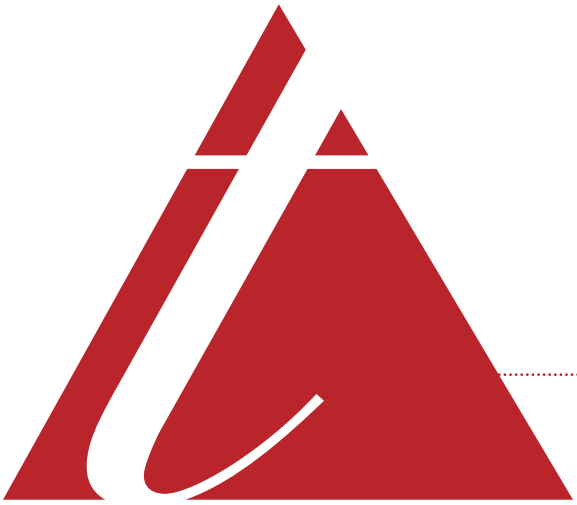

Traffic Operations Memorandum

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MEMORANDUM

Date: May 24th, 2017

To: David Stillman, Project Manager, City of Cupertino

From: Brooke DuBose, Project Manager
Robert Burchfield, PE
Craig Schoenberg, PE

Re: Stevens Creek Blvd and McClellan Road Class IV Bikeway Design: Traffic Operations Analysis

This memorandum documents the traffic operations analysis performed to support the Concept Design for the Stevens Creek Boulevard and McClellan Class IV Bikeway Design.

DESIGN APPROACH

The Stevens Creek Boulevard Protected Bike Lane project will provide barrier-separated bike lanes on Stevens Creek Boulevard from Foothill Boulevard to Tantau Avenue. Similarly, the McClellan Road Protected Bike Lane project will provide barrier-separated bike lanes between Byrne Avenue and De Anza Boulevard. The enhanced separation between motor vehicles and people riding bicycles will improve the comfort and safety for all users. A well-designed protected bike lane also needs to include intersection treatments that minimize the number of conflicts between bicycles and turning vehicles. Best practice for the design of intersections that include separated bike lanes is evolving rapidly and most state and municipal departments of transportation have not adopted standards or practices that address separated bike lanes at intersections. The design treatments recommended in this memorandum rely primarily on design guidance provided by the NACTO Urban Bikeway Design Guide[1], the FHWA Separated Bike Lane Planning and Design Guide[2], and the MassDOT Separated Bike Lane Planning & Design Guide[3].

[1] National Association of City Transportation Officials. *Urban Bikeway Design Guide.* 2011. Hereafter referred to as NACTO Guide.

[2] Federal Highway Administration. *Separated Bike Lane Planning and Design Guide.* Department of Transportation. 2015. Hereafter referred to as FHWA Guide.

[3] Massachusetts Department of Transportation. *Separated Bike Lane Planning and Design Guide.* 2015. Hereafter referred to as MassDOT Guide.

INTERSECTION TREATMENTS

Several types of signalization treatments for separated bike lanes are included in the NACTO and FHWA Guides. However, little guidance is provided to suggest which treatment should be selected for a particular context. The MassDOT Guide provides the most objective guidance available, and this is the resource that was applied to the intersections along the Stevens Creek and McClellan Boulevard corridors to define the recommended treatment type. Figure 1 (from that MassDOT Guide) defines turning vehicle volume thresholds above which a separate bike phase is recommended to address turning vehicle conflicts.

STEVENS CREEK BOULEVARD

Currently, all the intersections along Stevens Creek Boulevard have protected left-turn phases so no conflict occurs with through bicyclists and left-turning vehicles. However, there are potential conflicts between bicyclists and right-turning vehicles. The proposed design configuration of a separate bike phase, including one-way bike lanes on either side of Stevens Creek Boulevard, is recommended when there are 150 or more vehicle right turn movements per hour (during the peak hour).

Separated Bike Lane Operation	Motor Vehicles per Hour Turning across Separated Bike Lane			
	Two-way Street			One-way Street
	Right Turn	Left Turn across One Lane	Left Turn across Two Lanes	Right or Left Turn
One-way	150	100	50	150
Two-way	100	50	0	100

EXHIBIT 6A: Considerations for Time-separated Bicycle Movements

Figure 1. Considerations for Time-separated Bicycle Movements[4]

Turning movement counts for both the AM and PM peak hours at all 14 signalized intersections along the corridor were reviewed to identify where this threshold was exceeded. Ten intersections were identified where peak hour right-turn volumes from Stevens Creek Boulevard exceeded 150 vehicles per hour (vph). These intersections are shown in the table below.

Table 1. Peak Hour Right-Turn Volumes from Stevens Creek Boulevard Exceeding 150 vph

	AM vph		PM vph	
Intersection	**EB**	**WB**	**EB**	**WB**
Bubb	*	*	210	*
SR-85 SB	163	*	165	*

[4] Reprinted from MassDOT Guide, p 107.

SR-85 NB	*	603	*	793
Mary	232	*	181	180
Stelling	198	*	296	159
Bandley	*	179	*	*
De Anza	171	214	307	*
Wolfe/Miller	*	226	235	185
Finch	249	*	168	*
Tantau	*	319	*	*

*Right turn volume less than 150 vph

Based on these findings, these ten signalized intersections were identified as candidate locations where a signal phasing scheme that includes separate bike phases may be needed. At other signalized intersections along the corridor, a separate bike phase is not required, but may be considered as a treatment that will improve comfort for bicyclists.

MCCLELLAN ROAD

Currently, all the signalized intersections along McClellan Road have protected left-turn phases so no conflict occurs with through bicyclists and left-turning vehicles. The McClellan Road design options considered include both one-way and two-way separated bike lane alternatives. Peak hour turning movement counts at signalized intersections along McClellan Road were reviewed to identify where right-turning movements exceeded either a 150 vph threshold for one-way separated bike lanes, or a 100 vph threshold for right turns across a two-way separated bike lane. Turning movements that exceeded these thresholds are shown in the table below.

Table 2. Peak Hour Right-Turn Volumes from McClellan Road Exceeding 100 vph

	AM vph		Mid-Day vph		PM vph	
Intersection	**EB**	**WB**	**EB**	**WB**	**EB**	**WB**
Bubb	*	173	*	*	*	*
Stelling	*	*	*	140	*	*
De Anza	215	*	*	*	330	*

* Right turn volumes less than 100 vph

SIGNAL PHASING -- SEPARATE BIKE PHASE

The MassDOT Guide provides helpful examples of how signal phasing can be designed to provide separate bike phases. Example phasing schemes from the guide were adapted to the Stevens Creek Boulevard and McClellan Road context and then analyzed for traffic operations performance using Synchro.

STEVENS CREEK BOULEVARD

The signal phasing shown in Figure 2 from the MassDOT Guide demonstrates the fundamental phasing scheme that was adapted for use at Stevens Creek Boulevard intersections that have a high level of right-turn conflicts.

The SR85 NB intersection was treated as a special case given the unique intersection configuration. Alternative options for both geometry and signal phasing were evaluated at SR85 NB. The results of this analysis are summarized in the Traffic Operations section that follows.

CONCURRENT PROTECTED BIKE PHASING PLAN

1. Through vehicle movements on Steven Creek Boulevard are served along with the through bicycle movements and the east/west pedestrian movements.
2. Side-street left-turn movements are served as well as the right turn movements from Stevens Creek Boulevard where separate right-turn lanes are provided.
3. Side-street through/right turn movements and north/south pedestrian movements are served.
4. Left-turn movements from Stevens Creek Boulevard are served as well as side-street right-turn movements where separate right-turn lanes are provided.

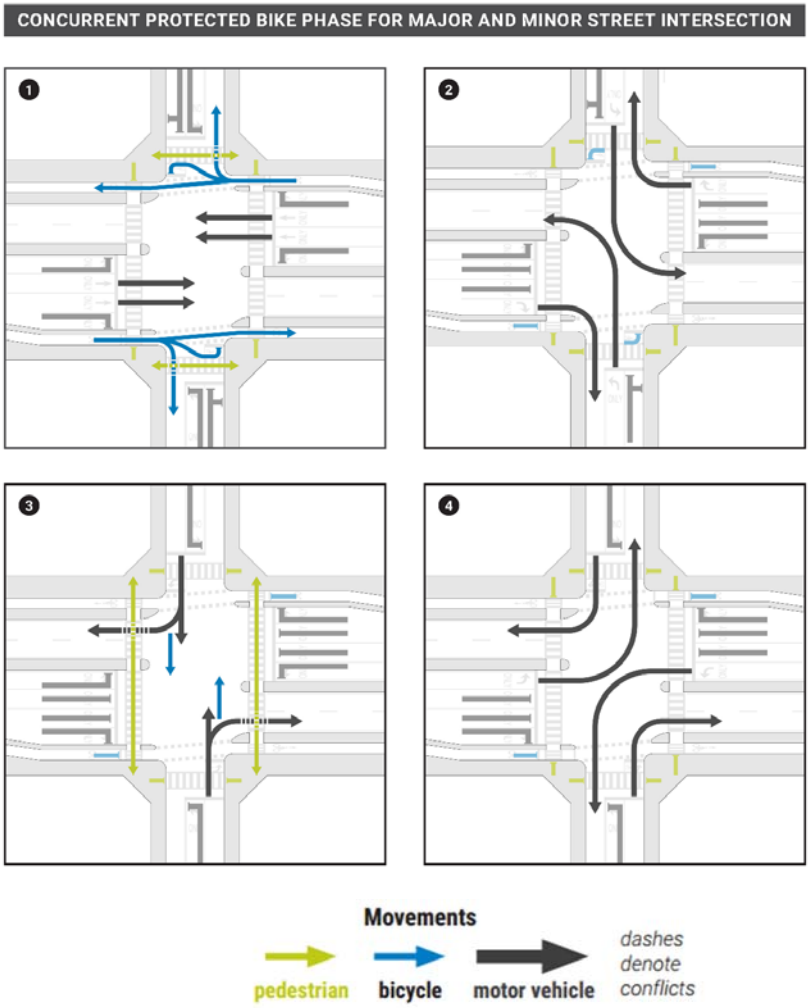


Figure 2. Concurrent Protected Bike Phase for Major and Minor Street Intersection[5]

[5] Adapted from MassDOT Guide, p 120.

An essential design feature of this phasing scheme is the provision of dedicated right-turn lanes on the major street (i.e. Stevens Creek Boulevard). In the proposed design, the existing shared through/right-turn approach lanes on Stevens Creek Boulevard are converted to dedicated right-turn lanes at intersections where a separate bike phase is desired. For example, the proposed lane configuration for the Stevens Creek Boulevard intersection with Stelling Road is shown in Figure 3. One challenge that this signal phasing presents is a potential conflict between U-turn movements made during the side street left-turn phase and concurrent Stevens Creek Boulevard right-turns. This situation occurs at the intersections with Stelling Road, De Anza Boulevard and Wolfe/Miller Road. To address this potential conflict the concurrent right-turn movement should be controlled with a flashing yellow arrow rather than a green arrow. We also recommend placing a regulatory sign with the message 'RIGHT TURNS YIELD TO U-TURNS' to supplement the flashing yellow right-turn arrow.

