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MEMORANDUM

Date: January 23, 2013

Project #: 123830

To: Chris Ratekin
Caltrans Planning
P.O. Box 942874, MS #32
Sacramento, CA 94274

From: Alice Chen / Aaron Elias / Amy Lopez

Project: Caltrans Smart Mobility Framework - PO# 2660-2212000748-2

Subject: Complete Streets Assessment – Approach and Assumptions

INTRODUCTION

This memo presents our approach and assumptions in conducting the Complete Streets Assessment as part of the implementation of the Smart Mobility Framework (SMF).

Complete Streets Assessment Background

As described in Subtask 5.2a of our detailed work plan, this task entails providing input and support to the I-680 CSMP team during review of the draft "Preliminary Guidance on Incorporation of Complete Streets Issues in Caltrans System Planning Documents" and advising on how to utilize the guidance for the I-680 corridor. The draft guidance covers the inventory of infrastructure, then operational analysis to identify deficiencies and develop recommendations.

One critical component of Complete Streets assessment that appears to be lacking in the preliminary guidance is the interaction among the modes. This interaction among the modes is particularly important on urban arterials where all modes are sharing the public right-of-way. One method of measuring the performance of urban arterials from a multimodal perspective is to use the methodologies from the 2010 Highway Capacity Manual. The multimodal methodology provides a useful tool to evaluate the interactions among modes and understand trade-offs between them. Specifically, recommendations to improve the traffic flow and reduce delays along a congested, urban freeway corridor, such as I-680, could affect the operations for other modes that share the parallel arterials and interface with freeway traffic at the interchanges.

In November 2012, our team reviewed the preliminary data collection plan and outline for the I-680 CSMP Complete Streets Report (dated October 30, 2012). Given the magnitude of the data collection effort, the direction was to focus the data collection effort and possibly tier the effort so that the coverage of the complete streets network was complete, but the level of detailed data collection items would be reduced. Our SMF team was asked to supplement their efforts by assisting in the data collection efforts. After discussion, augmenting the data collection effort was not considered the best use of the resources for the SMF effort and the direction was to continue in the review but also to conduct a focused testing of the multimodal level of service methodology in the 2010 Highway Capacity Manual. This memo presents our approach to conducting the testing of the 2010 HCM multimodal LOS methodology.

Multimodal Level of Service as a Smart Mobility Framework Performance Measure

One of the SMF performance measures related to the SMF principle of reliable mobility is multi-modal service quality. One of the metrics is multimodal level of service (MMLOS). The HCM 2010 methodologies provide a LOS by mode for autos, transit, bicyclists, and pedestrians for urban arterials and capture the interaction among modes. The HCM 2010 MMLOS can be used to monitor and forecast corridor performance for non-auto modes on the parallel arterials as well as at the interface between the freeway and local streets. Applying the 2010 HCM methodologies for the entire I-680 CSMP Complete Streets network would entail more resources, particularly with data collection, than budgeted for both the CSMP and SMF efforts. However, this effort is intended to test the 2010 HCM methodologies at specific locations using the resources allocated for the SMF effort.

APPROACH

This section describes our process for selecting specific locations for conduct the MMLOS analysis. The first step was to understand the data needs and consider options for collecting the data or applying default values based on the sensitivity of the methodology to specific inputs. Second, the HCM 2010 methodologies allow for varying levels of analysis from the single intersection to the entire facility. Several options were considered by balancing the data needs with available resources, yet provide meaningful results for corridor performance.

HCM 2010 methodology data needs

One of the perceived challenges of applying the HCM 2010 MMLOS is the need for data.

Table 1 outlines data necessary for an MMLOS analysis. Analysis of MMLOS using HCM 2010 methodology can be achieved through data collection in the field, recommended default values, and online resources such as Google Earth or Maps.

