Intersection LOS Methodologies

Intersection level-of-service (LOS) has been calculated for all control types using the methods documented in the Transportation Research Board publications *Highway Capacity Manual, Fourth Edition, 2000*. Traffic operations have been quantified through the determination of LOS. LOS determinations are presented on a letter grade scale from "A" to "F", whereby LOS "A" represents free-flow operating conditions and LOS "F" represents over-capacity conditions. For a signalized or all-way stop-controlled (AWSC) intersection, an LOS determination is based on the calculated average delay for all approaches and movements. For a two-way stop-controlled (TWSC) intersection, an LOS determination is based upon the calculated average delay for all movements of the worst-performing approach. LOS definitions for different types of intersection controls are presented in Table 1.

Roadway LOS Methodologies

Roadway LOS has also been calculated using methods documented in the *Highway Capacity Manual*. On SR 29, AM and PM peak-hour operations were quantified on an arterial roadway analysis for the northbound and southbound segments. Arterial operations are calculated in terms of the average speed of vehicles traveling through a specific arterial segment. The AM and PM LOS for the remaining study roadways were quantified by the peak hour volume per number of lanes. Tables 2A and 2B present the roadway segment LOS thresholds and estimated daily volume capacities for a set of roadway types.

TABLE 1
LOS CRITERIA AND DEFINITIONS FOR INTERSECTIONS

Level of Service	Type of Flow	Delay	Maneuverability	Stopped Delay/Vehicle		
				Signalized	Unsignalized	All-Way Stop
A	Stable Flow	Very slight delay. Progression is very favorable, with most vehicles arriving during the green phase not stopping at all.	Turning movements are easily made, and nearly all drivers find freedom of operation.	< 10.0	< 10.0	< 10.0
B	Stable Flow	Good progression and/or short cycle lengths. More vehicles stop than for LOS A, causing higher levels of average delay.	Vehicle platoons are formed. Many drivers begin to feel some what restricted within groups of vehicles.	>10.0 and < 20.0	>10.0 and < 15.0	>10.0 and < 15.0
C	Stable Flow	Higher delays resulting from fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant, although many still pass through the intersection without stopping.	Back-ups may develop behind turning vehicles. Most drivers feel somewhat restricted	>20.0 and < 35.0	>15.0 and < 25.0	>15.0 and < 25.0

D	Approaching Unstable Flow	The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high volume-to-capacity ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.	Maneuverability is severely limited during short periods due to temporary back-ups.	>35.0 and < 55.0	>25.0 and < 35.0	>25.0 and < 35.0
E	Unstable Flow	Generally considered to be the limit of acceptable delay. Indicative of poor progression, long cycle lengths, and high volume-to-capacity ratios. Individual cycle failures are frequent occurrences.	There are typically long queues of vehicles waiting upstream of the intersection.	>55.0 and < 80.0	>35.0 and < 50.0	>35.0 and < 50.0
F	Forced Flow	Generally considered to be unacceptable to most drivers. Often occurs with over saturation. May also occur at high volume-to-capacity ratios. There are many individual cycle failures. Poor progression and long cycle lengths may also be major contributing factors.	Jammed conditions. Back-ups from other locations restrict or prevent move-ment. Volumes may vary widely, depending prin-cipally on the downstream back-up conditions.	> 80.0	> 50.0	> 50.0

References: 2000 Highway Capacity Manual

TABLE 2A
LOS CRITERIA FOR ARTERIAL ROADWAY SEGMENTS

Urban Street Class	**I**	**II**	**III**	**IV**
Range of Free Flow Speeds (FFS)	55 to 45 mi/h	45 to 35 mi/h	35 to 30 mi/h	35 to 25 mi/h
Typical FFS	50 mi/h	40 mi/h	35 mi/h	30 mi/h
LOS	**Average Travel Speed (mi/h)**			
A	> 42	> 35	> 30	> 25
B	> 34 – 42	> 28 – 35	> 24 – 30	> 19 – 25
C	> 27 – 34	> 22 – 28	> 18 – 24	> 13 – 19
D	> 21 – 27	> 17 – 22	> 14 – 18	> 9 – 13
E	> 16 – 21	> 13 – 17	> 10 – 14	> 7 – 9
F	≤ 16	≤ 13	≤ 10	≤ 7

TABLE 2B
LOS CRITERIA FOR ROADWAY SEGMENTS

		Maximum Peak Hour Volume Per Lane				
Roadway Type	**LOS:**	**A**	**B**	**C**	**D**	**E**
Expressway-High Access Control		570	660	760	850	950
Expressway-Moderate Access Control		520	610	700	790	870
Divided Arterial (w/ LTL)		500	560	650	730	810
Undivided Arterial (no LTL)		410	470	540	610	680
Collector		270	340	125	470	540

Notes: Based on Highway Capacity Manual, Fourth Edition , Transportation Research Board, 2000.