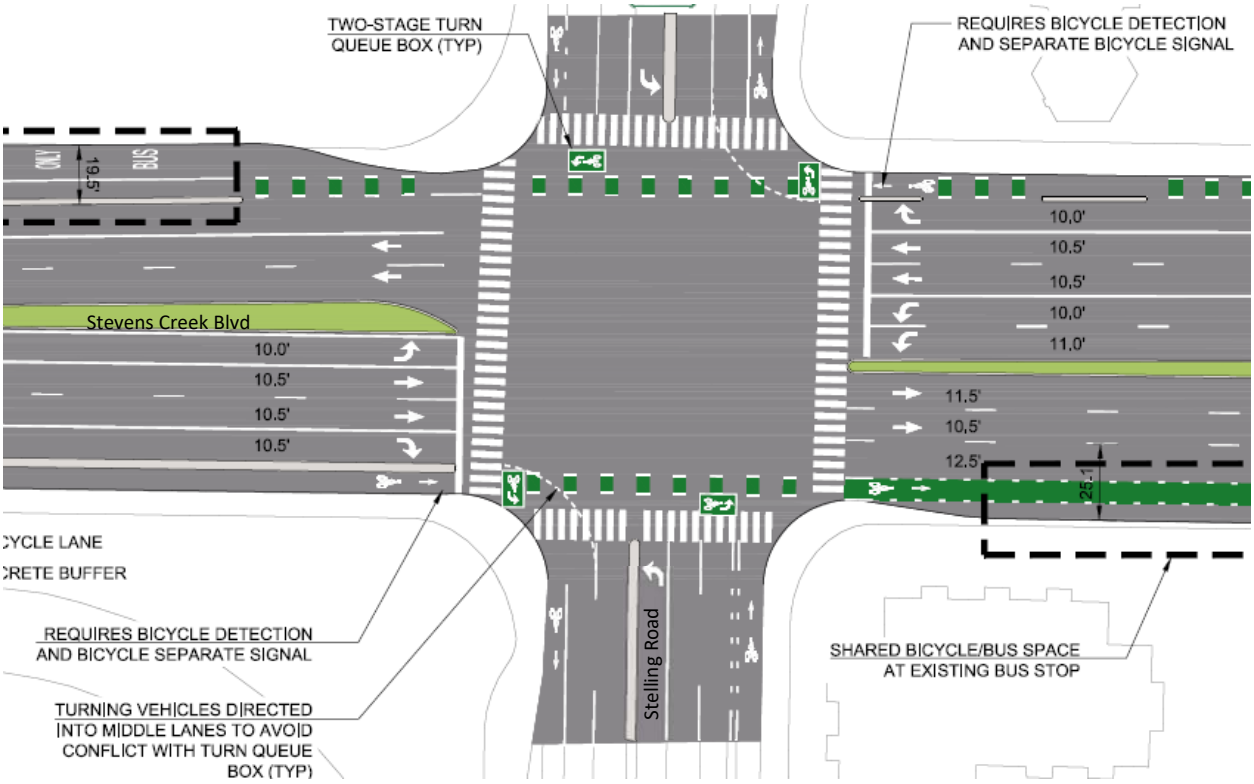


Figure 3. Proposed Stelling Road Intersection Design

MCCLELLAN ROAD

On McClellan Road, intersections of potential concern are Bubb Road, Stelling Road, and De Anza Boulevard. Right-turn volumes exceed the recommended thresholds at Bubb Road in the WB direction during the AM peak hour, Stelling Road WB during midday, and at De Anza Boulevard during the AM and PM peak hours for the EB direction.

At the Bubb Road intersection a phasing scheme similar to Figure 4, which is taken from the MassDOT Guide, is recommended for Design Option A, which provides a two-way protected bike lane on the north side of McClellan Road. This phasing concept includes an exclusive phase for east/west bicycle and pedestrian movements.

The other design option (Design Option B) would have unidirectional protected bike lanes on either side of the street. Signal phasing for this option at Bubb Road uses an exclusive bicycle phase to manage the right turn conflicts (as per the phasing plan shown in Figure 2).

At Stelling Road an exclusive bicycle phase is needed for Design Option A (two-way PBL), but is not required for Design Option B (Directional PBL).

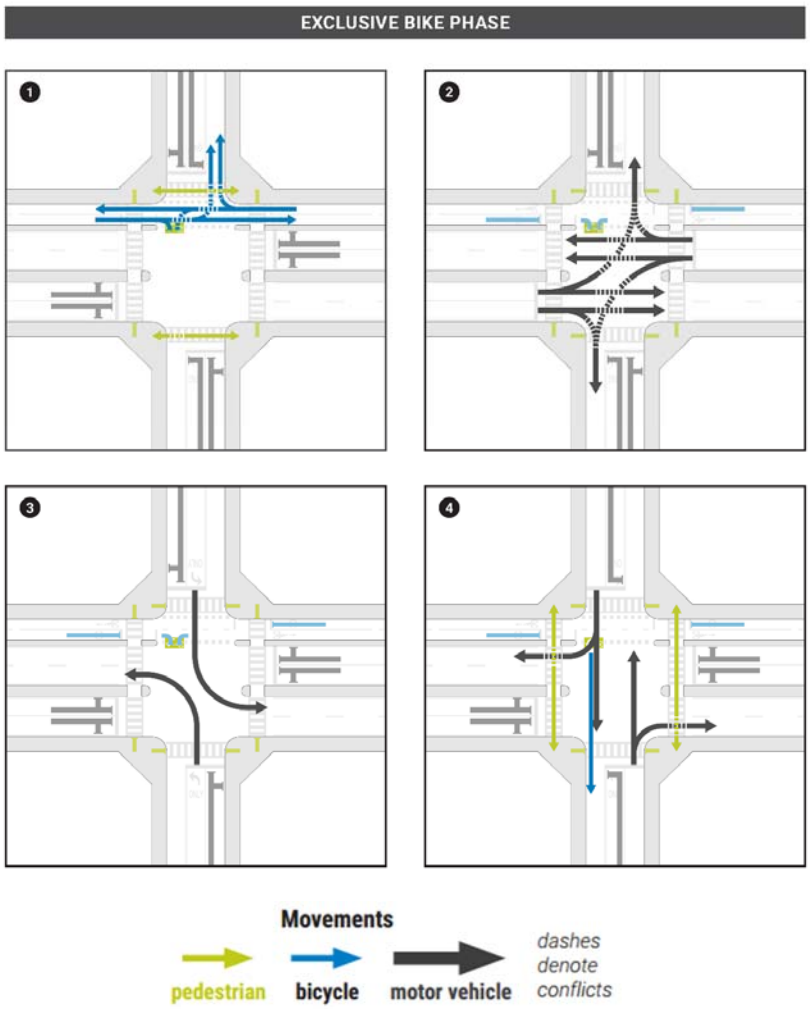


Figure 4. Exclusive Bike Phase for Two-way Protected Bike Lane[6]

[6] Adapted from MassDOT Guide, p 121.

TRAFFIC OPERATIONS ANALYSIS

STEVENS CREEK BOULEVARD

The feasibility of the proposed lane configuration and phasing scheme was tested at the Stelling Road, De Anza Boulevard, and Wolfe/Miller Road intersections using the Synchro software. These intersections were selected to demonstrate feasibility because of their relatively high existing volume-to-capacity operating condition. Existing operating conditions were compared with the proposed design. Existing traffic flows and signal timing parameters were based on data from the 2012 Existing Conditions Report for the Program for Arterial System Synchronization Project. The results of this analysis are summarized in Tables 3 and 4. Detailed reports for the analyses are included in Appendix A.

Table 3. Comparison of Intersection LOS With and Without a Separated Bike Phase, Based on Synchro Analysis Software

Stevens Creek Boulevard	**Existing LOS**		**Proposed LOS**	
Intersection	**AM**	**PM**	**AM**	**PM**
Stelling Road	D	D	D	E
De Anza Boulevard	D	E	D	E
Wolfe/Miller	E	D	E	D

Table 4. Comparison of Intersection V/C With and Without a Separate Bike Phase, Based on Synchro Analysis Software

Stevens Creek Boulevard	**Existing V/C**		**Proposed V/C**	
Intersection	**AM**	**PM**	**AM**	**PM**
Stelling Road	0.91	0.94	0.93	0.96
De Anza Boulevard	0.84	0.97	0.84	1.00
Wolfe/Miller	1.02	0.88	0.97	0.92

The results of the traffic operations analysis indicate minimal changes to intersection LOS and V/C with the proposed configuration. The only change in HCM 2000 Level of Service was found at the Stelling Road intersection where the LOS is projected to change from D to LOS E under the proposed condition. However, this change in LOS correlates with a very small change in expected volume-to-capacity (V/C) ratio. A change from 0.94 V/C in the existing condition to 0.96 V/C in the proposed configuration. At the Wolfe/Miller intersection the V/C is projected to improve with the proposed configuration from 1.02 V/C to 0.97 V/C.

Based on these findings, it is anticipated that the proposed intersection improvements will maximize safety and not meaningfully impact traffic conditions. However, additional traffic analysis for other intersections where a separate bike phase may be needed (Bubb, SR-85 interchange, Mary, Bandley, Finch, and Tantau) should be performed to support final design. Analysis of signal progression through the corridor may also be needed to integrate the proposed signal phasing at individual intersections within the overall corridor signal progression plan.

SR85 NB

A number of geometric options were considered for the SR85 NB intersection. Based on input from the City, as well as the results of the Synchro analysis, Option 3 is recommended. The geometric design for this option is shown in Figure 5.