Table 1: Data necessary for multimodal LOS analysis

Physical Characteristics and Geometry
• Number of lanes, access points, right turn islands, curb presence, and continuous barriers
• Lengths and/or widths of: median, lanes, parking, sidewalk, buffer, etc.
• Bus stops, shelters, benches, near-side
• Speed limits
• Pavement conditions
Traffic and Signal Data
• AADT's or peak hour turning movements
• Number of RTOR and permitted lefts
• Left/Right Turn Percentage
• Parking occupancy percentage
• Pedestrian volume
• Heavy vehicle percentage
• Number of RTOR and permitted lefts
• K, D, and peak hour factors
• Through adjusted saturation flow rate
• Cycle lengths
• g/C ratio for the through movement
• Pedestrian walk time
• Arrival types
Transit Data
• Frequency (headways)
• Load factor (crowdedness)
• Bus on-time performance (reliability)
• Scheduled speed
• Average passenger trip length

Several levels of analysis

The HCM 2010 MMLOS methodology is capable of analyzing LOS for various modes at the intersection, link (roadway between two signalized intersections), segment (link plus downstream intersection) and facility (several contiguous segments) levels.

Intersection LOS

Intersection-only analysis offers LOS for bicycles and pedestrians. The significant factor affecting bicycle and pedestrian LOS at an intersection is intersection crossing distance. Long crossing distances cause higher delay and more exposure to cross traffic than do short crossing distances.

The HCM 2010 urban street facilities methodology does not assign an intersection LOS score for auto or transit. Auto LOS at the intersection is covered in its own chapter within the HCM while transit LOS is based on the relative attractiveness of the bus service from a user's perspective. Transit passengers are not as concerned with how the bus operates at a specific intersection; rather, their interest is in how the bus operates overall. Therefore, transit service is evaluated only at the link and segment levels and captures user perception through factors such as headway, reliability, bus stop amenities, bus crowding, and travel time.

Link LOS

Along links, the difference between free-flow speed and actual speed influences auto LOS. Pedestrian and bicycle LOS along a link is determined through factors that affect the user's perspective of LOS. Lateral separation between auto traffic and cyclists or pedestrians has the greatest impact on bicycle and pedestrian LOS. Transit LOS along a link is influenced primarily by headways and reliability.

Segment LOS

Segment LOS for all modes features a combination of the intersection and link scores. Bicycle and pedestrian LOS also incorporate a third factor to better capture user perception. The third factor for bicyclists is the number of driveways along the corridor that have significant vehicle volumes turning in and out in front of the bicyclists. Pedestrian LOS at the segment considers the difficulty in crossing the street being analyzed for the third factor. The more difficult it is for the pedestrian to get to the other side, the worse the LOS is.

Facility (or corridor) LOS

LOS for each mode along a whole facility or corridor combines the segment LOS scores for each mode. The combination is done by performing a length-weighted average of the individual LOS results for each mode.

Selecting appropriate scale of facility for analysis

In order to find an approach to corridor analysis that will provide the best snapshot of overall multimodal LOS while respecting the limited resources with which the analysis will be supported, several scenarios at various scales were considered.

1. One option is to perform analysis on the links of a few arterials through the corridor in both directions during the AM and PM peaks while omitting analysis of intersections. This option would require a less time-intensive effort than an intersection-plus-link analysis, and it would yield results for transit, bicycle, and pedestrian LOS. A drawback to this approach is the loss of meaningful information about intersections for bicycle and pedestrian LOS, both of which are impacted by the crossing distance of an intersection.
2. Another option is to identify one parallel arterial and to analyze its full length through the corridor in both directions during the AM and PM peaks. As one would expect, a detailed analysis for an entire arterial is exceedingly more costly than a similar analysis along a

strategically identified segment of that arterial. Conducting a thorough analysis of a parallel arterial along all or most of its length through the corridor requires a relatively large time investment in data collection and analysis, and it yields LOS scores for the full facility as well as every segment therein.

3. The third approach is to perform a detailed analysis at discreet sections along several parallel arterials. Because a length of roadway comprised of several segments rarely exhibits significant shifts in LOS, this approach will provide the best overall picture of arterial LOS along parallel facilities. Data collection efforts and analysis for those segments will focus on the peak hour of the day in the peak direction in order to yield a conservative LOS for each segment.

