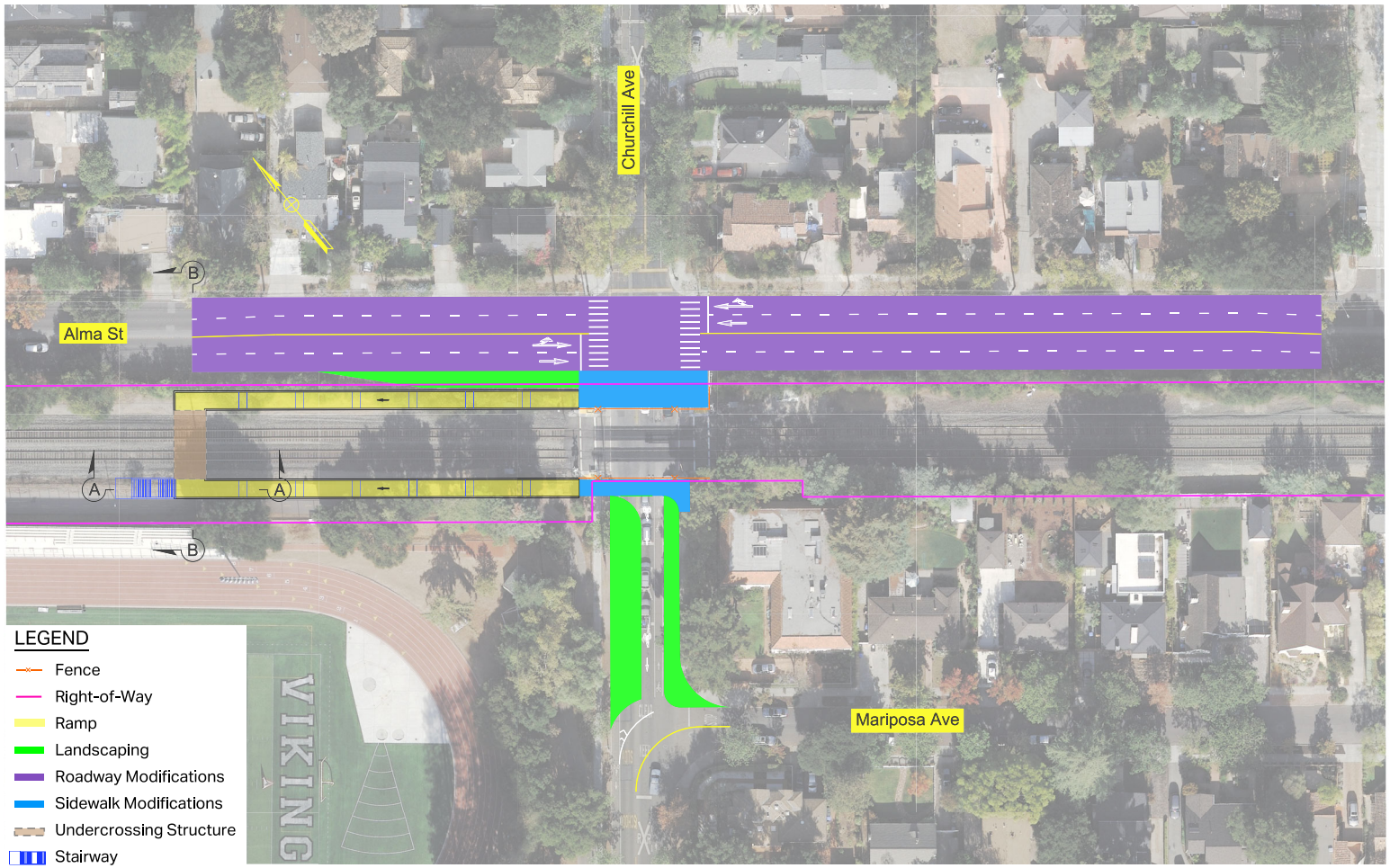