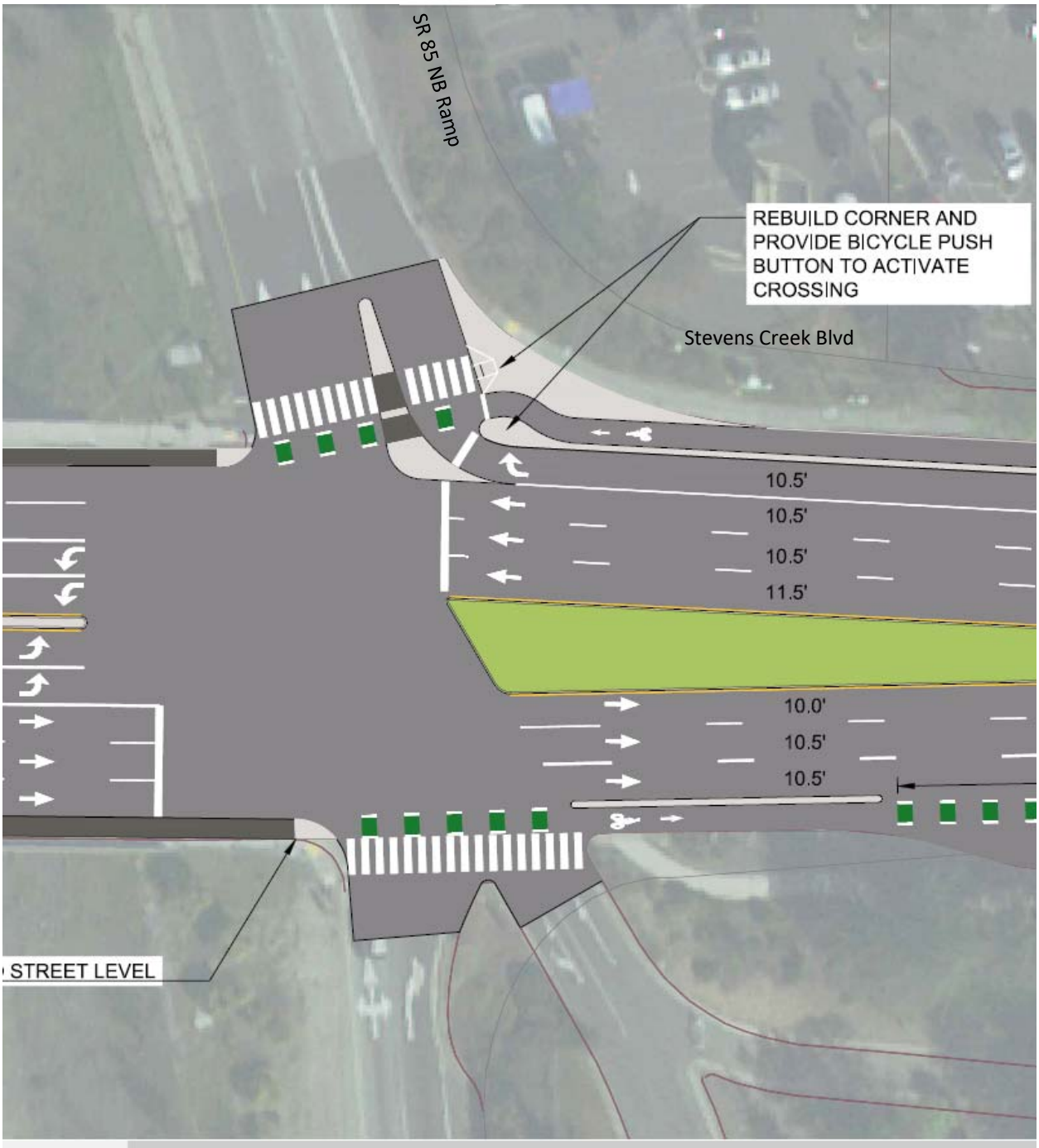


Figure 5. Proposed Geometric Design; Steven Creek Boulevard & SR 85 NB—Option 3

The key geometric feature of Option 3 is the significantly reduced corner radius for the WB to NB right-turn movement. This results in a shorter crossing distance for bicycle and pedestrians and will reduce the speed of the right turn movement. A signal display is added for the westbound channelized right-turn and an exclusive bicycle phase is provided after the eastbound left-turn phase. The receiving lane is maintained for the westbound channelized right-turn so this movement is permitted during all phases except the bicycle phase. The minimum recommended bicycle phase is 10 seconds long and eastbound/westbound through vehicles will move concurrently, as will eastbound/westbound pedestrians if there is a pedestrian actuation. We recommend that this phase be implemented with an Interim Approval-compliant bike signal so bikes will **not** be permitted to cross during the concurrent westbound right-turn movement.

All existing vehicle movements are maintained. The westbound right-turns are prohibited for the 10 second bicycle phase but are permitted during all other times. They must yield to pedestrians crossing during the westbound through phase. These operations allow for adequate capacity for the westbound right movement.

Table 5. Intersection LOS—Stevens Creek Boulevard & R85 NB

Option	AM	PM
Existing Condition	C (32.5)	C (34.4)
Option 3 (Exclusive Bike Phase)	C (34.1)	D (35.3)

MCCLELLAN ROAD

As noted previously the intersection operations for McClellan Road at the Bubb Road and Stelling Road intersections included consideration of two design options for protected bike lanes: Design Option A – Two-way PBL, and Design Option B – Unidirectional PBLs on either side of the street. The cross-sections for Options A and B are shown in Figures 6 and 7. Traffic operations for these alternatives, as well as existing conditions, were analyzed using traffic data provided by the City of Cupertino. The results of the analyses are summarized in Tables 6 and 7. The intersection of McClellan Road and De Anza Boulevard presents unique operational and geometric challenges. The analysis of this intersection is summarized in a separate section that follows.

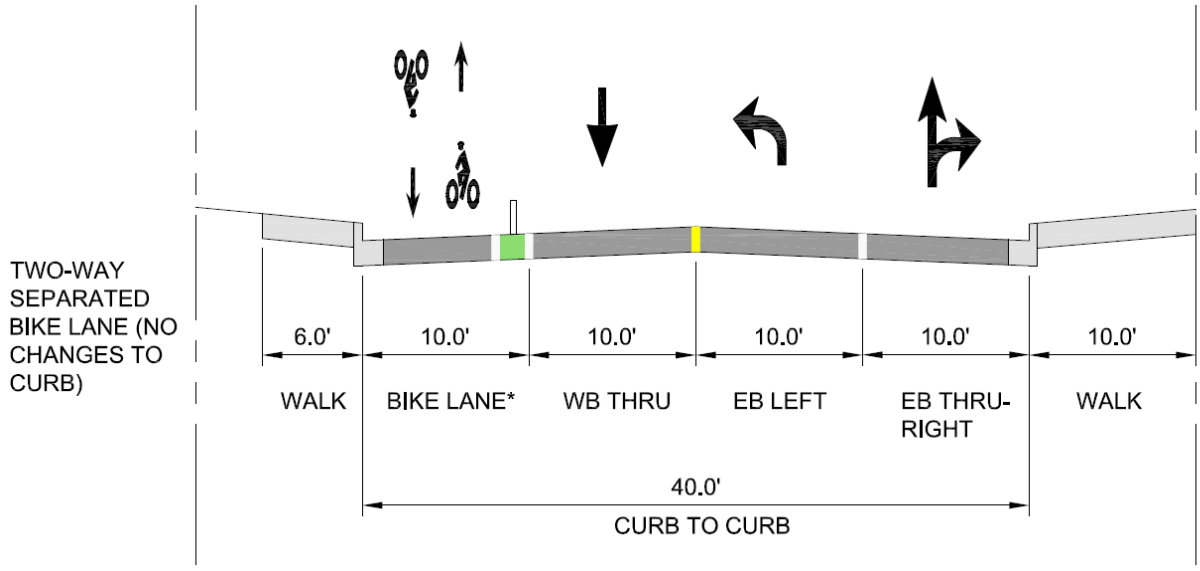


Figure 6. Proposed Cross-Section Option A; McClellan Road West of Bubb Road

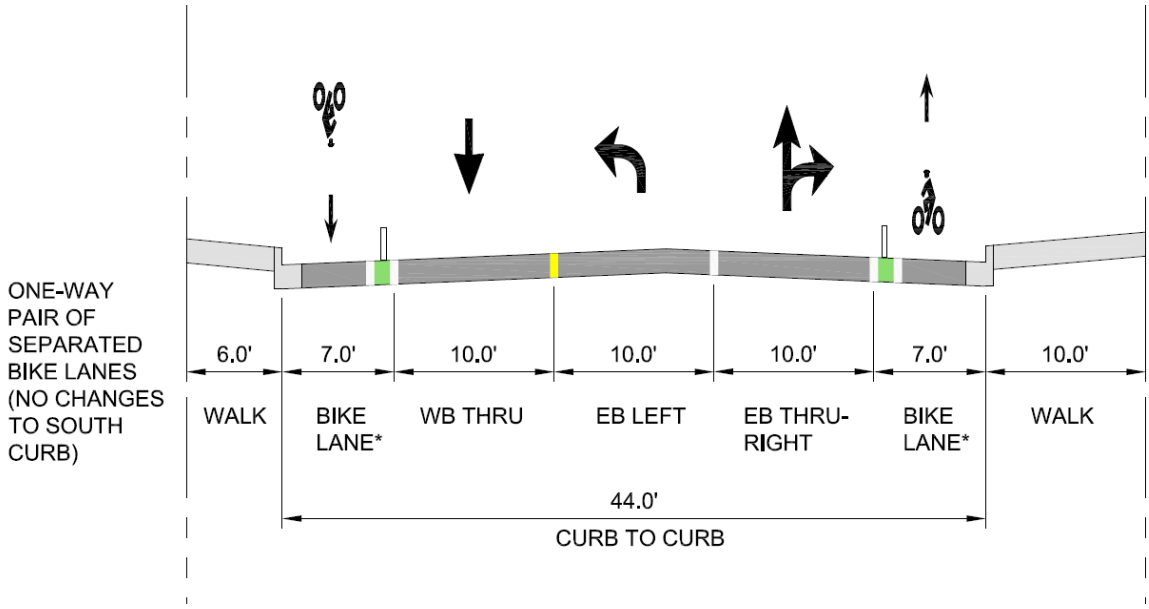


Figure 7. Proposed Cross-Section Option B; McClellan Road West of Bubb Road

Table 6. McClellan Road & Bubb Road Intersection Operations; Intersection LOS and Delay based on Synchro Analysis Software

Alternative	Bike Lane Option	Bike Phasing	Right Turn on Red	AM Intersection LOS and Delay (seconds)	PM Intersection LOS and Delay (seconds)
Existing	**-**	-	All Permitted	D (35.4)	D (36.7)
Existing Optimized	**-**	-	All Permitted	C (26.9)	C (30.8)
Option A	**Two-way PBL**	Exclusive Bike Phase	Eastbound Right / Northbound Right Permitted	D (47.5)	D (41.8)
Option B	**Unidirectional PBLs**	Exclusive Bike Phase	Prohibited	D (48.0)	D (45.1)

Table 7. McClellan Road & Stelling Road Intersection Operations; Intersection LOS and Delay based on Synchro Analysis Model

Alternative	Bike Lane Option	Bike Phasing	Right Turn on Red	AM Intersection LOS and Delay (seconds)	PM Intersection LOS and Delay (seconds)
Existing	**-**	-	All Permitted	C (27.4)	C (28.0)
Existing Optimized	**-**	-	All Permitted	C (23.3)	C (24.1)
Option A	**Two-way PBL**	Concurrent Separated Bike Phase	Eastbound Right / Northbound Right Permitted	C (23.8)	C (24.8)
Option B	**Directional PBL**	No Bike Phase	Prohibited	C (23.5)	C (24.4)

Assumptions and operating parameters for the Alternatives are summarized below:

EXISTING

The existing signals are running actuated uncoordinated with long maximum green times for a maximum cycle length of 170 seconds at Bubb Road and 200 seconds at Stelling Road. Given the existing traffic volumes, the signals serve each movement/phase until there is a sufficient gap in traffic (or it hits its maximum time) and then switches to the next phase. This causes long delays as the signals waits for these gaps.

EXISTING OPTIMIZED

The maximum green times were decreased to force the signal to change prior to it gapping out, which has the effect of reducing the overall intersection delay. The maximum cycle length was reduced to 80 seconds at Bubb Road and 90 seconds at Stelling Road.