Our recommendation is the third approach of performing a detailed multimodal LOS analysis at discreet sections along several parallel arterials throughout the corridor. This approach offers Caltrans a meaningful overview of MMLOS for transit riders, bicyclists, and pedestrians, while respecting the limited resources available to complete this portion of a corridor analysis. By taking this strategic approach to segment selection, rather than identifying only one or two multi-segment lengths of parallel arterials, this approach offers a snapshot of LOS for transit passengers, bicyclists, and pedestrians on parallel arterials throughout the I-680 corridor. This approach will be effective both for the I-680 CSMP effort and for other similar future corridor analyses.

NEXT STEPS

Our team will work with the CSMP team to identify segments along parallel arterials throughout the I-680 corridor that exemplify the full lengths of those roadways.

KAI will be responsible for acquiring the data needed to perform an MMLOS analysis using the 2010 HCM. These data will come from a variety of sources such as field visits, satellite imagery, and intersection turn movement counts. However, our assumption is that our data collection efforts would augment that collected by the I-680 CSMP team.

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MEMORANDUM

Date:	March 10, 2013	Project #: 123830
To:	Chris Ratekin Caltrans Planning P.O. Box 942874, MS #32 Sacramento, CA 94274	
From:	Alice Chen / Amy Lopez	
Project:	Caltrans Smart Mobility Framework - PO# 2660-2212000748-2	
Subject:	Complete Streets Assessment – Identification of Segments for Analysis	

INTRODUCTION

This memo presents our recommended parallel arterial segments for multimodal level of service (MMLOS) analysis in conducting the Complete Streets Assessment as part of the implementation of the Smart Mobility Framework (SMF). Our approach for the Complete Streets Assessment was presented in a previous memo dated January 23, 2013.

SEGMENT SELECTION

This section describes our process to identify discreet segments along several parallel arterials for which to perform a detailed MMLOS analysis. Because a length of roadway comprised of several segments rarely exhibits significant shifts in LOS, this approach will provide the best overall picture of arterial LOS along parallel facilities. Data collection efforts and analysis for those segments will focus on the peak hour of the day in the peak direction in order to yield a conservative LOS for each segment.

Identifying viable parallel arterials

The first step was to start with the parallel arterials as identified for the I-680 CSMP Complete Streets Report as presented to the Technical Advisory Committee (TAC) on September 21, 2012. This was necessary in order to ensure the final segment selection reflects facilities throughout the corridor. Second, those roadways were compared with the CCCTA bus map to narrow the list of potential arterials to those which have transit service. Concurrently, the list of roadways was compared to the list of shared use paths highlighted in the September 21st TAC meeting; however, those paths are for non-motorized traffic and, therefore, are not appropriate for MMLOS analysis. The third step involved gathering preliminary details about the roadways with transit service, particularly identifying volume counts available to the CSMP team. The availability of counts informed our decisions to determine end points of analysis segments along each arterial. In several instances, no more than three sets of intersection counts were available for a given roadway. Most of those segments span one-half to one mile between the two most distant intersections with available counts.

Identifying specific segments

Upon completion of these steps, we had identified ten roadways for analysis spanning the entire corridor from San Ramon to Martinez. However, four roadways were located within the City of Walnut Creek: California Boulevard, Broadway, Main Street, and Civic Drive. From these four roadways, we selected California Boulevard as it serves the BART station at Ygnacio Valley Road (the northern end of the identified segment), and it is the Walnut Creek arterial of closest proximity to I-680. We continued to refine the list of potential analysis segments so that each segment would be approximately one-half mile in length. Our effort to limit segment length led to a reduction in the amount of data to be collected for analysis while retaining the integrity of the analysis by selecting a segment that reflects conditions of the greater facility. In some cases, only one end of a segment has available count data. This process to limit the length of each segment also involved consideration of the cross-sections at various points along the arterials. Attention to the features of each roadway ensures several types of roadway cross-sections are included in the analysis. The recommended analysis segments and preliminary data are arranged in Table 1.

