

Capacity calculation assumptions and results
by Joe Hummer, Mobility and Safety
For James Upchurch, TPD
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General

We made a number of assumptions to arrive at the recommended capacity values below. These assumptions were from the “NCLOS Program 2010 Update” (released in June 2013) as much as possible. The general assumptions which applied to most or all of the types of road included that:

- LOS D and LOS E capacities are shown in vehicles per day in two directions;
- In uninterrupted facilities level of service (LOS) D was at a density of 35 vpm;
- In interrupted facilities LOS D was at a control delay of 55 sec/veh;
- In uninterrupted facilities LOS E was at a density of 45 vpm or a demand to capacity (v/c) of 1.0;
- In interrupted facilities LOS E was at a control delay of 80 sec/veh or a v/c of 1.0;
- At intersections, 15 percent of the approach demand turns left and 15 percent turns right;
- The region of NC (coastal vs piedmont vs mountains) does not matter;
- For terrain, level = 0% grade, rolling = +3% grade, and mountainous = +5% grade;
- Lanes are 12 feet wide; and
- The proportion of the daily traffic in the peak hour (K) was 0.09.

The calculations followed Version 6 (2016) of *Highway Capacity Manual* (HCM) methods unless otherwise noted.

Freeway

This uninterrupted facility is defined in the same way as the SPOT definition of “freeway”. We used the freeway portion of HCM Chapter 12. In that chapter, capacity and LOS depend primarily on trucks moving up grades. Key assumptions included:

- The base free flow speed = speed limit + 10 mph; and
- The right-side lateral clearance was 10 ft.

The difference between urban, suburban, and rural was captured in a few variables:

- The speed limit was 70 mph in a rural area, 65 mph in a suburban area, and 60 mph in an urban area;
- The total ramp density was 0.5 per mile in a rural area and 1.0 per mile in an urban or suburban area;
- The directional split in the peak hour (D) was 0.65 in a rural area and 0.60 in an urban or suburban area; and
- The peak hour factor (PHF) was 0.85 rural in a rural area and 0.90 in an urban or suburban area.

LOS D

Terrain	Percent trucks	Two lanes per direction			Three lanes per direction			Four lanes per direction		
		Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
Level	5	65000	66300	57800	97400	99400	86700	130000	132600	115600
	10	62200	63300	55200	93300	95200	82900	124400	126900	110600
	15	59800	60900	53200	89800	91500	79800	119600	122000	106300
	20	57800	58900	51300	86700	88300	77100	115600	117800	102700
	25	55700	56700	49400	83500	85200	74200	111500	113500	99000
	30	53500	54600	47700	80400	82000	71500	107200	109300	95400
	35	51700	52600	45800	77400	79100	68900	103300	105400	91800
Rolling	5	60400	61700	53700	90700	92400	80700	120900	123300	107500
	10	57800	58900	51300	86700	88300	77100	115600	117800	102700
	15	55400	56500	49200	83100	84800	74000	110900	113100	98600
	20	53300	54400	47400	80200	81700	71100	106900	108900	94900
	25	51300	52400	45600	77000	78500	68500	102800	104800	91500
	30	48900	49800	43400	73300	74800	65100	97800	99800	87000
	35	46700	47400	41400	70000	71300	62200	93300	95000	82900
Mountainous	5	56300	57200	49900	84400	85900	75000	112600	114600	100000
	10	53500	54600	47700	80400	82000	71500	107200	109300	95400
	15	51300	52400	45600	77000	78500	68500	102800	104800	91500
	20	49300	50200	43800	73900	75400	65800	98700	100600	87700
	25	47400	48300	42200	71100	72600	63200	95000	96900	84400
	30	44600	45400	39700	66900	68100	59500	89300	90900	79300
	35	42000	43000	37400	63100	64400	56100	84300	85900	74900