OPTION A: TWO-WAY PBL

Bubb Road--Exclusive Bike Phase

- A 15-second exclusive bike phase is provided before the EB/WB left turn movements. WB and SB Right Turns on Red (RTOR) are prohibited since they cross the PBL.
- The 15-second exclusive bike phase causes an additional 20.6 (AM Peak) and 10.0 (PM Peak) seconds of overall intersection delay compared to the Existing Optimized conditions.

Stelling Road-- Concurrent Separated Bike Phase

- Bikes are served with the EB/WB through movements. WB rights are prohibited during this phase and are served with the SB left turn phase. WB RTORs are prohibited during the EB/WB through movements, as they would cross the two-way bike facility (WB RTOTs could be allowed during NB/SB movements if the location of the bicycle two-stage turn queue box did not conflict). SB RTORs are prohibited as they would cross the two-way bike facility, and drivers will not intuitively expect cyclists from two directions (they would look left to see WB vehicles, but not right to see EB bicyclists).
- Overall intersection operations are maintained in Option A compared to the Existing Optimized conditions. The WB right-turn movement, which is most affected by the changes in Option A, changes from LOS B in Existing Optimized to LOS C in Option A which is considered acceptable for traffic operations.

OPTION B: DIRECTIONAL PBL

BUBB ROAD

- A 15-second exclusive bike phase is provided before the EB/WB left turning movements. RTOR are prohibited for all movements since they cross the PBL.
- Option B operates the same as Option A at Bubb Road with the exception of no RTOR. Adding the no RTORs causes an additional 0.5 (AM Peak) and 3.3 (PM Peak) seconds of overall intersection delay in Option B compared to Option A.

STELLING ROAD

- No separate bike phase is needed because the right turn volumes are below the threshold of 150 vehicles per hour as specified in Figure 1. Bikes are served with the EB/WB through movements. WB RTORs should be prohibited if the location of the bicycle two-stage turn queue box conflicts with the movement.
- Option B operates the same as the Existing Optimized conditions at Stelling Road with the exception of no RTOR. Adding the no RTOR causes an additional 0.2 (AM Peak) and 0.3 (PM Peak) seconds of overall intersection delay in Option B compared to Existing Optimized Conditions.

MCCLELLAN ROAD & DE ANZA BOULEVARD

The McClellan Road & De Anza Boulevard intersection was analyzed for a proposed revised geometry that re-establishes the historic off-set geometry. Intersection signal phasing with no specific accommodations for bicycles was tested as well as two options that provide a time separated phases for the eastbound bicycle and eastbound right turning vehicles. A time separated phase was not tested for the westbound bicycle/right turn movement because the right turning volume does not meet the threshold of 150 vehicles per hour. The proposed geometry is shown in Figure 8.

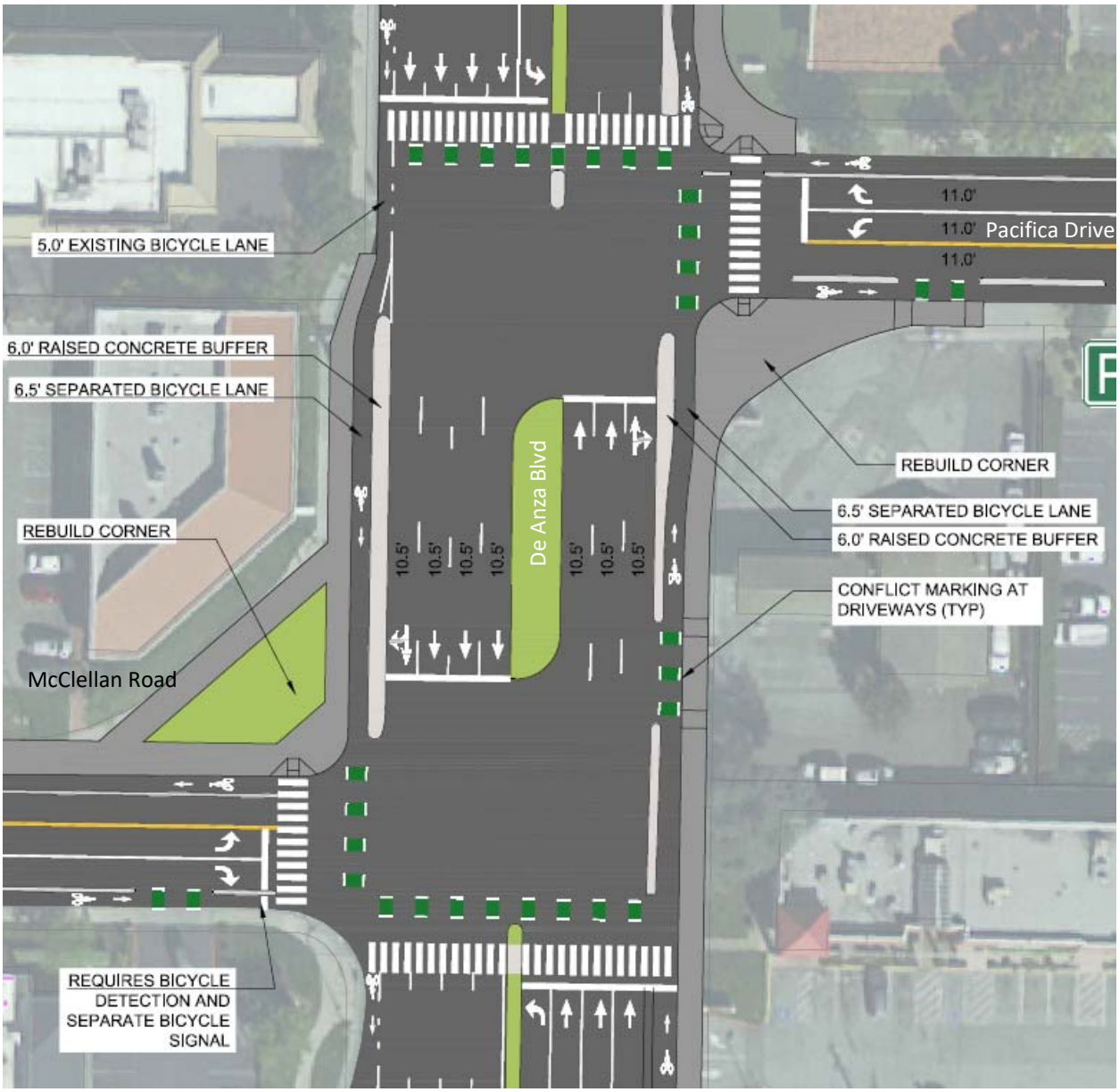


Figure 8. Proposed Geometric Design; McClellan Boulevard/Pacifica Drive/De Anza Boulevard

The proposed intersection geometry with revised signal phasing was analyzed for LOS as well as queue lengths. The results are summarized in Tables 8 and 9.

For the base option (No Bike Option) the Synchro analysis used was developed by a previous study and was provided by the City of Cupertino. Several options for signal phasing were developed and tested for LOS and queue length. The goal was to find an option that would provide an overall intersection LOS of D or better and result in 95% queue lengths that don't exceed the storage length available. Option 1 and Option 2 both provide a separate phase for EB bikes on McClellan Road during the EB left-turn movement while right-turns from McClellan Road overlap with the NB to WB left-turn movement. In Option 1, the EB right-turns are prohibited from turning right on red at all times. To reduce delay for the EB right-turns in Option 2 we assumed that EB right-turns would be allowed to make a right-turn on red arrow during the N/S phase. This will require use of a special blank-out regulatory sign to permit right-turns on red arrow that would activate during the N-S phase. For the PM peak hour, we evaluated a 140 second cycle length (Option 2A) and a 120 second cycle length (Option 2B). Figure 9 illustrates the proposed phasing for Options 1 and 2. The analysis concluded that signal phasing Option 2B with a 120 second cycle length performed best within these parameters.

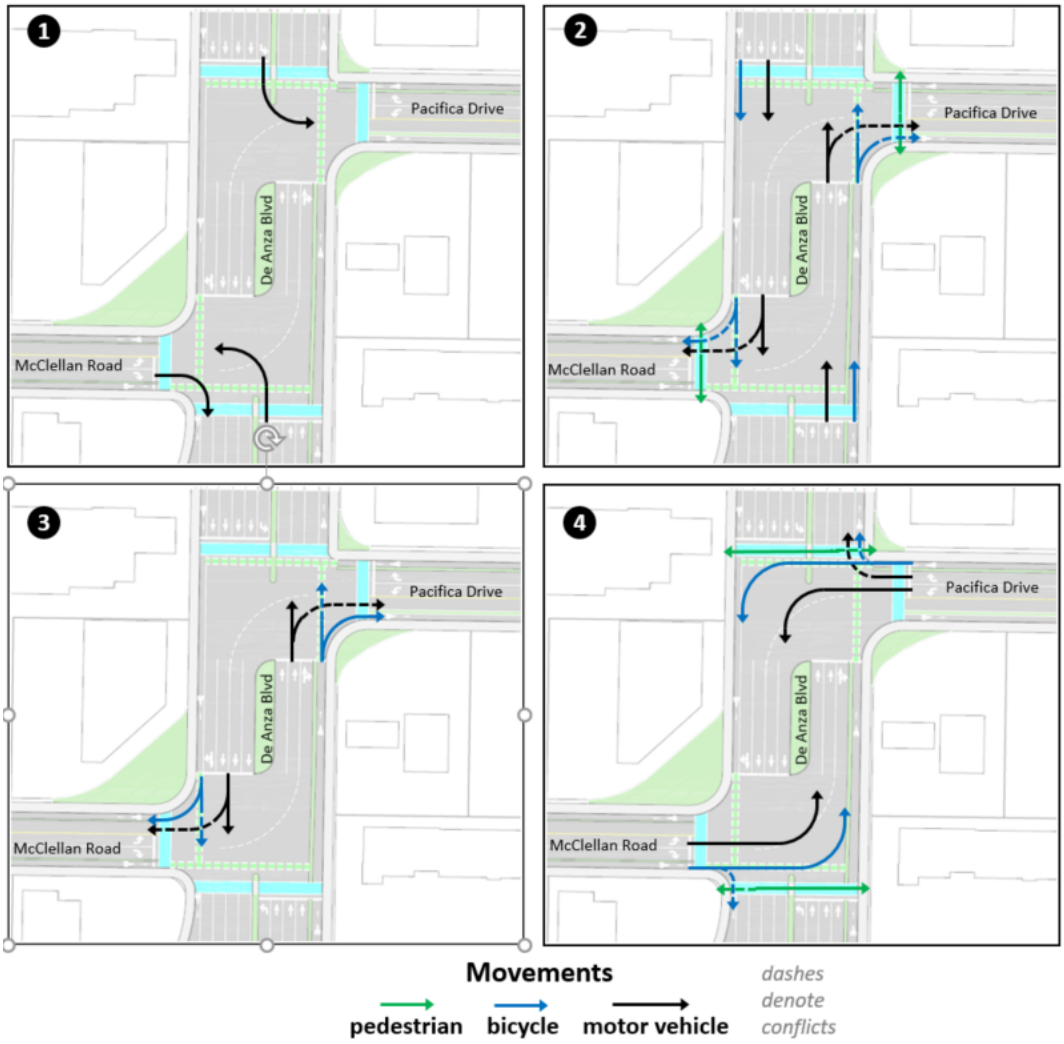


Figure 9. Proposed Time Separated eastbound bicycle phase; McClellan Boulevard/Pacifica Drive/De Anza Boulevard