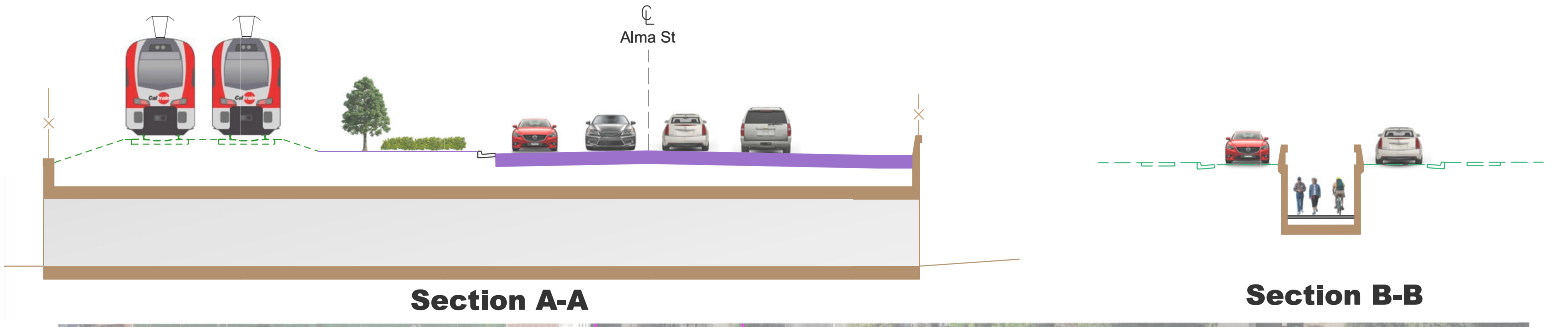