Table 1: Recommended Analysis Segments

Arterial	Community	From/To	Length (mi)	Counts Available @	Intersections Signal	Intersections No Signal	CCCTA Route	Features
Alcosta Blvd	San Ramon	Crow Canyon Rd/ Norris Canyon Terrace	0.4	Crow Canyon Rd	2	0	92X (partial)	sidewalk, bike lanes, raised or landscaped median, NO on-street parking
Railroad Ave	Danville	Hartz Ave/ San Ramon Valley Blvd	0.6	Hartz Ave	3	6	21	sidewalks, bike lanes, painted or NO median, on-street parking
Danville Blvd	County/ Alamo/Diablo	Cedar Lane/ Stone Valley Rd	0.5	Stone Valley Rd	2	6	21	sidewalks, bike lanes, painted or NO median, NO on-street parking
California Blvd	Walnut Creek	Ygnacio Valley Rd/ Mt. Diablo Blvd	0.6	Ygnacio Valley Rd, Trinity Ave, Mt. Diablo Blvd	5	2 for NB; 4 for SB	2 & 21 (whole); 1 & 4 (partial)	sidewalks, NO bike lanes, raised or landscaped median, on-street parking
Buskirk Ave	Pleasant Hill	Monument Blvd/ Shaw Rd	0.6	Monument Blvd	3	3	18	sidewalks, NO bike lanes, raised or landscaped median, limited on-street parking
Diamond Blvd	Concord	Galaxy Way/ Willow Pass Rd	0.6	Willow Pass Rd	6	0	91X	sidewalks, NO bike lanes, raised or landscaped median, NO on-street parking
Pacheco Blvd	Martinez	S Buchanan Cir/ Center Dr	0.4	Center Dr	1	3 for NB; 2 for SB	18 & 19	sidewalks, bike lanes, raised median, on-street parking
			3.7		**22**	**22**		

HCM 2010 methodology data needs

As discussed in the memo of January 23, 2013, one of the perceived challenges of applying the HCM 2010 MMLOS is the need for data. Table 2 outlines data necessary for an MMLOS analysis. Analysis of MMLOS using HCM 2010 methodology can be achieved through data collection in the field, recommended default values, and online resources such as Google Earth or Maps.

Table 2: Data necessary for multimodal LOS analysis

Physical Characteristics and Geometry
• Number of lanes, access points, right turn islands, curb presence, and continuous barriers
• Lengths and/or widths of: median, lanes, parking, sidewalk, buffer, etc.
• Bus stops, shelters, benches, near-side
• Speed limits
• Pavement conditions
Traffic and Signal Data
• AADT's or peak hour turning movements
• Number of RTOR and permitted lefts
• Left/Right Turn Percentage
• Parking occupancy percentage
• Pedestrian volume
• Heavy vehicle percentage
• Number of RTOR and permitted lefts
• K, D, and peak hour factors
• Through adjusted saturation flow rate
• Cycle lengths
• g/C ratio for the through movement
• Pedestrian walk time
• Arrival types
Transit Data
• Frequency (headways)
• Load factor (crowdedness)
• Bus on-time performance (reliability)
• Scheduled speed
• Average passenger trip length

Available data

Some data will be collected as part of the CSMP Complete Streets effort, including: lengths of roadways, whether on-street parking is permitted, whether a roadway has sidewalk and bicycle facilities, the completeness or continuity of existing sidewalks and bicycle facilities, and transit routes along a roadway.

Additional data needed

Several additional data are necessary in order to conduct MMLOS analysis along the proposed segments, including: number of lanes and access points, speed limit, on-street parking occupancy, pavement condition, amenities at bus stops (bench, shelter, etc.), frequency of bus arrival, bus load factor, and other data. KAI will be responsible for acquiring the additional data needed to perform an MMLOS analysis using the 2010 HCM. These data will come from a variety of sources such as field visits, satellite imagery, and intersection turn movement counts.

NEXT STEPS

Upon agreement on the analysis segments along parallel arterials throughout the I-680 corridor, KAI will gather data made available by the CSMP team and will collect other data necessary for the analysis. Then KAI will move ahead with the HCM 2010 multimodal analysis of the agreed upon segments.