The results of the queue length analysis indicate that the expected queues for Option 2 will be acceptable at all times during the AM peak hour with a few locations where the 95% queue exceeds the available storage length during the PM peak hour. The locations of concern are NB lefts where the available storage length is 370 feet and the 95% queue is 467 feet, and EB where the available queue space to Felton Way is 400 feet and the 95% queue for EB right-turns is 448 feet. The traffic impact of a queue exceeding the storage length at either of these locations would be relatively minor. For EB McClellan the queue could extend back to Felton Way and create difficulty for drivers turning left in to, or out of, Felton Way. However, this event would likely occur only once on average during the PM peak hour, and the duration would be short. Similarly, the queue for NB left turns on De Anza is expected to exceed the available left turn storage once or twice per hour during the PM peak. The impact of the left-turn queue extending to the through lane at this location would be minor since there are three through lanes on De Anza and ample room for through vehicles to maneuver past the left-turn queue. Reestablishing the offset geometry would result in an internal storage length of approximately 200 feet along De Anza Blvd to be used by the eastbound and westbound left-turning vehicles and northbound and southbound vehicles. Given the amount of green time for these movements with the 120 second cycle length, the 200 feet provides adequate room for these vehicles to store.

These findings suggest that the off-set intersection design is operationally feasible and provides opportunities for improving safety and access for both pedestrians and bicyclists with only minor trade-offs in performance for motor vehicles. We recommend carrying this design option forward for further refinement in the design process.

Table 8. Overall Intersection LOS (delay) and Queue Length Summary

Option	AM Peak					PM Peak				
	Cycle Length (sec)	Intersection LOS and Delay (seconds)		95th Percentile Queue (feet)		Cycle Length (sec)	Intersection LOS and Delay (seconds)		95th Percentile Queue (feet)	
		De Anza & Pacifica	De Anza & McClellan	EBL	EBR		De Anza & Pacifica	De Anza & McClellan	EBL	EBR
No Bikes Option	120	C (23.1)	D (36.1)	117	57	140	C (32.6)	C (25.5)	173	372
Option 1	120	B (15.0)	C (28.9)	254	161	140	E (69.3)	E (56.5)	411	740
Option 2A	120-	B (15.0) -	C (28.8) -	254 -	106 -	140	D (43.1)	C (34.1)	264	513
Option 2B						120	D (54.3)	D (40.6)	320	448

Table 9. Available Storage Length versus PM Queue Length

Movement	Storage Length (feet)	95th Percentile Queue (feet)	
		Option 2 (120 sec.)	No Bikes Option
Northbound Left	370	467	532
Southbound Left	230	182	209
Eastbound	400 (to Felton Way)	320 (EB left) / 448 (EB right)	173 (EB left) / 372 (EB right)
Westbound	780 (to Torre Ave)	423 (WB left)	202 (WB left)
Northbound Internal	200	85	73
Southbound Internal	200	73	65

BICYCLE SIGNAL INFRASTRUCTURE REQUIREMENTS

In order to comply with national and California MUTCD guidelines, implementing separate bike phases at recommended intersections along the Stevens Creek and McClellan Boulevard corridors will require some modifications to signal hardware that are essential elements of the design. These changes include:

- Right-turn signal displays
- Bike signal displays
- 'No Turn on Red' blank out signs
- Detection for right-turn lanes and bike lanes
- Pole and mast arm modifications as needed to support new signal displays

Figure 10 depicts the general requirements for traffic and bicycle signals displays on Stevens Creek Boulevard at the WB approach to Stelling Road that would be needed to support the implementation of a Protected Bike Lane.

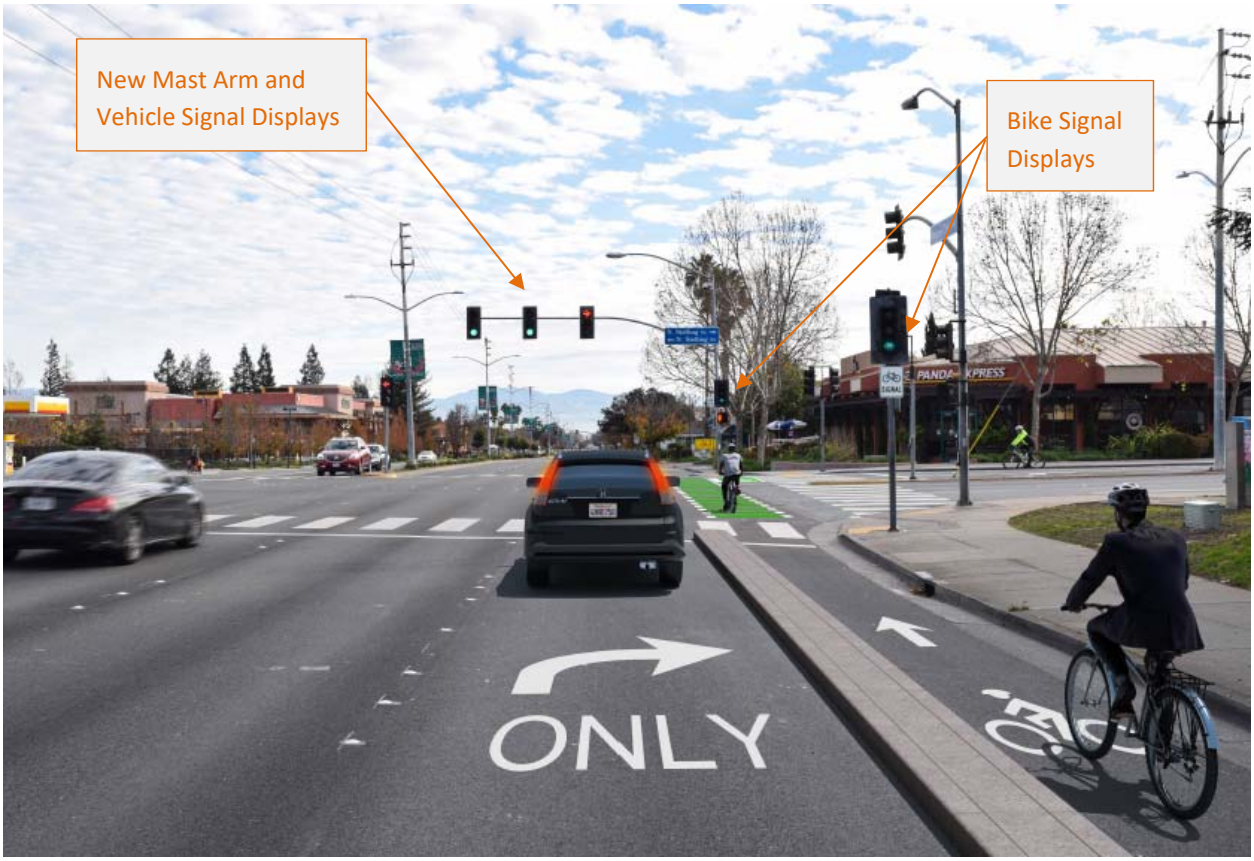
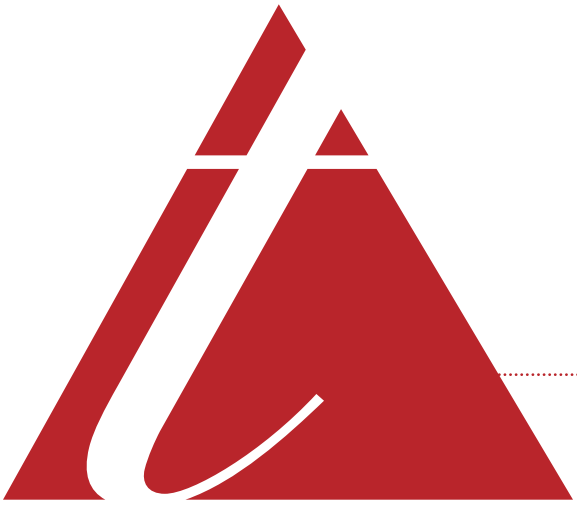


Figure 10. Rendering of a Protected Bike Lane with Bike Signal; WB Stevens Creek Boulevard at Stelling Road



Implementation Plan Memorandum

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To: David Stillman

From: Brooke DuBose, Robert Burchfield, and Craig Schoenberg

Date: May 23, 2017

Subject: Cupertino Class IV Bikeway Design – Recommendations for Implementation Phasing

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Implementation Plan Recommendations for the Stevens Creek Boulevard and McClellan Road Bikeway Designs – DRAFT

Toole Design Group offers the following recommendations for the phased implementation of the Stevens Creek Boulevard and McClellan Road Class IV Bikeway Designs. It is understood that funding and resource constraints require that the project is constructed in separate phases. The length and complexity of the proposed segment phases were sized with cost feasibility as a primary consideration.

Stevens Creek Boulevard

TDG recommends implementing the Steven Creek Class IV Bikeway in the following three phases:

- Phase 1: Tantau Avenue to Torre Avenue (1.2 miles)
- Phase 2: Torre Avenue to Mary Avenue (1.0 miles)
- Phase 3: Mary Avenue to Foothill Boulevard (1.3 miles)

Each proposed phase is described below, and includes a recommended construction sequence.

Phase 1: Tantau Avenue to Torre Avenue

The recommended first phase of construction of the Class IV Bikeway on Stevens Creek Boulevard should include the segment between Tantau Avenue and Torre Avenue. Minor modifications to existing signal infrastructure will be required at five approaches on three separate intersections (Tantau Avenue, Finch Avenue, and Wolfe Road).

It is expected that only minimal restriping will be necessary west of Perimeter Road, where the existing lanes have already been narrowed to accommodate the buffered bike lane. To the east of Perimeter Road, more extensive restriping will be required to provide sufficient space for the new buffer.

There are existing slip lanes (and pedestrian pork chop islands) on the north side of the corridor at the Wolfe Road intersection. The concept design removes these islands and rebuilds the corner. It may be possible to defer this civil work until a later phase of the project, by simply installing the bike lane buffer and disallowing right turning vehicles from entering the slip lane. Further evaluation is necessary to ensure large vehicles can make the turn around the existing islands.

The proposed floating bus stop configuration for the westbound stop, located just west of the Wolfe Road intersection, is the other major civil construction item in this phase.

It is recommended that the improvements are carried through (to the west of) the Torre Ave intersection, and that the transition to the existing buffered bike lanes occurs at this point.