Figure 1
Churchill Closure (Option 1)



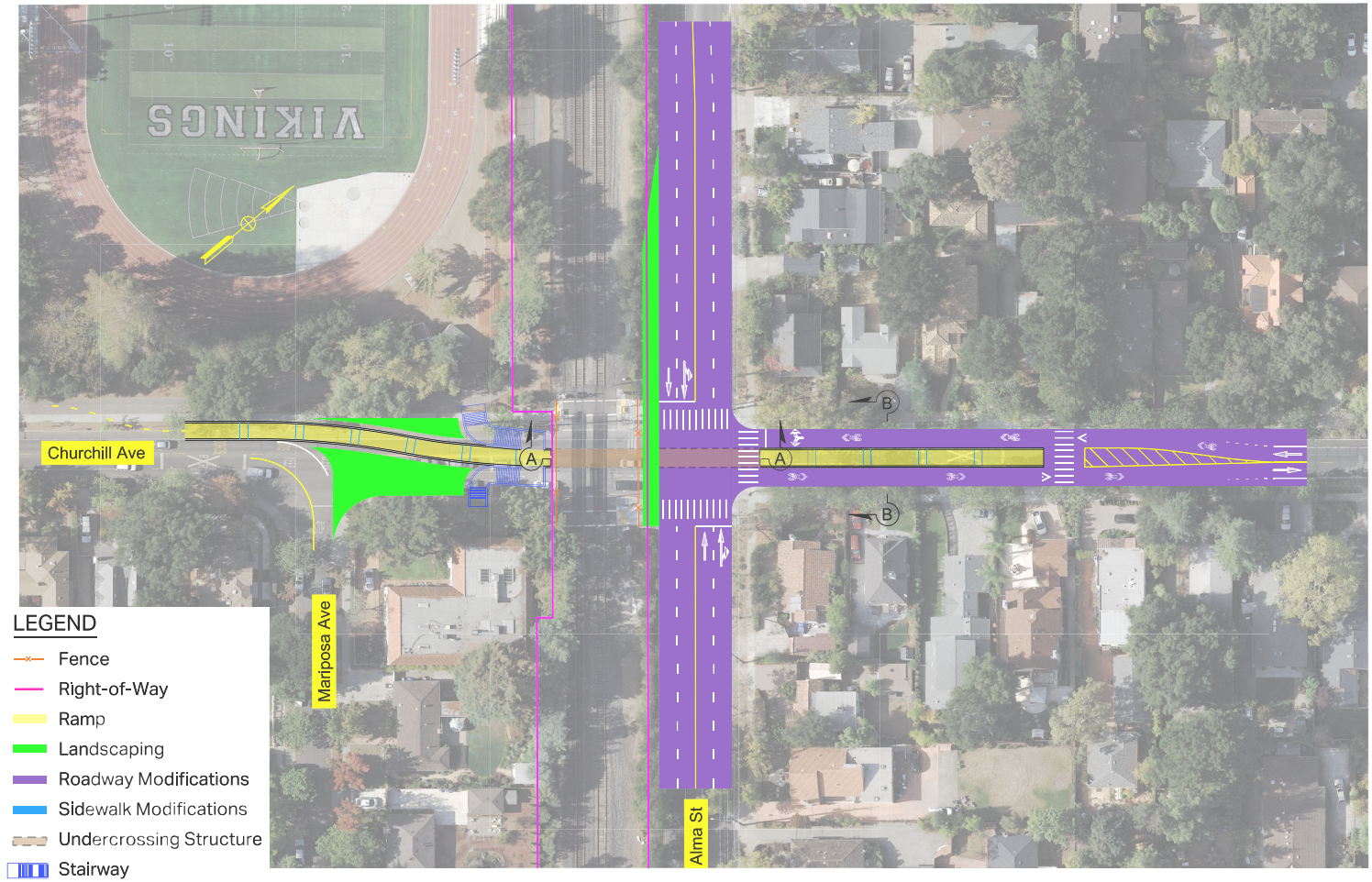
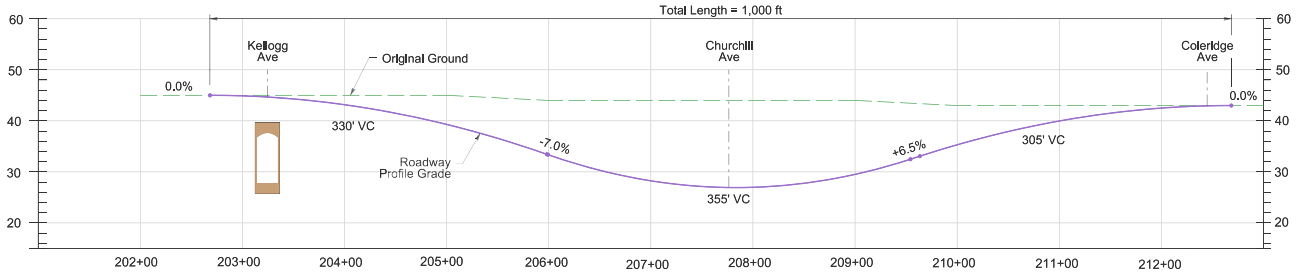