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MEMORANDUM

Date:	May 8, 2013	Project #: 12383
To:	Chris Ratekin Caltrans - Planning P.O. Box 942874, MS #32 Sacramento, CA 94274	
From:	Alice Chen / Amy Lopez	
Project:	Caltrans Smart Mobility Framework - PO# 2660-2212000748-2	
Subject:	Pilot Area 1: Complete Streets Assessment using HCM 2010 – Analysis Results	

INTRODUCTION

This memo presents the results of our Complete Streets Assessment of level of service (LOS) for transit, bike, and pedestrian modes as part of the implementation of the Smart Mobility Framework (SMF). Our approach for the Complete Streets Assessment was presented in a memo dated January 23, 2013, and our method to select segments for analysis was presented in a memo dated March 10, 2013. In addition to discussing the results of our analysis, this memo provides a preliminary discussion of issues confronted as part of the analytical process.

DATA NEEDS AND AVAILABILITY

2010 Highway Capacity Manual Methodology Data Needs

As discussed in earlier memos, the application of the 2010 *Highway Capacity Manual* (HCM) multimodal level of service (MMLOS) methodology requires additional data when compared to traditional vehicle LOS methodologies. Table 1 outlines data necessary for an MMLOS analysis. Analysis of MMLOS using HCM 2010 methodology can be achieved through data collection in the field, recommended default values, and online resources such as Google Earth or Maps.

Table 1: Data necessary for multimodal LOS analysis

Physical Characteristics and Geometry
• Number of lanes, access points, right turn islands, curb presence, and continuous barriers
• Lengths and/or widths of: median, lanes, parking, sidewalk, buffer, etc.
• Bus stops, shelters, benches, near-side
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• K, D, and peak hour factors
• Through adjusted saturation flow rate
• Cycle lengths
• g/C ratio for the through movement
• Pedestrian walk time
• Arrival types
Transit Data
• Frequency (headways)
• Load factor (crowdedness)
• Bus on-time performance (reliability)
• Scheduled speed
• Average passenger trip length

Available data utilized

Several types of data were collected as part of the CSMP Complete Streets effort. Those data utilized by KAI were intersection peak-hour counts for the downstream signalized intersection of each study segment. In some cases, the CSMP data collection effort provided intersection peak-hour counts for additional signalized intersections along the study segment. In those cases, the provided counts were incorporated into the analysis. In addition, the fact sheets prepared by Nelson/Nygaard were used for identifying segments for HCM analysis as well as a starting point for the geometric design data.

Additional data collected

Several additional data were necessary in order to conduct MMLOS analysis along the proposed segment. With sensitivity to the available budget for this data collection and greater analysis effort, and based on experience applying the 2010 HCM MMLOS methodology, KAI identified certain data to collect and other data to address with professional assumptions.

KAI collected the following data:

- Number of lanes
- Number of access points
- Number of right turn islands
- Curb presence
- Presence of continuous barrier
- Lengths and/or widths of: median, vehicle lanes, bicycle lane, on-street parking, sidewalk, and buffer area
- Bus stops, shelters, benches, presence on near side of intersection
- Speed limits
- Scheduled speed of transit
- Frequency of bus arrival (headway)

Assumptions for select data inputs

- Auto speed: half posted speed limit – This negates the need for signal timing data as the mean speed is assumed rather than calculated. In previous studies, we found that the mean speed of autos along a segment is approximately half the posted speed limit.
- Transit speed: calculated based on distance and time between scheduled stops
- Of all right turns, percent made on red: 10% (only where no channelized right turn lane exists)
- Of all left turns, percent as permitted lefts: 10% (only where left turns are permitted)
- On-street parking occupancy: 20%
- PHF: 0.90
- Bus on time percentage: 90%
- Bus Load Factor (crowdedness): 80%
- Heavy vehicle percentage: 2%
- Pavement condition: type “3” was used to reflect a smooth ride for autos and exhibit few, if any, visible signs of surface deterioration.
- K and D factors: no assumptions were made because peak-hour volumes were available.
- Pedestrian walk time was based a walking speed of 3.5 feet/second.
- Pedestrian volume was omitted from the analysis.

