



Attachment L

Level of Service (LOS) Definitions

Level of Service Definitions

Signal Controlled Intersections

The evaluation criteria used to analyze signalized intersections is based on the procedures set forth in the latest version of the *Highway Capacity Manual* (HCM)¹.

The level of service (LOS) of a signalized intersection can be characterized for the entire intersection, each intersection approach, and each lane group. Control delay alone is used to characterize LOS for the entire intersection or an approach. Control delay and volume-to-capacity ratio are used to characterize LOS for a lane group. Delay quantifies the increase in travel time due to traffic signal control. It is also a measure of driver discomfort and fuel consumption. The volume-to-capacity ratio quantifies the degree to which a phase's capacity is utilized by a lane group.

The levels of service range between level of service A (relatively congestion-free) and level of service F (congested).

Level of service A – This level is typically assigned when the volume-to-capacity ratio is low and either progression is exceptionally favorable or the cycle length is very short. If LOS A is the result of favorable progression, most vehicles arrive during the green indication and travel through the intersection without stopping.

Level of service B – This level is typically assigned when the volume-to-capacity ratio is low and either progression is highly favorable or the cycle length is short. More vehicles stop than with LOS A.

Level of service C – This level is typically assigned when progression is favorable or the cycle length is moderate. Individual *cycle failures* (i.e., one or more queued vehicles are not able to depart as a result of insufficient capacity during the cycle) may begin to appear at this level. The number of vehicles stopping is significant, although many vehicles still pass through the intersection without stopping.

Level of service D – This level is typically assigned when the volume-to-capacity ratio is high and either progression is ineffective, or the cycle length is long. Many vehicles stop and individual cycle failures are noticeable.

Level of service E - This level is typically assigned when the volume-to-capacity ratio is high, progression is unfavorable, and the cycle length is long. Individual cycle failures are frequent.

¹ Highway Capacity Manual, 6th Edition, Transportation Research Board, Washington D.C., 2016.

Level of Service F - This level is typically assigned when the volume-to-capacity ratio is very high, progression is very poor, and the cycle length is long. Most cycles fail to clear the queue.

A lane group can incur a delay less than 80 s/veh when the volume-to-capacity ratio exceeds 1.0. This condition typically occurs when the cycle length is short, the signal progression is favorable, or both. As a result, both the delay and volume-to-capacity ratio are considered when lane group LOS is established. A ratio of 1.0 or more indicates cycle capacity is fully utilized and represents failure from a capacity perspective (just as delay in excess of 80 s/veh represents failure from a delay perspective).

The following lists the LOS thresholds established for motorized vehicle mode at a signalized intersection.

CONTROL DELAY (s/veh)	LOS by Volume-to-Capacity Ratio ^a	
	≤1.0	≥1.0
≤10	A	F
>10-20	B	F
>20-35	C	F
>35-55	D	F
>55-80	E	F
>80	F	F

^a For approach-based and intersection wide assessments, LOS is defined solely by control delay.

Two Way Stop Controlled Intersections

The evaluation criteria used to analyze Two-Way Stop Controlled (TWSC) intersections is based on the procedures set forth in the latest version of the *Highway Capacity Manual* (HCM)¹.

Level of service (LOS) for a TWSC intersection is determined by the computed or measured control delay. For motor vehicles, LOS is determined for each minor street movement (or shared movement), as well as the major -street left turns, by using the criteria given in the Table below. LOS is not defined for the intersection as a whole or for major-street approaches for three primary reasons: (a) major-street through vehicles are assumed to experience zero delay; (b) the disproportionate number of major-street through vehicles at a typical TWSC intersection skews the weighted average of all movements, resulting in a very low overall average delay for all vehicles; and (c) the resulting low delay can mask LOS deficiencies for minor movements. LOS F is assigned to a movement if its volume-to-capacity ratio exceeds 1.0, regardless of the control delay.

The LOS criteria for TWSC intersections differ somewhat from the criteria for signalized intersections, primarily because user perceptions differ among transportation facility types. The expectation is that a signalized intersection is designed to carry higher traffic volumes and will present greater delay than an unsignalized intersection. Unsignalized intersections are also associated with more uncertainty for users, as delays are less predictable than they are at signals.

The levels of service range between level of service A (relatively congestion-free) and level of service F (very congested).

The following thresholds are used to determine TWSC levels of service:

CONTROL DELAY (s/veh)	LOS by Volume-to-Capacity Ratio ^a	
	v/c ≤ 1.0	v/c ≥ 1.0
≤ 10	A	F
> 10-15	B	F
> 15-25	C	F
> 25-35	D	F
> 35-50	E	F
> 50	F	F

^a The LOS criteria apply to each lane on a given approach and to each approach on the minor street. LOS is not calculated for major-street approaches or for the intersection as a whole.

All Way Stop Controlled Intersections

The evaluation criteria used to analyze All-Way Stop Controlled (AWSC) intersections is based on the procedures set forth in the latest version of the *Highway Capacity Manual (HCM)*¹.

The level of service of an AWSC intersection are the criteria by which the quality of traffic service is measured. The levels of service range between level of service A (relatively congestion-free) and level of service F (very congested).

AWSC intersections are a type of unsignalized intersection that require drivers on all approaches to stop at the intersection before proceeding. Because each driver must stop, the decision to proceed into the intersection is a function of traffic conditions on the other approaches. If no traffic is present on the other approaches, a driver can proceed immediately after stopping. If there is traffic on one or more of the other approaches, a driver proceeds only after determining that no vehicles are currently in the intersection and that it is the driver's turn to proceed. The AWSC methodology analyzes each intersection approach separately.

The key variable in determining the capacity of an AWSC intersection is the distribution of traffic volumes among the approaches. Under ideal conditions traffic would be

evenly distributed among the approaches. The flow rate for any given approach increases as the traffic decreases on the other approaches, allowing a smaller headway between vehicles departing from the stop line.

The following thresholds are used to determine AWSC levels of service:

CONTROL DELAY (s/veh)	LOS by Volume-to-Capacity Ratio ^a	
	v/c ≤ 1.0	v/c ≥ 1.0
≤ 10	A	F
> 10-15	B	F
> 15-25	C	F
> 25-35	D	F
> 35-50	E	F
> 50	F	F

^a For approaches and intersection wide assessment, LOS is defined solely by control delay.