Figure 2
Churchill Closure (Option 2)



Alma St (Profile)

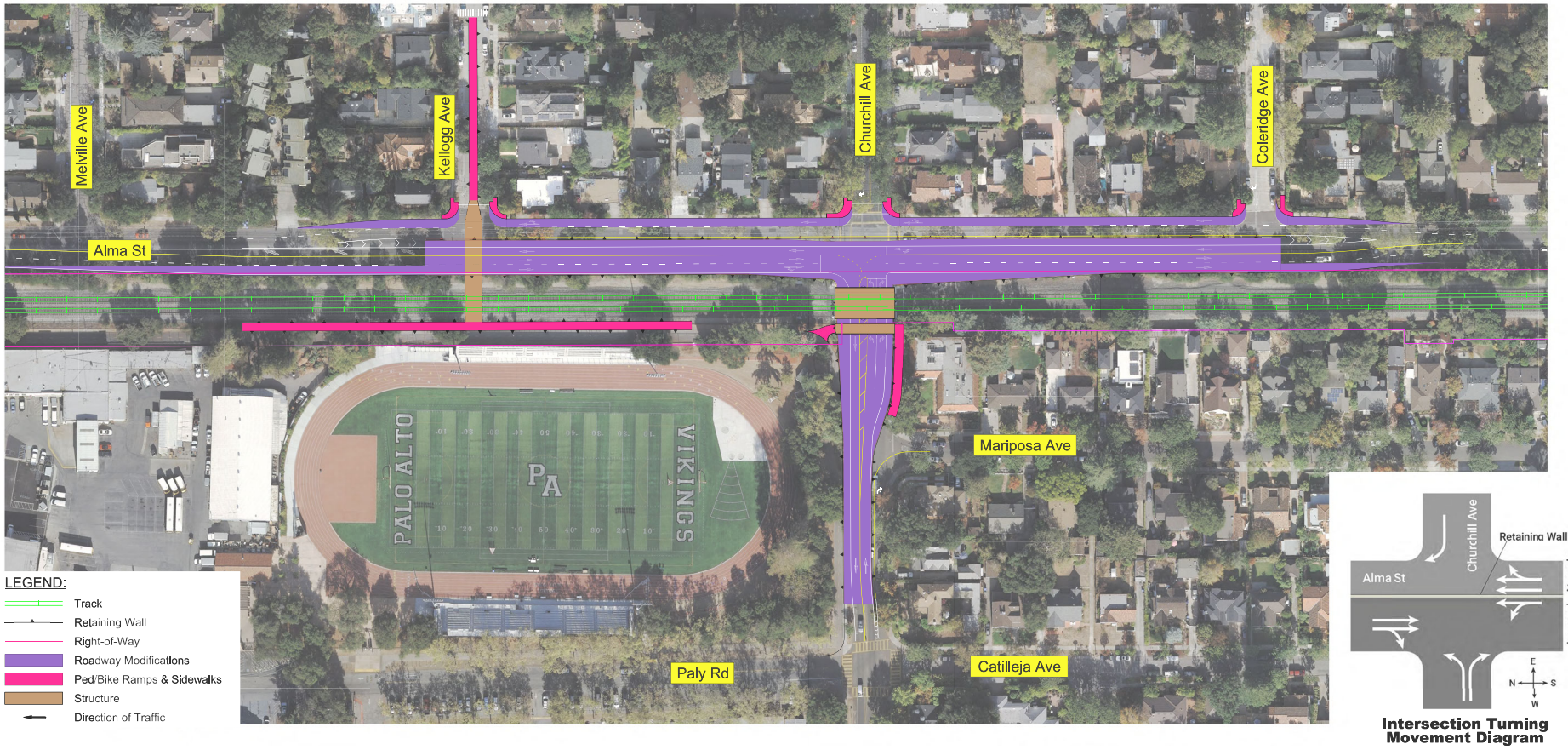


Figure 3
Churchill Partial Underpass Alternative

NORTH
Not to Scale

Alma/Meadow Intersection

Table 5 provides a comparison of bicycle and pedestrian travel times between the Hybrid/Trench and Underpass alternatives at the Alma/Meadow intersection.

Under the Hybrid/Trench alternative, an elevated structure (viaduct) would carry the railroad tracks over Meadow Drive, and the Alma/Meadow intersection would continue to provide a direct connection to all turning movements for pedestrians and bicycles.

Under the Underpass alternative, Meadow Drive would be lowered beneath Alma Street and the railroad tracks, and pedestrians and bicyclists traveling east/west would be completely separated from train and vehicular traffic (see Figure 4). Under this alternative, a two-way pedestrian/bicycle path would be located along the south side of Meadow Drive. Bicyclists and pedestrians traveling on westbound Meadow Drive would cross Meadow Drive via the marked crosswalks at Emerson Street and then cross Meadow Drive again near 2nd Street to get back onto the north side of the road. On northbound Park Boulevard, bicyclists would use the pedestrian/bicycle bridge to the west of Alma Street to cross Meadow Drive. Bicyclists on southbound Park Boulevard would use the crossing at 2nd Street to cross Meadow Drive. An additional delay time of 30 seconds was assumed at each of the crossings.

As shown in Table 5, the Underpass would reduce delays for bicyclists and pedestrians traveling along Meadow Drive compared to the Hybrid/Trench. Along Park Boulevard, this alternative shows increased delays for bicyclists due to the additional turning movements required to cross over or around the underpass. Along Alma Street, this alternative shows reduced delays for pedestrians due to the removal of the traffic signal.