RESULTS

The 2010 HCM MMLOS methodology evaluates roadways in several parts. They are named and defined as follows:

- Intersection – the intersection of two or more roadways; diameter of intersection is the distance between the stopbar for the direction of analysis approach and either the nearest side of the opposing crosswalk or the opposing stopbar in the absence of a crosswalk.
- Link – the portion of roadway between two consecutive signalized intersections
- Segment – a link and its downstream intersection
- Facility – two or more consecutive segments

Segment LOS combines the intersection and link LOS scores and includes some additional factors, such as the number of access points along the right side of the road. The methodology does not analyze transit service at the intersection or link levels; it only analyzes transit LOS at the segment level.

The results of KAI's analysis show a range of levels of service for alternative modes along the study segments. Table 2 below lists the segments included in the analysis.

Table 2: Analysis Segments

Arterial	Community	From/To	Analysis Period	Analysis Direction
Alcosta Blvd	San Ramon	Norris Canyon Terr/ Crow Canyon Rd	PM	Northbound
Buskirk Ave	Pleasant Hill	Hookston Rd/ Oak Park Blvd	AM	Southbound
California Blvd	Walnut Creek	Lacassie Ave/ Ygnacio Valley Rd	PM	Northbound
Danville Blvd	County	Cedar Ln/ Stone Valley Rd	PM	Southbound
Diamond Blvd	Concord	Willows Shopping Center/ Willow Pass Rd	PM	Southbound
Pacheco Blvd	Martinez	S Buchanan Cir/ Center Dr	AM	Southbound
Railroad Ave	Danville	Church St/ Hartz Ave	AM	Northbound

Alcosta Boulevard, PM peak, Northbound Direction

Alcosta Boulevard forms a T-intersection with Crow Canyon Road. It does not have a through movement, but it does have a through crosswalk. Bicycle LOS at the intersection level cannot be directly analyzed in the absence of a through movement; however, the presence of a through crosswalk permits pedestrian LOS analysis at the intersection level. This segment does not have transit service in the direction of analysis, so transit automatically has LOS F.

Table 3: LOS results for Alcosta Boulevard – Norris Canyon Terrace to Crow Canyon Road

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit						F
Bike			2.48	B		
Ped	3.34	C	4.00	D	4.33	E

Buskirk Avenue, AM peak, Southbound Direction

Buskirk Avenue does not have a sidewalk along the west side of the street, which is adjacent to a chain-link fence that prevents access to I-680. The west side of the street is the side analyzed for the southbound movement because this direction carried more traffic during the peak hour. The methodology assumes pedestrians will walk in the street when no sidewalk is present. This condition has a negative impact on pedestrian LOS at the link and segment level. The transit headway is one (1) bus per hour, which negatively affects the transit LOS on this segment.

Table 4: LOS results for Buskirk Avenue – Hookston Road to Oakpark Boulevard (Coggins Drive)

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit					5.59	F
Bike	3.94	D	4.89	E	4.20	D
Ped	2.65	B	6.00	F	4.92	E

California Boulevard, PM peak, Northbound Direction

The results for California Boulevard indicate a desirable LOS for all alternative modes along the segment. This is due to the presence of a bike lane, a sidewalk with an effective width of six feet, low speed limit (25 MPH) and therefore low mean speed of vehicles, zero access points along the right side of the road for the direction of analysis, and high frequency transit service (four buses per hour).

Table 5: LOS results for California Boulevard – Lacassie Avenue to Ygnacio Valley Road

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit					2.25	B
Bike	3.01	C	2.29	B	3.44	C
Ped	2.81	C	3.18	C	2.59	B

Danville Boulevard, PM peak, Southbound direction

Danville Boulevard between Cedar Lane and Stone Valley Road has a northern portion without a sidewalk and curbs for the southbound direction. The southern portion of the study section of the road has a sidewalk and curbs in the southbound direction. The study segment was divided into two analysis segments to capture the difference between absence and presence of sidewalk and curb along the road. Intersection LOS cannot be provided for the northern segment because it does not have a downstream intersection. In essence, that segment terminates mid-block approximately where the sidewalk and curb begin.