LOS E

Terrain	Percent trucks	Two lanes per direction			Three lanes per direction			Four lanes per direction		
		Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
Level	5	74100	75000	65300	111100	112600	98100	148100	150000	130800
	10	70900	71900	62600	106300	107800	93800	141700	143700	125300
	15	68100	69100	60200	102200	103700	90400	136500	138100	120500
	20	65900	66700	58100	98700	100000	87200	131700	133500	116400
	25	63500	64300	56100	95200	96500	84100	126900	128700	112100
	30	61100	61900	54000	91700	92800	81000	122200	123900	108000
	35	58900	59600	52000	88300	89400	77900	117800	119400	104100
Rolling	5	68900	69800	60900	103300	104800	91300	137800	139600	121700
	10	65900	66700	58100	98700	100000	87200	131700	133500	116400
	15	63300	64100	55900	94800	96100	83800	126500	128100	111800
	20	60900	61700	53700	91300	92600	80700	121700	123300	107500
	25	58500	59300	51600	87800	89100	77600	117200	118700	103400
	30	55700	56500	49200	83500	84600	73800	111500	113000	98500
	35	53100	53900	46800	79600	80700	70400	106300	107800	93800
Mountainous	5	64200	65000	56600	96100	97400	85000	128100	130000	113300
	10	61100	61900	54000	91700	92800	81000	122200	123900	108000
	15	58500	59300	51600	87800	89100	77600	117200	118700	103400
	20	56300	56900	49600	84300	85400	74500	112400	113900	99300
	25	54100	54800	47700	81100	82200	71600	108100	109600	95600
	30	50900	51500	45000	76300	77200	67400	101700	103100	89900
	35	47900	48500	42400	72000	73000	63600	95900	97200	84800

Expressway

This uninterrupted facility is defined in the same way as the SPOT definition of “multilane segment”. We used the multilane highway portion of HCM Chapter 12. This facility has either two or three through lanes per direction. In Chapter 12, capacity and LOS depend primarily on trucks moving up grades. Key assumptions included:

- The PHF was 0.9; and
- The D was 0.6.

Suburban and urban expressways were assumed to be identical. They differed from rural expressways in a few variables:

- The speed limit was 55 mph in urban and suburban areas and 60 mph in rural areas;
- The access point density was 25 per mile in urban and suburban areas and 8 per mile in rural areas; and
- The lateral clearance was 8 feet in urban and suburban areas and 12 feet in rural areas.

LOS D

Terrain	Percent trucks	Two lanes per direction		Three lanes per direction	
		Urban or suburban	Rural	Urban or suburban	Rural
Level	5	55700	62200	83700	93400
	10	53300	59600	80200	89500
	15	51300	57400	77000	86100
	20	49600	55400	74400	83100
	25	47800	53300	71700	80100
	30	45900	51300	69100	77100
	35	44300	49400	66500	74300
	Rolling	5	51900	58000	78000
10		49600	55400	74400	83100
15		47600	53100	71500	79800
20		45700	51100	68700	76800
25		44100	49300	66300	73900
30		42000	46900	63000	70300
35		40000	44600	60000	67100
Mountainous		5	48300	53900	72400
	10	45900	51300	69100	77100
	15	44100	49300	66300	73900
	20	42400	47200	63500	70900
	25	40700	45400	61100	68300
	30	38300	42800	57400	64200
	35	36100	40400	54300	60600

LOS E

Terrain	Percent trucks	Two lanes per direction		Three lanes per direction	
		Urban or suburban	Rural	Urban or suburban	Rural
Level	5	65600	72000	98400	107900
	10	62800	68900	94200	103300
	15	60400	66300	90700	99400
	20	58300	64000	87500	96000
	25	56200	61700	84400	92500
	30	54100	59400	81200	89100
	35	52200	57200	78300	85900
	Rolling	5	61100	67000	91600
10		58300	64000	87500	96000
15		56000	61500	84000	92200
20		53900	59200	80900	88700
25		51900	56900	77900	85400
30		49400	54200	74100	81300
35		47100	51700	70600	77500
Mountainous	5	56800	62300	85200	93500
	10	54100	59400	81200	89100
	15	51900	56900	77900	85400
	20	49800	54600	74700	82000
	25	47900	52600	71900	78900
	30	45100	49400	67600	74100
	35	42500	46700	63800	70000