Table 5
Bicycle and Pedestrian Delays at Alma/Meadow

Bike Route	Direction	Alma Street/ Meadow Road Grade-Separation Alternatives	
		Hybrid/ Trench/ Viaduct	Underpass
Daily # of Bicycles [1]			622
Cyclists/Pedestrian navigate through a major signal?		Yes (28,000 daily Vehicles)	No
East/west Bicycle - Travel Time (seconds) [2,3] (between Wilkie Way and Romana Street)	EB [8]	224	138
	WB [9]	224	209
East/west Pedestrian - Travel Time (seconds) [3,4] (between Wilkie Way and Romana Street)	EB [8]	650	530
	WB [9]	650	570
Distance along Travel Path (feet) [5]	EB [8]	1600	1600
	WB [9]	1600	1680
# of Turns along the East/West Travel Path	EB [8]	0	0
	WB [9]	0	4
North/south Bicycle - Travel Time (seconds) (Park Boulevard between Maclane Street and Davenport Way) [6]	NB [11]	97	107
	SB [10]	97	153
Distance along Travel Path (feet)	NB [11]	1000	1235
	SB [10]	1000	1412
# of Turns along the North/south Travel Path along Park Boulevard	NB [11]	0	4
	SB [10]	0	4
North/south Pedestrian - Travel Time (seconds) (Alma St between Lindero Dr and Alma Village Cir) [7]	NB [12]	598	532
	SB [12]	650	570
Distance along Travel Path (feet)	NB [12]	1595	1595
	SB [12]	1595	1595
# of Turns along the Travel Path on Alma Street	NB [12]	0	0
	SB [12]	0	0

Notes

[1] Based on traffic counts conducted on 4/11/2023 and 4/12/2023

[2] Bike speed is assumed to be 10 mph for the Hybrid/Trench alternatives. Bike speed is assumed to be 8 mph for the underpass alternative to account for the change in grade along the underpass and sharp turns to access the pedestrian/bike bridge to connect to the two-way cycle track.

[3] Under the Hybrid/Trench alternatives, the bike/ped travel time accounts for the wait time at the Alma/Meadow traffic signal. With the underpass alternative, pedestrians and cyclists traveling east/west will be completely separated from train and vehicular traffic on Alma Street. Full pedestrians and cyclist movement maintained. Pedestrians and cyclists will have more circuitous routes traveling east/west across the corridor because the pedestrian/bike path is located on the south side of Meadow Drive. It is assumed that cyclists/pedestrians traveling on westbound Meadow Drive would cross Meadow Drive via the marked crosswalks at Emerson Street and then cross Meadow Drive again near 2nd Street to get back onto the right/north side of the road. An additional delay time of 30 seconds was assumed at each of the crossings.

Table 5 (continued)
Bicycle and Pedestrian Delays at Alma/Meadow

[4] Pedestrian speed is assumed to be 3 feet/second.

[5] Distance is measured from the midpoint at each intersection.

[6] With the underpass alternative, it is assumed that cyclists on northbound Park Boulevard would use the ped/bike bridge to the west of Alma to cross Meadow Drive and bicycles on southbound Park Boulevard would use the crossing at 2nd Street to cross Meadow Drive. A 30s delay was included for the crossing at 2nd Street.

[7] For the underpass alternative, pedestrians on Alma Street would use the ped/bike bridge on the east side of Alma Street to cross Meadow Drive.

[8] See Figure 4 Path A

[9] See Figure 4 Path B

[10] See Figure 4 Path C

[11] See Figure 4 Path D

[12] See Figure 4 Path E

indicates reduced delays compared to the Hybrid/Trench/Viaduct alternatives.

indicates increased delays compared to the Hybrid/Trench/Viaduct alternatives.

