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MEMORANDUM

Date: May 8, 2013

Project #: 12383

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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
• 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 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.