Proposed Phase 1 Construction Sequence

1. Civil construction of floating bus stop island west of Wolfe Road, and optional reconstruction of north side corners at Wolfe Road.
2. Signal modifications; cover new right-turn signals and bicycle signals until turn-on.
3. Remove conflicting pavement markings and install new markings.
   3.1. Place temporary flex posts on intersection approaches with new right turn lanes.
   3.2. Uncover and turn on new signal displays and implement new signal phasing.
4. Install precast concrete barrier.

Phase 2: Torre Avenue to Mary Avenue

The proposed Phase 2 segment includes the segment from Torre Avenue to Mary Avenue. This segment includes major modifications to existing signal infrastructure at the Mary Avenue, Stelling Road, and westbound Bandley Drive intersections. Minor signal improvements are needed at the De Anza Boulevard intersection.

Minimal restriping of lane lines will be needed in this segment because the existing lanes have already been narrowed to accommodate the buffered bike lane.

Civil construction will be required to modify bus stops at the following four locations:

- Westbound, east of Saich Way;
- Westbound, west of De Anaza Boulevard;
- Westbound, west of Torre Avenue; and
- Eastbound, east of Mary Avenue.

Proposed Phase 2 Construction Sequence

1. Construct bus stop modifications at four locations.
2. Signal modifications; cover new right-turn signals and bicycle signals until turn-on.
3. Remove conflicting pavement markings and install new markings.
   3.1. Place temporary flex posts in the buffer area on intersection approaches where new right-turn lanes are installed.
   3.2. Uncover and turn on new signal displays and implement new signal phasing.
4. Install precast concrete barrier.

Phase 3: Mary Avenue to Foothill Boulevard

The final phase is 1.3 miles in length and includes the segment from Mary Avenue to Foothill Boulevard. Major civil work will be required at the SR 85 interchange northbound on-ramp to reconstruct the northeast corner and island, and to construct a shared sidewalk level path. Major signal modifications will also be needed at this intersection. This work will require additional coordination and permitting from Caltrans. Civil work will be required for modifications to medians and installation of buffer medians that exceed the width of precast dimensions in some locations.

Major signal modifications are needed at the eastbound approach to Bubb Road.

Major pavement marking removal and installation are needed in the segment from Peninsula Avenue to Orange Avenue and east of Foothill Boulevard.

Proposed Phase 3 Construction Sequence

1. Civil construction of SR 85 improvements.

1.1. Temporary traffic control for SR 85 NB on-ramp.
1.2. Signal modifications for SR 85 northbound on-ramp; cover new right-turn signals and bicycle signal until turn-on.

2. Remove conflicting pavement markings and install new markings.
   2.1. Place temporary flex posts on intersection approaches with new right-turn lanes.
   2.2. Uncover and turn on new signal displays and implement new signal phasing.
3. Civil construction to modify medians and install wide buffer medians for protected bike lanes.
   3.1. Install precast concrete barrier.

Stevens Creek Boulevard Summary

Phase 1: Tantau Avenue to Torre Avenue (1.2 miles)

- Install precast concrete buffer
- Minor signal modifications required at five intersection approaches
- Civil work required on north side of corridor at Wolfe Road
- Install pavement markings (Perimeter Road to Tantau Avenue has existing bike lanes; travel lanes have not been narrowed to provide a bike lane buffer)
- Provide construction traffic control (plan for high level of effort at Tantau Avenue and Wolfe Road)

Phase 2: Torre Avenue to Mary Avenue (1.0 miles)

- Install precast concrete buffer
- Minor signal modifications required at two intersection approaches
- Major signal modifications required at five intersection approaches
- Install pavement markings
- Civil work required at floating bus stops
- Provide construction traffic control (plan for high level of effort at De Anza Boulevard and Stelling Road)

Phase 3: Mary Avenue to Foothill Boulevard (1.3 miles)

- Install precast concrete buffer
- Major signal modifications required at SR 85 interchange and eastbound approach to Bubb Road
- Civil work required at SR 85 interchange and median/buffer locations
- SR 85 interchange requires additional permitting with Caltrans
- Install pavement markings
- Provide construction traffic control (plan for high level of effort at SR 85 interchange)

McClellan Road

TDG recommends implementing the McClellan Road Class IV Bikeway in the following three phases:

- Phase 1: Stelling Road to Byrne Avenue (0.9 miles)
- Phase 2: Torre Avenue to Stelling Road (0.7 miles)
- Phase 3: McClellan Road & De Anza Boulevard Intersection Modification

Each proposed phase is described below, and includes a recommended construction sequence.

Phase 1: Stelling Road to Byrne Avenue

Phase 1 includes improvements to the segment from Stelling Road to Byrne Avenue. The primary improvements include a precast concrete barrier, a reconstructed or new sidewalk and curb along most of the north side the Phase 1

segment, reconstructed corners with neck-downs (four corners total), new bicycle signal displays for westbound Bubb Road, and pavement markings.

Proposed Phase 1 Construction Sequence

1. Construct new curb, gutter, and sidewalk on the north side.
2. Reconstruct, or construct new, sidewalk on the north side.
3. Reconstruct corners with proposed neck-downs.
4. Install new bike signal displays for westbound Bubb Road; cover displays until turn-on.
5. Remove conflicting markings and install new pavement markings.
6. Turn on new bike signals and implement new traffic signal phasing.
7. Install precast concrete barrier.

Phase 2: Torre Avenue to Stelling Road

Phase 2 includes improvements to the segment from Torre Avenue to Stelling Road. The primary improvements consist of a precast concrete barrier, a reconstructed sidewalk on the north side between Bonny Drive and Stelling Road, reconstructed corners with neck-downs (12 corners total), and pavement markings.

Proposed Phase 2 Construction Sequence

8. Reconstruct north side sidewalk.
9. Reconstruct corners with proposed neck-downs.
10. Remove conflicting markings and install new pavement markings.
11. Install precast concrete barrier.

Phase 3: McClellan Road & De Anza Boulevard Intersection Modification

The final phase of the McClellan Road Class IV Bikeway includes modification to the McClellan Road and De Anza Boulevard intersection to recreate the historic off-set intersection spacing between McClellan Boulevard and Pacifica Drive. These modifications consist primarily of civil work to reconstruct the SE and SW corners, and installing new traffic signal poles, mast arms, and signal displays - including bike signals - for the realigned eastbound and westbound approaches.

Proposed Phase 3 Construction Sequence

1. Install new traffic signal poles, mast arms, and displays for eastbound and westbound approaches along with new foundations and concrete work as necessary. Cover signal displays until turn-on.
2. Place temporary traffic barriers to create new curb lines and traffic close pattern, between Pacifica Drive and McClellan Road.
3. Install temporary walk signal displays for north-south pedestrian movements. Demolish the median nose on the south leg and establish a new crosswalk location.
4. Turn on new signals for eastbound and westbound approaches.
5. Remove existing signal hardware for eastbound and westbound approaches.
6. Remove conflicting markings and install new pavement markings.
7. Reconstruct SE and SW corners and adjacent curb. Construct or place bike barrier.
8. Install new pedestrian signal poles and displays.

McClellan Road Summary

Phase 1: Stelling Road to Byrne Avenue (0.9 miles)

- Install precast concrete buffer
- Construct new curb, gutter, and sidewalk (approx. 4,000 feet)
- Corner reconstruction with neckdowns (4 total)

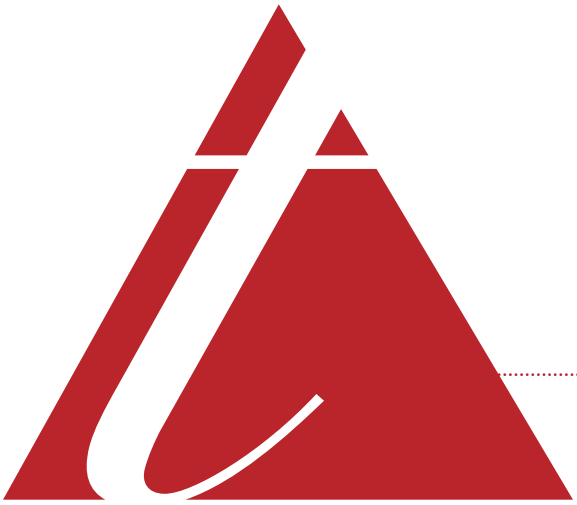
- Install new bicycle signal displays for the westbound approach to Bubb Road
- Install pavement markings
- Provide construction traffic control

Phase 2: Torre Avenue to Stelling Road (0.7 miles)

- Install precast concrete buffer
- Construct new, or reconstruct, concrete sidewalk (approx. 800 feet)
- Provide construction traffic control
- Reconstruct corners with neckdowns (12 total)
- Install pavement markings

Phase 3: McClellan Road & De Anza Boulevard Intersection Modification

- Reconstruct corners and adjacent curb lines in the SE and SW corners
- Install new signal poles, mast arms, and signal displays for the eastbound and westbound approaches
- Install pavement markings
- Provide construction traffic control



Design Memorandum

Toole Design Group

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Date: May 23, 2017

To: Julie Chiu, Associate Civil Engineer, City of Cupertino
David Stillman, Project Manager, City of Cupertino

From: Brooke DuBose, AICP
Robert Burchfield, PE
Craig Schoenberg, PE

Re: Stevens Creek Blvd and McClellan Road Class IV Bikeway Design: Concept Design Memorandum

MEMORANDUM

This memorandum describes the information contained within the Concept Design plan view drawings for both the Stevens Creek Boulevard and McClellan Road Class IV Bikeway Design projects for the City of Cupertino. Assumptions and items not included in the design are also detailed.

Figure 1 Class IV Bikeway Corridors (highlighted in yellow)

General Assumptions

The Concept Design is drawn on GIS information provided by the City of Cupertino. In some cases, the actual curb-to-curb width of the roadway may not match what is provided from GIS information. Spot measurements in the field were taken at locations where the roadway appeared to pinch. It is expected that the next project phase will conduct a detailed corridor survey to determine curb-to-curb widths.

Pavement markings are schematic in nature. Pavement markings denote the function of each lane of traffic, but do not represent actual location or frequency that they may be required.

Locations where separate signal phasing is required for the Class IV bicycle lane are identified on the plan sheets. However, signing, pavement marking and signal detection locations are not identified. The traffic analysis memorandum details the signal analysis conducted for this project, including recommended signal phasing and other requirements.

Stevens Creek Boulevard Corridor

At either end of the corridor (Foothill Boulevard and Tantau Avenue), the extents of the concept design encompasses the entire intersection. In general, bicycle facility treatments that provide for safe and visible connections to existing bicycle lanes on all intersection streets are shown on the concept plans (e.g. two stage turn queue boxes).

Motor vehicle lane widths are 10.5 feet minimum for a through-lane, and 10 feet minimum for a turn-lane. The preferred width of the separated bicycle lanes is 7 feet (includes existing gutter pan, but does not include proposed buffer). There are several locations where the preferred width cannot be met. A minimum width of 6 feet should be used in these instances. The buffer is identified as a pre-cast concrete curb median, and varies in width depending on the location (1.5-2 feet). There are several locations where more width is available. In these instances a cast-in-place concrete curb median may be more appropriate.