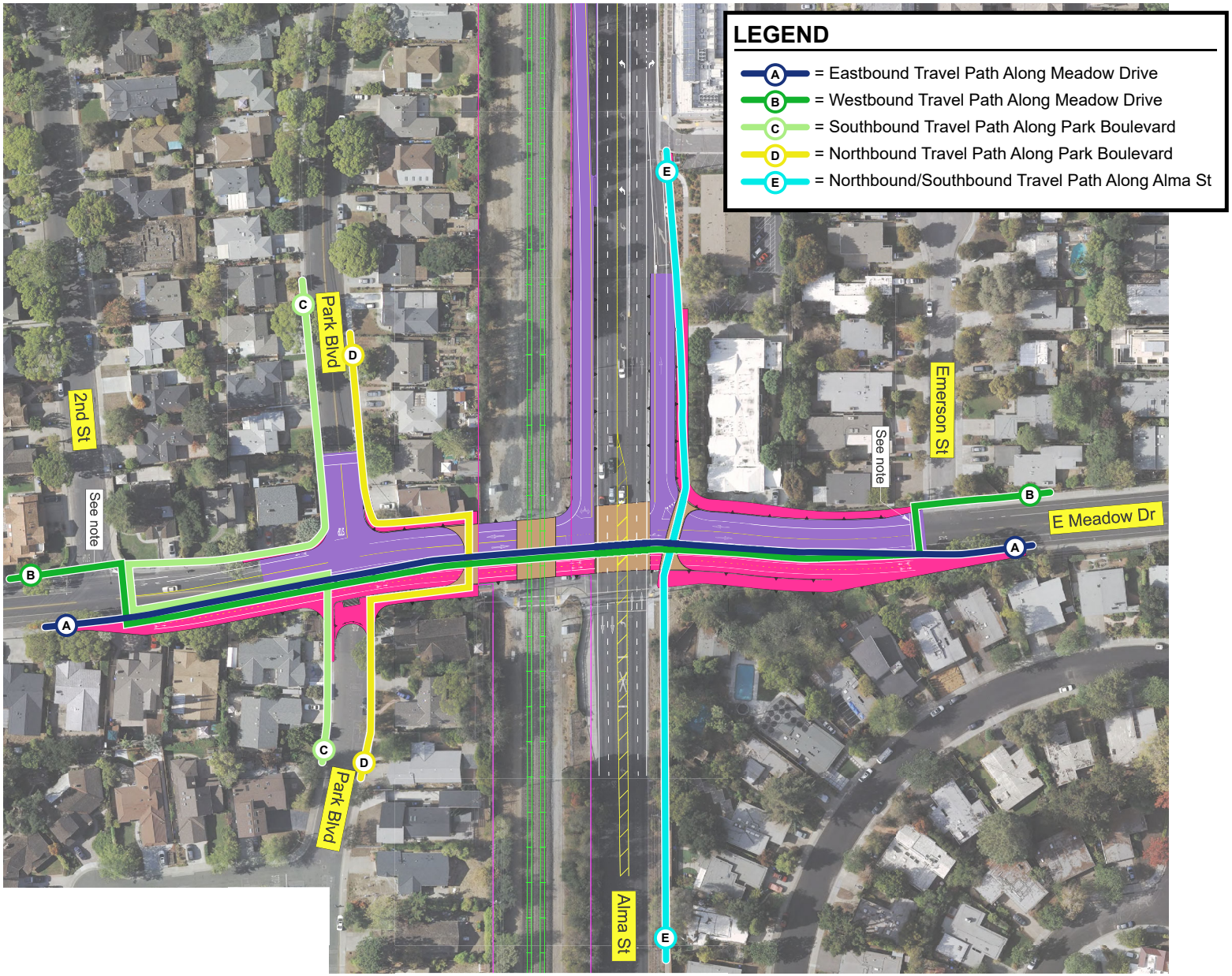


Figure 4
Cyclist/Pedestrian Travel Paths Near Alma/Meadow

NORTH
Not to Scale

Alma/Charleston Intersection

Table 6 provides a comparison of bicycle and pedestrian travel times between the Hybrid/Trench alternatives and Underpass alternative at the Alma/Charleston intersection.

Under the Hybrid/Trench alternative, an elevated structure (viaduct) would carry the railroad tracks over Charleston Drive, and the Alma/Charleston intersection would continue to provide a direct connection to all turning movements for pedestrians and bicycles.

Under the Underpass alternative, Charleston Road would be lowered beneath Alma Street and the railroad tracks, and pedestrians and bicyclists traveling east/west would be completely separated from train and vehicular traffic (see Figure 2). Under this alternative, a two-way pedestrian/bicycle path would be located along the north side of Charleston Road. Bicyclists and pedestrians traveling on eastbound Charleston Road would use the pedestrian/bicycle bridge to the west of Alma Street to access the two-way cycle track and then cross Charleston Road via the marked crosswalks at Mumford Place to get back onto the south side of the road. On northbound Park Boulevard, bicyclists would use the pedestrian/bicycle bridge to the west of Alma Street to cross Charleston Road. Bicyclists on southbound Park Boulevard would use the crossing at Ruthelma Avenue to cross Charleston Road. An additional delay time of 30 seconds was assumed at each of the crossings.