Applicable LOS Policies

The 2008 *City of American Canyon Citywide Circulation Study* specifies minimum level-of-service standards for all streets and intersections within the City's jurisdiction. In section 4.2.2, the City establishes the following performance standards for acceptable LOS:

"Maintain a Citywide Level of Service not to exceed LOS D with an average vehicle delay of 40 seconds for intersection during peak hours. Excepted intersections are Flosden Road/American Canyon Road and SR 29/American Canyon Road, which will operate at LOS E/F with build-out development."

"Maintain a peak period LOS not to exceed D with an average vehicle delay of 40 seconds for collector and arterial roadways."

"Maintain a peak period LOS not to exceed C with an average vehicle delay of 25 seconds for residential streets."

Traffic Signal Warrants

A supplemental traffic signal warrant analysis has been completed to determine whether unsignalized study intersections may require or benefit from the installation of a traffic signal. The term "signal warrant" refers to any of the eight established methods used by Caltrans to quantify the need for a traffic signal at an unsignalized intersection. The eight signal warrant methods are described in the latest edition of the California *Manual on Uniform Traffic Control Devices* (MUTCD).

The California MUTCD indicates that the installation of a traffic signal should be considered only if one or more of the eight signal warrants are met. This TIAR has performed the peak-hour volume-based Warrant 3 on study intersections projected to operate at LOS "D" or worse. The results of the included signal warrant analyses may indicate that a traffic signal could be beneficial to the operations of an intersection. The final decision to install a traffic signal should, however, be based upon further studies utilizing additional warrants as presented in the California MUTCD. Because Warrant 3 analysis was only applied to intersections operating at LOS "D" or worse, it is possible that unsignalized study intersections operating at LOS "C" or better that also meet Warrant 3 go unidentified in this TIAR.

Technical Analysis Parameters

This TIAR provides a "planning level" evaluation of traffic condition, which is considered sufficient for CEQA/NEPA clearance purposes. The "planning level" evaluation incorporates appropriate heavy vehicle adjustment factors, peak-hour factors, and signal lost-time factors. LOS operations will be determined using HCM-2000 methodologies for determining intersection delay, incorporating the aforementioned factors.

For Existing conditions, PHF observed from the counts was used within the analysis. For future conditions, a PHF of 0.92 or observed (if greater than 0.92) was used within the analysis. In addition, a minimum traffic signal cycle length of 80 seconds will be used at signalized intersection locations, with 4 seconds of "lost time" per critical signal phase.

Study intersections along SR 29 were analyzed with a truck percentage estimate of 6.5%, which was derived from the 2009 Caltrans-published *Annual Average Daily Truck*

Traffic on the California State Highway System (http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/truck/2009final.pdf). A standard truck factor of 2% was assigned for the remaining study intersections. Heavy vehicle adjustment factors account for differences in navigation times through intersections for trucks, recreational vehicles, and buses in level-of-service calculations.

The *Synchro Version 7* software suite by Trafficware will be used to implement the HCM-2000 analysis methodologies. A "design level" evaluation (including queuing on intersection lane groups, stacking length requirements, coordinated signal operations analyses, etc.) will not be included.

Significance And Mitigation Thresholds

The following thresholds of significance were used to determine if the project impact is significant and requires mitigation:

Signalized Intersections:

The project is considered to have a significant impact if it would:

- Result in a signalized intersection that will operate at an acceptable LOS in the *No Project* condition to deteriorate to an unacceptable LOS in the *Plus Project* condition; or,
- Increase the delay by more than 5 seconds at a signalized intersection that will operate at an unacceptable LOS in the *No Project* condition.

Unsignalized Intersections:

The project is considered to have a significant impact if it would:

- Result in an unsignalized intersection that will operate at an acceptable LOS in the *No Project* condition to deteriorate to an unacceptable LOS in the *Plus Project* condition; or,
- Increase the delay by more than 5 seconds at an unsignalized intersection that is already operating or will already operate at an unacceptable LOS in the *No Project* condition.

Roadways:

The project is considered to have a significant impact if it would:

- Result in a roadway that will operate at an acceptable LOS in the *No Project* condition to deteriorate to an unacceptable LOS in the *Plus Project* condition; or,
- Increase the V/C ratio by more than 5% at a roadway that will operate at an unacceptable LOS in the *No Project* condition.