Two-Lane Highway Segment

This uninterrupted facility is defined in the same way as the SPOT definition of “two-lane segment”. This facility has one through lane per direction. We used a LOS procedure developed during NCHRP 17-65 which will be in version 6.1 of the HCM. Capacity and LOS depend primarily on faster vehicles platooning behind trucks and other slower vehicles. Key assumptions included:

- In consultation with the NCHRP 17-65 Principal Investigator (Scott Washburn at the University of Florida) we set the LOS E to F boundary at 16 followers/mi/ln for facilities with speeds of 50 mph or above or 20 followers/mi/ln for facilities with speeds below 50 mph;
- Rural, suburban, and urban areas were identical;
- There were zero passing zones or lanes;
- The segment length was two miles;
- Vertical class and alignment coefficients were based on Table 2-14 with class 1 for level terrain, class 2 for rolling terrain, and class 4 for mountainous terrain;
- 5 percent trucks;
- The PHF was 0.9; and
- D was 0.6.

LOS D

Terrain	Speed limit, mph	Capacity, vpd
Level	45	12100
	50	13300
	55	14400
Rolling	45	12100
	50	13200
	55	14300
Mountainous	45	11200
	50	12100
	55	13100

LOS E

Terrain	Speed limit, mph	Capacity, vpd
Level	45	16100
	50	17600
	55	19200
Rolling	45	16100
	50	17500
	55	19000
Mountainous	45	14800
	50	16000
	55	17300

Boulevard

This interrupted facility is defined in the same way as the SPOT definition of “arterial”. This facility has two, three, or four through lanes per direction. Capacity and LOS are defined for a through movement at the stop bar on the way into an isolated, fixed-time signalized intersection. The calculations were made using Chapter 19 of the HCM. Key assumptions included:

- Speed limit does not matter;
- Urban vs suburban vs rural does not matter;
- The intersection is not in a central business district;
- All turns are made from exclusive turn lanes;
- 5 percent trucks;
- There were no stopping buses near the intersection;
- There was no on-street parking near the intersection;
- The signal cycle was 120 sec long;
- Total lost time was 4 sec per phase;
- Typical green time for the through movement was 35 sec long;
- Yellow and all-red for the through phase was 7 sec long;

- Ideal saturation flow was 1900 pcphpl;
- The PHF was 0.9; and
- D was 0.6.

We also calculated capacities for cases where the through movement receives a longer green time of 50 sec and show those values below. This could be the case at a meeting of an important boulevard with a less important major thoroughfare, minor thoroughfare, or local street. Note that if the through movement on the boulevard receives a longer green time the through movement for the intersecting street must receive a smaller green time, and capacity values are provided for those smaller green time cases below. It is not possible for both intersecting roadways to receive longer green times, or for one street to receive a longer green time and the other street to receive a typical green time.

LOS D, High Share of Green

Terrain	2 lanes ea direction	3 lanes ea direction	4 lanes ea direction
Level	34800	50600	68000
Rolling	34300	49800	67000
Mountainous	33900	49300	66300

LOS D, Typical Share of Green

Terrain	2 lanes ea direction	3 lanes ea direction	4 lanes ea direction
Level	23700	34800	47200
Rolling	23300	34300	46500
Mountainous	23000	33900	46000

LOS E, High Share of Green

Terrain	2 lanes ea direction	3 lanes ea direction	4 lanes ea direction
Level	36200	51800	69100
Rolling	35700	51000	68000
Mountainous	35300	50500	67300

LOS E, Typical Shared of Green

Terrain	2 lanes ea direction	3 lanes ea direction	4 lanes ea direction
Level	25500	36900	49500
Rolling	25100	36300	48800
Mountainous	24800	35900	48300

Reduced Conflict Boulevard

This facility is the street with the u-turn crossovers at a reduced conflict intersection, also known as a superstreet, synchronized street, restricted crossing u-turn intersection, or a j-turn intersection. The calculation is the same as for the boulevard, above, except that the signal of interest, where capacity is reached, is at the u-turn crossover and the typical green time for the through movement at that spot is 77 seconds.