In general, the existing outside curbs along the corridor are not changed. Some curb will need to be replaced in the vicinity of sidewalk level bicycle lanes, including floating bus stop locations. Throughout the corridor, it is anticipated that only the outside vehicular lane requires restriping, but this should be confirmed in future design phases, when more detailed survey information is available; however, there are several known pinch points (e.g. between Portal Ave and Wolfe Road). Additional restriping may be required at pinch points.

The bus stop treatments reflect design coordination with Valley Transportation Authority. For more detail on specific bus stop designs, see the Bus Stop Technical Memorandum, also provided with this submittal.

McClellan Road Corridor

Motor vehicle lane widths are 10 feet minimum for all lanes. The preferred width of the separated bicycle lane is 7 feet (includes existing gutter pan, but does not include proposed buffer). There are numerous locations where the preferred width cannot be met due to the constrained right-of-way. A minimum width of 5.5 feet should be used. The buffer is identified as a precast concrete curb median, and varies in width depending on the location (1.5-2 feet). There are several locations with more width available, where a cast-in-place concrete curb median may be more appropriate.

Between Byrne and Imperial Road, on the west end of the project limits, the westbound bicycle lane is shown at sidewalk level. This is to increase visibility of cyclists along this section that has many residential driveways. The proposed roadway section assumes the City of Cupertino will acquire

additional right-of-way on the Northside of the road to allow for a consistent 60-foot section. In other constrained right-of-way locations, it is anticipated that sidewalk will need to be reconstructed (locations identified on the concept plans)

Existing bicycle facilities on intersecting roadways are shown on the concept plans, and bicycle facility treatments, including two-stage queue boxes, that allow for safe connections are identified.

The plans show a concept at the intersection of McClellan Road, Pacifica Drive and De Anza Boulevard that creates an offset intersection, allowing for a bicycle and pedestrian crossing on the Southside of De Anza. This substantially improves walking and bicycling connections through this intersection, but requires major modifications of the corner radii of the intersection and traffic signal hardware.

At Torre Avenue, the Class IV Bikeway transitions to a Class III Bike Route (to the east) and Class III Bike Boulevard (to the north). The concept design for the Class III facilities are contained in a separate plan view document, and identifies general wayfinding locations, pavement markings, speed and volume management treatments, and intersection crossing improvements.

Bus Stop Technical Memorandum and Appendix A

TooleDesignGroup

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Date: May 4, 2017

To: Julie Chiu, Associate Civil Engineer, City of Cupertino
David Stillman, Project Manager, City of Cupertino

From: Brooke DuBose, AICP
Craig Schoenberg, PE

Re: Stevens Creek Blvd and McClellan Road Class IV Bikeway Design: Bus Stops

MEMORANDUM

This memorandum summarizes the coordination between Toole Design Group (TDG), the City of Cupertino and Valley Transportation Authority (VTA), regarding the proposed Class IV Bikeway Concept Designs on Stevens Creek Boulevard and McClellan Road, and the existing bus stops along these corridors.

Data Collection

TDG identified existing bus stops along each of the design corridors, and obtained information from VTA describing the existing average daily passenger boardings and alightings, bus routes and peak hour frequency at each bus stop. The majority of the bus stops are located along Stevens Creek Boulevard, with only three stops identified on McClellan Road. An inventory of the stops is included in Appendix A. The stop location and weekday activity along Stevens Creek Boulevard is shown in Figure 1. The three stops on McClellan Road are located at Felton Way (east and westbound) and Stelling Road (eastbound).

In coordination with VTA, TDG revised the existing bus stop inventory to show the bus network restructuring anticipated through the Next Network project (Table 1). Implementation of the Next Network project will result in a higher frequency of buses at specific stops along Stevens Creek Boulevard, but no changes to stops along McClellan Road. The Next Network project will eliminate some stops along the west end of Stevens Creek Boulevard.

Design Recommendations

Based on bus stop frequency, weekday activity, and bus stop location, recommendations were made for bus stop designs that accommodate Class IV Bikeways. At locations where the expected frequency of buses is less than six per hour, the recommended bus stop design is a **shared bus/bicycle space** (Figure 2). This is the existing configuration in many locations along the corridor. At locations where the frequency exceeds six buses per hour, two different design treatments are recommended, depending on

the existing geometry at that location: a **floating, in-lane bus stop** (Figure 3); or a **full bus pullout** (Figure 4).

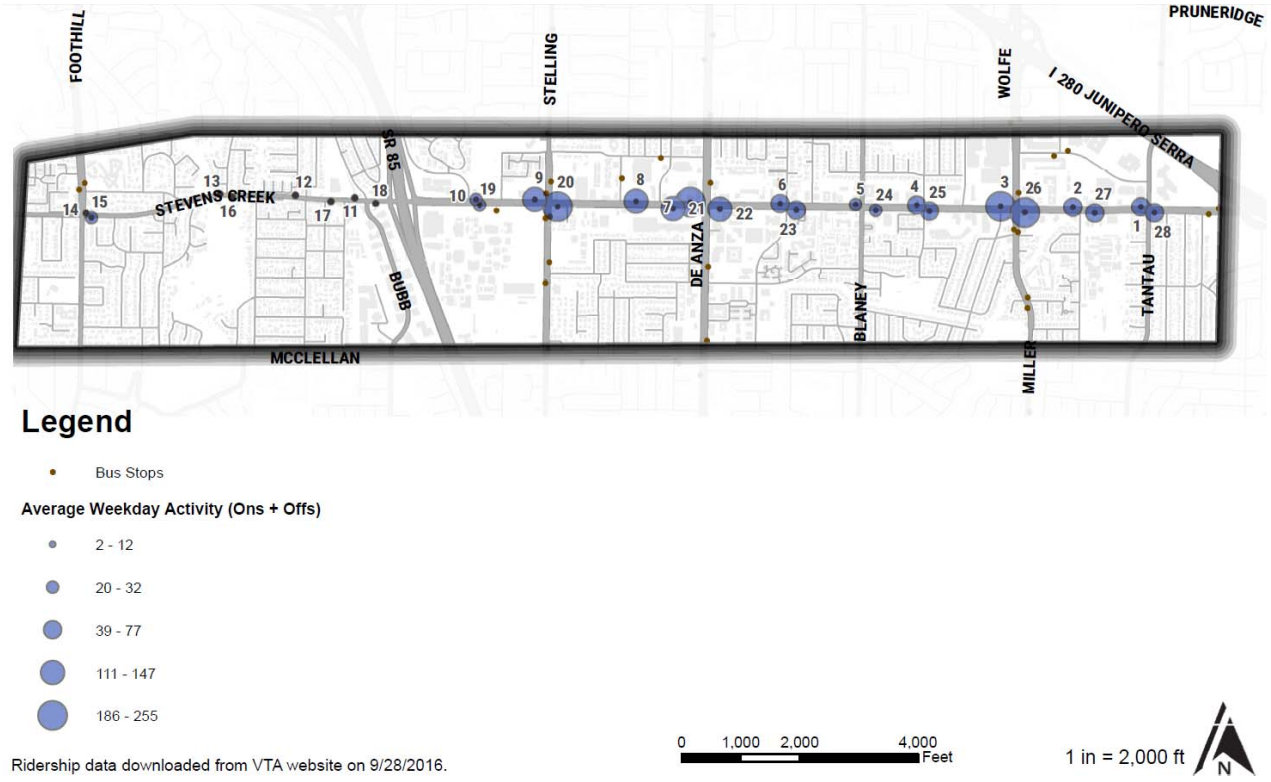

Figure 1 - Average Existing Weekday Bus Activity on Stevens Creek Boulevard

Table 1 - VTA Frequency on Stevens Creek Boulevard & McClellan Road

Route	Existing Bus Frequency (per peak hour)	Next Network Bus Frequency (per peak hour)
23	5	4
25	3	5
51		2
53	2	2
55	2	2
81	3	
323	4	
523		5