As shown in Table 6, the Underpass would reduce delays for bicyclists and pedestrians traveling along Charleston Road compared to the Hybrid/Trench. Along Park Boulevard, this alternative shows increased delays for bicyclists due to the additional turning movements required to cross over or around the underpass. Along Alma Street, this alternative shows slightly reduced delays for pedestrians due to elimination of some vehicular turning movements at the Alma/Charleston ramp signals.

Table 6
Bicycle and Pedestrian Delays at Alma/Charleston Road

Bike Route	Direction	Alma Street/ Charleston Road Grade-Separation Alternatives	
		Hybrid/ Trench/ Viaduct	Underpass
Daily # of Bicycles [1]		429	
Cyclists/Pedestrian navigate through a major signal?		Yes (33,000 daily Vehicles)	No
East/west Bicycle - Travel Time (seconds) [2,3] (between Ruthelma Avenue Carlson Court)	EB [8]	253	236
	WB [9]	253	209
East/west Pedestrian - Travel Time (seconds) [3,4] (between Ruthelma Avenue Carlson Court)	EB [8]	819	790
	WB [9]	819	707
Distance along Travel Path (feet) [5]	EB [8]	2120	2370
	WB [9]	2120	2120
# of Turns along the East/West Travel Path	EB [8]	0	5
	WB [9]	0	0
North/south Bicycle - Travel Time (seconds) (Park Blvd between Carolina Ln and Darlington Ct) [6]	NB [11]	66	76
	SB [10]	66	139
Distance along Travel Path (feet)	NB [11]	540	875
	SB [10]	540	1255
# of Turns along the North/south Travel Path along Park Boulevard	NB [11]	0	4
	SB [10]	0	4
North/south Pedestrian - Travel Time (seconds) (Alma St between Ely Pl and Lindero Dr) [7]	NB [12]	647	620
	SB [12]	647	620
Distance along Travel Path (feet)	NB [12]	1605	1605
	SB [12]	1605	1605
# of Turns along the Travel Path on Alma Street	NB [12]	0	0
	SB [12]	0	0

Notes

[1] Based on traffic counts conducted on 4/11/2023 and 4/12/2023

[2] Bike speed is assumed to be 10 mph for the Hybrid/Trench/Viaduct alternatives. Bike speed is assumed to be 8 mph for the underpass alternative to account for the change in grade along the underpass and sharp turns to access the pedestrian/bike bridge to connect to the two-way cycle track.

[3] Under the Hybrid/Trench alternatives, the bike/ped travel time accounts for the wait time at the Alma/Charleston traffic signal. With the underpass alternative, pedestrians and cyclists traveling east/west will be completely separated from train and vehicular traffic on Alma Street. Full pedestrians and cyclist movement maintained. Pedestrians and cyclists will have more circuitous routes traveling east/west across the corridor because the pedestrian/bike path is located on the north side of Charleston Road. With the underpass alternative, it is assumed that eastbound bicycles on Charleston Road would access the two-way cycle track via the bike/ped bridge to the west of Alma to connect to the two-way cycle track on the northside of Charleston Road and then would use the crossing at Mumford Place to access the eastbound bike lane on Charleston Avenue. An additional delay times of 30 seconds was assumed at the Mumford Place crossing.

Table 6 (continued)
Bicycle and Pedestrian Delays at Alma/Charleston

[4] Pedestrian speed is assumed to be 3 feet/second.

[5] Distance is measured from the midpoint at each intersection.

[6] With the underpass alternative, it is assumed that cyclists on northbound Park Boulevard would use the ped/bike bridge to the west of Alma to cross Charleston Road and bicycles on southbound Park Boulevard would use the crossing at Ruthelma Avenue to cross Charleston Road. A 30s delay was included for the crossing at Ruthelma Avenue.

[7] For the underpass alternative, pedestrians on Alma Street would use the signal at Alma/Charleston Road Ramps to cross Charleston Road.