LOS D, Typical Share of Green

Terrain	2 lanes ea direction	3 lanes ea direction	4 lanes ea direction
Level	38200	54700*	73000*
Rolling	37600	53900*	71900*
Mountainous	37200	53400*	71100*
* v/c exceeds 1.0 below 55 sec/veh delay, so LOS D and E demands are equal.			

LOS E, Typical Share of Green

Terrain	2 lanes ea direction	3 lanes ea direction	4 lanes ea direction
Level	38300	54700*	73000*
Rolling	37700	53900*	71900*
Mountainous	37300	53400*	71100*
* v/c exceeds 1.0 below 55 sec/veh delay, so LOS D and E demands are equal.			

Multilane Major Thoroughfare

This facility looks much like a boulevard, and the capacity calculation was just like that for the boulevard as described above. The tables for typical share of green time below are identical to those for a boulevard that receives a typical share of green time. The multilane major thoroughfare does not carry the high levels of long distance through traffic that the boulevard does, however, so it would never receive the high shares of green time shown in the tables above for the boulevard. In fact, where a multilane major thoroughfare intersects with a boulevard, the boulevard could well receive a high share of green time which means that this facility would receive a low share of green time, assumed as 20 seconds to create the tables below.

LOS D, Typical Share of Green

Terrain	2 lanes ea direction	3 lanes ea direction	4 lanes ea direction
Level	23700	34800	47200
Rolling	23300	34300	46500
Mountainous	23000	33900	46000

LOS D, Low Share of Green

Terrain	2 lanes ea direction	3 lanes ea direction	4 lanes ea direction
Level	12100	18400	25600
Rolling	11900	18100	25200
Mountainous	11700	17900	24900

LOS E, Typical Shared of Green

Terrain	2 lanes ea direction	3 lanes ea direction	4 lanes ea direction
Level	25500	36900	49500
Rolling	25100	36300	48800
Mountainous	24800	35900	48300

LOS E, Low Share of Green

Terrain	2 lanes ea direction	3 lanes ea direction	4 lanes ea direction
Level	14700	21600	29200
Rolling	14500	21200	28700
Mountainous	14300	21000	28400

Two-Lane Major Thoroughfare

In terms of capacity, this facility is identical to the multilane major thoroughfare described above except that it has just one through lane per direction.

LOS D, Typical Share of Green

Terrain	Capacity, vpd
Level	11600
Rolling	11400
Mountainous	11200

LOS D, Low Share of Green

Terrain	Capacity, vpd
Level	5400
Rolling	5300
Mountainous	5300

LOS E, Typical Share of Green

Terrain	Capacity, vpd
Level	12900
Rolling	12700
Mountainous	12600

LOS E, Low Share of Green

Terrain	Capacity, vpd
Level	7200
Rolling	7100
Mountainous	7000

Minor Thoroughfare

In terms of capacity, this facility is the same as the two-lane major thoroughfare as described above except that there is a shared through and right turn lane rather than an exclusive through lane.

LOS D, Typical Share of Green

Terrain	Capacity, vpd
Level	9200
Rolling	9100
Mountainous	9000

LOS D, Low Share of Green

Terrain	Capacity, vpd
Level	4400
Rolling	4300
Mountainous	4200

LOS E, Typical Share of Green

Terrain	Capacity, vpd
Level	10300
Rolling	10200
Mountainous	10000

LOS E, Low Share of Green

Terrain	Capacity, vpd
Level	5800
Rolling	5700
Mountainous	5600