Table 6: LOS results for Danville Boulevard – Cedar Lane to Stone Valley Road

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit					3.79	D
Bike			3.02	C	3.56	D
Ped			5.25	F	3.93	D
Transit					3.59	D
Bike	3.21	C	2.74	B	4.49	E
Ped	2.04	B	4.03	D	2.67	B

Diamond Boulevard, PM peak, Southbound Direction

The analysis shows that all pedestrians are well-accommodated along the study segment of Diamond Boulevard. This is due to the presence of a buffer between the sidewalk and road, only one access point on the right side of the road for the direction of analysis, and a moderately low speed limit (35 MPH) that leads to a low mean speed (approximately 17 MPH). Bicycle LOS is poor because no bike lane is present. Transit LOS is poor as a result of low bus arrival frequency (1.33 buses per hour or one bus every 40 minutes).

Table 7: LOS results for Diamond Boulevard – from Willows Shopping Center to Willow Pass Road

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit					4.15	D
Bike	4.15	D	4.44	E	4.43	E
Ped	3.18	C	3.11	C	3.16	C

Pacheco Boulevard, AM peak, Southbound Direction

The LOS for each mode along Pacheco Boulevard indicates that each mode is accommodated on the segment. The unusual shift from LOS A and B for bicycles at the intersection and link levels, respectively, to LOS D for the segment can be attributed to the number of commercial driveways per mile along this short segment. The factor for number of access points per mile is not introduced into the LOS calculation until the segment level. This segment has five (5) access points within less than half of a mile (0.4 mi.).

Table 8: LOS results for Pacheco Boulevard – S. Buchanan Circle to Center Drive

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit					4.06	D
Bike	1.92	A	2.13	B	3.70	D
Ped	2.45	B	2.66	B	2.47	B

Railroad Avenue, AM peak, Northbound Direction

The results for Railroad Avenue indicate that pedestrian amenities and conditions are adequate along the study segment. A bicycle LOS for the intersection, and therefore the segment, cannot be provided because the downstream intersection does not have a through movement. Transit LOS is low primarily due to the frequency of transit service: only one (1) bus per hour. Like Pacheco Blvd., the Railroad Avenue segment experiences a drop in pedestrian LOS at the segment level because the segment has 14 access points along just under half of a mile (0.45 mi.). Were the methodology able to analyze the downstream intersection for bicycle LOS and then calculate the bicycle LOS for the segment, that mode likely would also experience a drop in LOS at the segment level as a result of the high number of access points.

Table 9: LOS results for Railroad Avenue – Church Street to San Ramon Valley Boulevard

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit					4.86	E
Bike			1.83	A		
Ped	2.13	B	2.08	B	2.35	B

LESSONS LEARNED

Some of the challenges in using the HCM 2010 methodology as a performance measure and possible ways to address in future applications of the 2010 HCM MMLOS methodologies include the following:

- MMLOS is more data intensive than the traditional vehicular LOS analysis, even with making assumptions for some of the less critical inputs. Application of MMLOS methodologies to planning-level analyses, such as this effort, would benefit from standard defaults or assumptions to off-set the data requirements.
- The methodology does not handle T-intersections. Professional judgment must be used to accommodate conditions of T-intersections.
- The individual segments selected from the study facilities are of varying lengths, which may diminish the validity of across-the-board comparison of MMLOS from one parallel arterial to another.
- Because the MMLOS analysis using available count data and did not have funds to collect additional traffic counts, the analysis was limited to select links tangent to the intersections for which count data was available. This may have limited our ability to select the best segments to represent the longer facility. For example, tour analysis covered a segment that happens to have a disproportionately high number of access points on the right side, which has a strong effect on bicycle LOS.
- Some of the parallel arterials identified by the CSMP team have notably different features in the northbound and southbound directions. For example, Buskirk Avenue has a sidewalk along only one side of the road, and Alcosta Boulevard only has transit service in one direction. By selecting only one direction of analysis, the results may not be as well representative of the level of service along the facility as we had hoped when planning our approach to conduct our analysis. Future efforts for parallel arterials should consider analysis of both directions, which would not necessarily double the costs, but would be more representative of the facility.
- As is commonly understood, the results of one’s analysis can only be as good as the data used. For at least one location, the available count data was incomplete, eliminating the possibility to analyze certain directions along certain segments connected to that intersection.