[8] See Figure 5 Path A

[9] See Figure 5 Path B

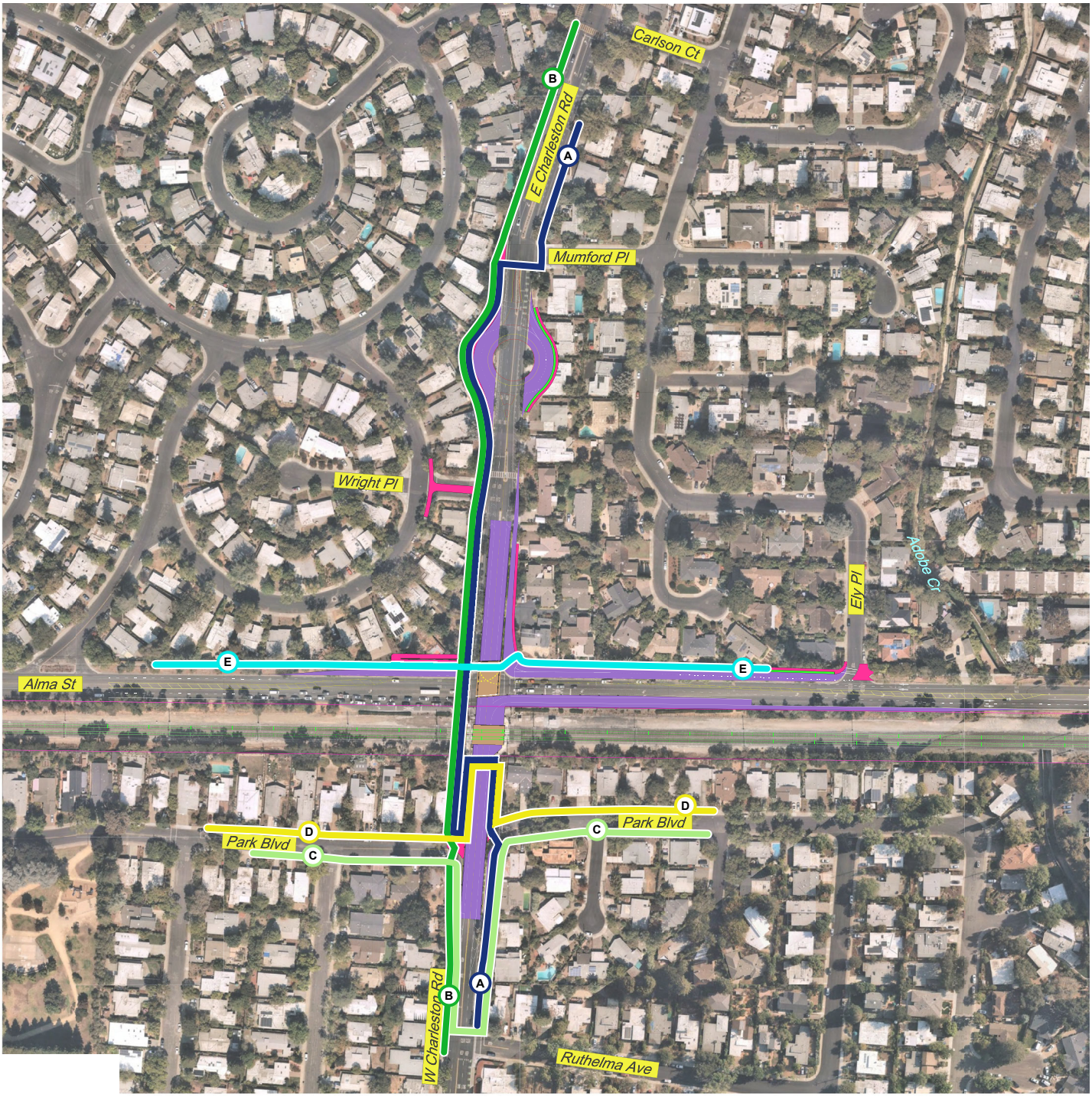
[10] See Figure 5 Path C

[11] See Figure 5 Path D

[12] See Figure 5 Path E

indicates reduced delays compared to the Hybrid/Trench/Viaduct alternatives.

indicates increased delays compared to the Hybrid/Trench/Viaduct alternatives.



LEGEND

- A = Eastbound Travel Path Along Charleston Rd
- B = Westbound Travel Path Along Charleston Rd
- C = Southbound Travel Path Along Park Boulevard
- D = Northbound Travel Path Along Park Boulevard
- E = Northbound/Southbound Travel Path Along Alma St

Figure 5
Cyclist/Pedestrian Travel Paths Near Alma/Charleston