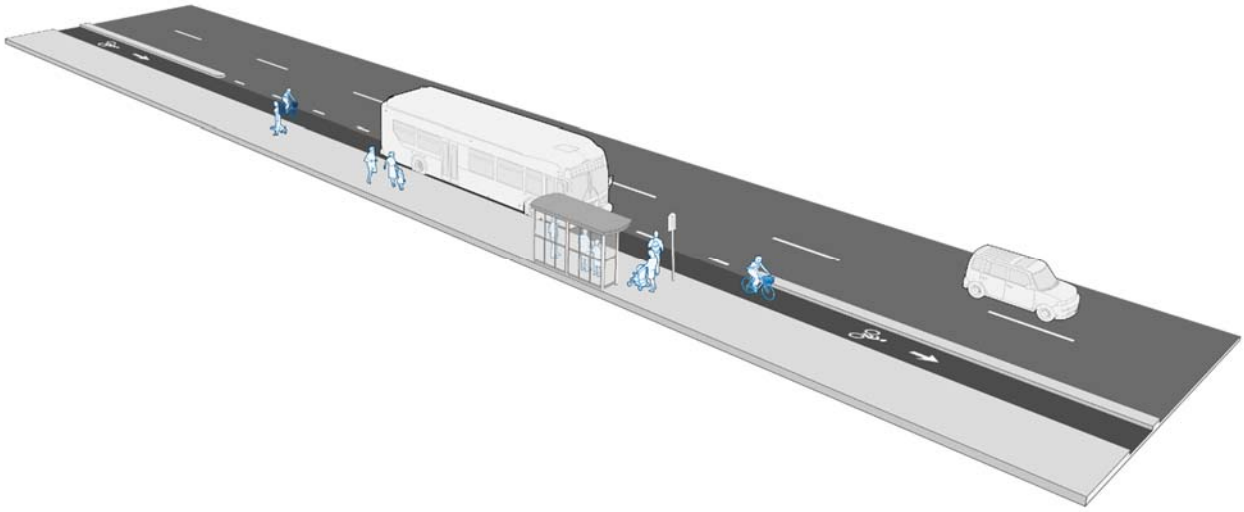

Figure 2 - Shared Bus/Bicycle Space at Existing Bus Stop

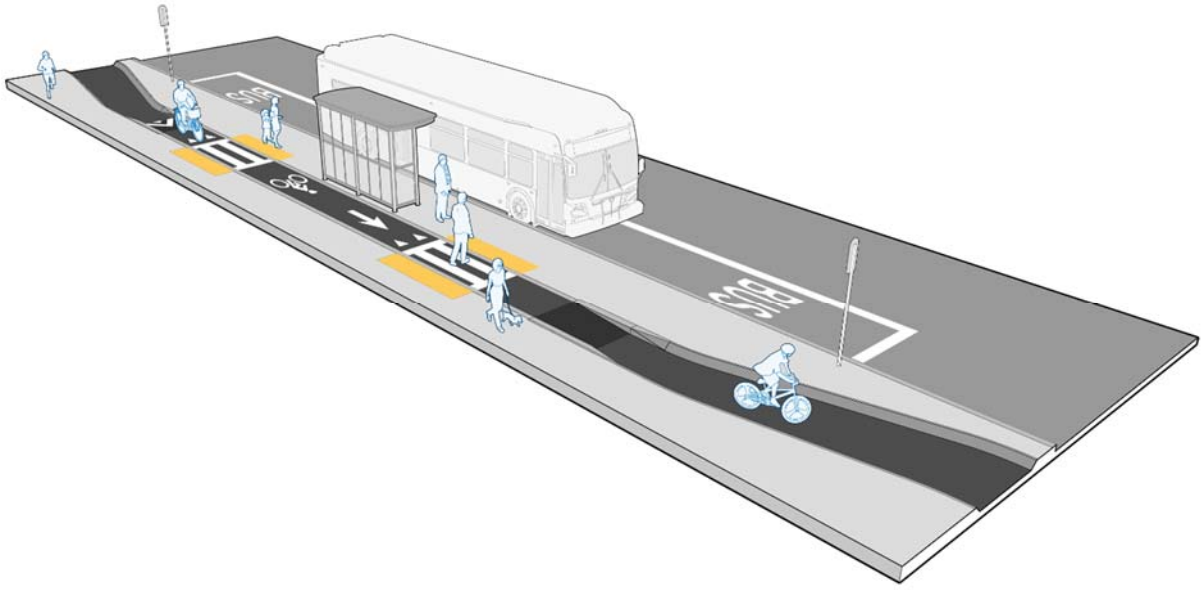

Figure 3 - Floating, In-lane Bus Stop

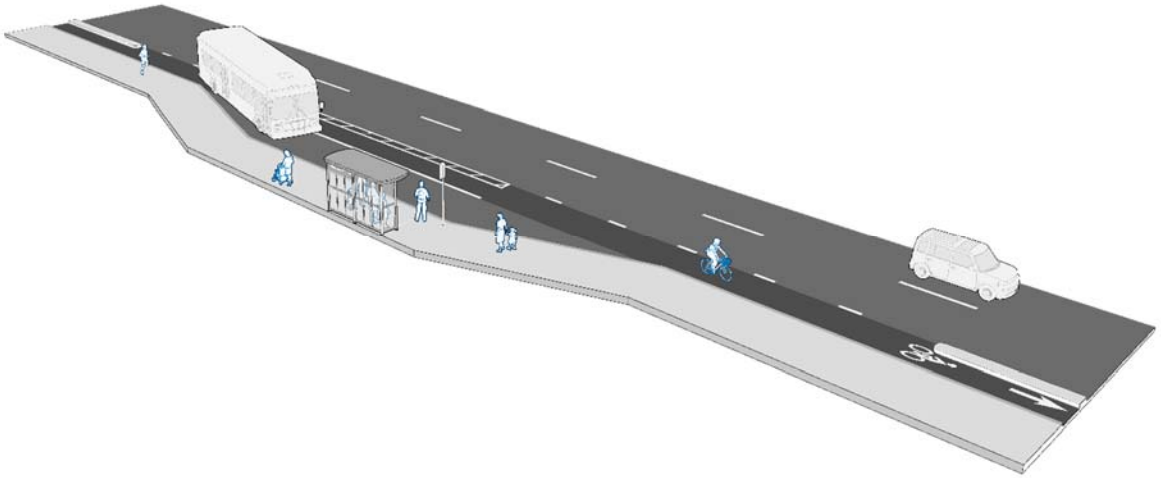

Figure 4 - Full Bus Pullout (Bicycle/Bus Weave)

Table 2 - Bus Stop Recommendation Summary

Bus Stop Type	Location
Floating, In-lane Bus stop	Saich Way (WB), De Anza Blvd (EB & WB), Wolfe Road (WB)
Full Bus Pullout	Phar Lap Dr (WB), Stelling Road (WB), Torre Ave (EB), Miller Rd (EB)
Shared Bus/Bicycle Space	All other locations (23)*

**includes 3 stops on McClellan Road*

In addition to VTA bus service, private buses and shuttles use existing bus stops along Stevens Creek Boulevard. The data collection and design recommendations above do not include any private buses or shuttles. While observing the corridor, it was noted that private buses and shuttles may have a longer dwell time at bus stops than VTA coaches. Where the dwell time is anticipated to be long, a shared bus/bicycle space (Figure 2) is not recommended. The shared space recommendation assumes that the conflict between buses and bicyclists will occur infrequently, resulting in few occasions when a bicyclist would need to merge into the adjacent motor vehicle travel lane.

The final concept design for Stevens Creek Boulevard and McClellan Road reflects VTA's final comments submitted on February 27, 2017. It is anticipated that future design efforts will continue to coordinate with VTA once more detailed design of each stop location is conducted.

APPENDIX A

Stevens Creek Blvd
VTA Bus Stops

No.	Location	Direction	Routes	Frequency (buses per hour)	Avg Wkday Boarding + Alighting (persons per hour)	Pullout?	Ex Width (incl. BL, Gutter) (feet)	Concept Design Treatment	VTA Comments	TDG Response	Additional Notes
1	just west of Tantau	westbound	23, 53	6	53	Y*	10.1	maintain shared bus/bike lane			
2	just west of Finch	westbound	23, 53	6	46	Y*	11.8	maintain shared bus/bike lane			
3	just west of Wolfe	westbound	23, 523	9	254	N	6	create in-lane bus stop island	Future 523 stop (60' buses). Will need 135' tangent. See VTA Passenger Facilities Standards Coordinate with VTA ETID	The proposed design is an in-lane stop, which would not require tapers.	Appears to be sufficient ROW
4	just west of Portal	westbound	23	4	41	N	7	maintain shared bus/bike lane			
5	just west of Blaney	westbound	23	4	31	N	7.2	maintain shared bus/bike lane			
6	just west of Torre	westbound	23	4	44	Y	8.5	maintain shared bus/bike lane	VTA Line 23 will operate 60' buses in near future (TBD). 60' tangent needed for duckout. See VTA Passenger Facilities Standards	The bus stop design is modified to a shared bus/bike space and the comment no longer applies.	
7	just west of De Anza	westbound	23, 55, 523	11	208	N	8	create in-lane bus stop island	Future 523 stop (60' buses). Coordinate with VTA ETID	The proposed platform length appears to be sufficient for 60' buses.	Appears to be sufficient ROW
8	btw Bandley/Saich	westbound	23, 51, 55	8	116	Y	12.4	create in-lane bus stop island	VTA Line 23 will operate 60' buses in near future (TBD). 60' tangent needed for duckout. See VTA Passenger Facilities Standards	The proposed design is an in-lane stop, which would not require tapers.	Appears to be sufficient ROW
9	just west of Stelling	westbound	51, 55	4	146	Y	18.1	maintain bike/bus weave (add barrier for bike comfort?)			
10	just east of Mary	westbound	51	2	20	N	7.4	relocate stop to far side (shared bus/bike lane)	No service expected in 2018		No ROW impacts anticipated because no changes to curb line needed
11	just west of Peninsula	westbound	51	2	6	N	7.6	maintain shared bus/bike lane			
12	just west of Orange	westbound	51	2	6	Y	13.6	maintain shared bus/bike lane			
13	just west of Phar Lap	westbound	51	2	2	Y	14.9	create full bus pullout (bike/bus weave)	No service expected in 2018		No ROW impacts anticipated because no changes to curb line needed; this stop may be removed in the future, per conversation with VTA
14	just east of Foothill	westbound	51	2	26	N	in right-turn pocket	maintain shared bus/bike lane			
15	just east of Foothill	eastbound	51	2	186	N	8	maintain shared bus/bike lane			
16	just east of Phar Lap	eastbound	51	2	111	Y	14.5	maintain shared bus/bike lane			
17	just east of Pasedena	eastbound	51	2	144	Y	15.9	maintain shared bus/bike lane			
18	just east of Bubb	eastbound	51	2	39	N	7.4	maintain shared bus/bike lane			
19	just east of Mary	eastbound	51, 55	4	31	N	7.7	maintain shared bus/bike lane	No service expected in 2018		
20	just east of Stelling	eastbound	25, 51, 55	9	55	Y	13.3	maintain shared bus/bike lane			**This stop is very constrained with existing civil work (ramp) at back of curb and narrow ROW, likely making a full pullout infeasible; an in-lane bus stop island is possible if the driveway within the bus stop zone is closed.**
21	just east of Bandley	eastbound	25, 51, 55	9	249	Y	16.7	maintain shared bus/bike lane			**The ROW appears to be sufficient to upgrade to an in-lane bus island; however, a dedicated right-turn lane is not required upstream, which removes flexibility of de-facto bus lane design (impacts ability to layover in lane); suggest adding a dedicated right-turn lane upstream, or creating a full bus pullout by moving curb**
22	just east of De Anza	eastbound	23, 523	9	77	Y	17.9	create in-lane bus stop island	VTA Line 23 will operate 60' buses in near future (TBD). See VTA Passenger Facilities Standards	The proposed platform length appears to be sufficient for 60' buses.	Appears to be sufficient ROW
23	just east of Torre	eastbound	23	4	39	Y	17.8	maintain bike/bus weave (add barrier for bike comfort?)			No ROW impacts anticipated because no changes to curb line needed
24	just east of Blaney	eastbound	23	4	31	N	7.7	maintain shared bus/bike lane			
25	just east of Portal	eastbound	23	4	55	N	6.5	maintain shared bus/bike lane			
26	just east of Miller	eastbound	23, 53, 523	11	250	Y	11	create full bus pullout (bike/bus weave)	VTA Line 523 will operate 60' buses. 135' tangent needed for duckout. See VTA Passenger Facilities Standards. Coordinate construction with VTA ETID	The proposed design does not recommend changes to the existing bus stop duckout, or curb line.	**Likely not sufficient ROW to create a full pullout here; an in-lane bus island is a challenge due to existing driveways within the stop length**
27	just east of Finch	eastbound	23, 53	6	77	N	7.1	maintain shared bus/bike lane			
28	just east of Tantau	eastbound	23	4	39	N	7.2	maintain shared bus/bike lane			

McClellan Road
VTA Bus Stops

No.	Location	Direction	Routes	Frequency (buses per hour)	Avg Wkday Boarding + Alighting (persons per hour)	Pullout?	Ex Width (incl. BL, Gutter) (feet)	Concept Design Treatment	VTA Comments	TDG Response	Additional Notes
1	just west of Felton	westbound	25, 53, 55	6	unknown	N		maintain shared bus/bike lane			
2	just east of Felton	eastbound	25, 53, 55	6	unknown	N		maintain shared bus/bike lane			
3	just east of Stelling	eastbound	25, 53, 55	6	unknown	N		maintain shared bus/bike lane			

VTA Next Network

Route	Frequency (per hour)	
23	4	
25	5	peak hour
51	2	peak hour
53	2	
55	2	
523	5	

Assumptions
Route 523 uses the same stops currently used by Route 323.
Route 25 and 55 serve both eastbound stops on Stevens Creek Blvd, when turning back.
Route 51 turns back at Stelling, serving all stops between Hwy 85 and Stelling

*Cupertino Main Street redeveloped this stop; no buffer on existing bike lane
ETID Engineering and Transportation Infrastructure Development division of VTA