

Appendix C

Cumberland Expressway Traffic Analysis and Methodology

Introduction

The traffic operational analysis was conducted using the capacity screening methodology from the *Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual* (NCHRP Report 825) to evaluate the potential for operational issues. Given that the volumes in the corridor appeared to be well below the capacity of the facility even in the highest volume areas, this screening approach was determined to be the most appropriate method for quickly and effectively determining if a detailed traffic operational analysis was needed.

Methodology

NCHRP Report 825 presents a service volume approach to examining capacity on freeways. The method uses information from the *Highway Capacity Manual 6th Edition* (HCM6) to develop peak hour directional volume thresholds for LOS A-C, LOS D, and LOS E. The relevant material for this approach is provided in **Figure 1**.

As outlined in the first yellow highlighted section of **Figure 1**, comparing the forecasted volume to a service volume capacity can highlight where capacity issues could be expected and where a detailed HCM6 analysis is warranted. The second highlighted section goes on to point out that comparing the volumes to a LOS threshold can be used to exclude sections from more detailed analysis. This screening analysis used the more conservative second approach and compared the projected 2045 volumes to the LOS D service volume threshold. It also examined the volumes to see if they fell in the LOS A through LOS C range.

The highlighted portion of the table in **Figure 1** shows the peak hour service volume thresholds for rural freeways in rolling terrain by LOS category. These values are based on an estimate of 12% trucks. The Cumberland Expressway has truck percentages that go as high as 21%, therefore, new lower thresholds were derived using this maximum segment percent trucks of 21%. The adjusted customized thresholds are presented in **Table 1**. These are vehicle per hour per lane volumes.

Table 1: Peak Hour Service Volume Thresholds

	Veh/hr/ln
LOS A-C	1,140
LOS D	1,400
LOS E	1,590

Traffic Operations Screening

While LOS E is the maximum capacity, for this analysis LOS D was selected as the “capacity” threshold to provide a conservative capacity test for further evaluation. The DHVs calculated for the corridor were compared to the LOS D threshold to determine if any segments warranted further analysis.

Figure 1: Page 45 from Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual (NCHRP Report 825)

4. Scoping and Screening Method

Generalized Service Volume Table

Whether or not a more detailed freeway facility analysis is needed can be determined by comparing the counted or forecasted peak hour or daily traffic volumes for the sections of the freeway between each on- and off-ramp to the values given in Exhibit 19. If all of the section volumes fall in the LOS E range or better, there will be no congestion spillover requiring a full facility analysis to better quantify the facility's performance. One can then use the HCM segment analysis procedures with defaults for some of the inputs to evaluate the performance of each segment. (Note that "segments" have a special definition in the HCM, while "sections" are defined in this Guide by the freeway on- and off-ramps.)

The service volumes in Exhibit 19 can also be used to quickly determine the geographic and temporal extent of the freeway facility that will require analysis. If the counted or forecasted volumes for a section fall below the agency's target LOS standard, then the section can be excluded from a more detailed analysis. If the volumes fall near or above the volume threshold for the agency's target LOS, then the section may require more detailed analysis.

Any section that exceeds the capacity values in Exhibit 19 will have queuing that may impact upstream sections and reduce downstream demands. In such a situation, a full freeway facility analysis is required to ascertain the freeway's performance. The facility analysis can be performed either using the HCM method with defaults, or the simplified HCM method, both of which are described later in this section.

The analyst may also use the capacities shown in Exhibit 19 to compute the peak hour, peak direction demand-to-capacity ratio for each segment under various improvement options. These options can then be quickly ranked according to their forecasted demand-to-capacity ratios for the critical sections of the freeway.

Exhibit 19. Daily and peak hour service volume and capacity table for freeways.

Area Type	Terrain	Peak Hour Peak Direction (veh/h/ln)			AADT (2-way veh/day/ln)		
		LOS A-C	LOS D	LOS E (capacity)	LOS A-C	LOS D	LOS E (capacity)
Urban	Level	1,550	1,890	2,150	14,400	17,500	19,900
Urban	Rolling	1,480	1,810	2,050	13,700	16,700	19,000
Rural	Level	1,460	1,770	2,010	12,100	14,800	16,800
Rural	Rolling	1,310	1,600	1,820	11,000	13,400	15,200

Source: Adapted from HCM (2016), Exhibit 12-39 and 12-40.

Notes: Entries are maximum vehicle volumes per lane that can be accommodated at stated LOS.

AADT = annual average daily traffic. AADT per lane is two-way AADT divided by the sum of lanes in both directions.

Urban area assumptions: Free-flow speed = 70 mph, 5% trucks, 0% buses, 0% RVs, peak hour factor = 0.94, 3 ramps/mi, 12-ft lanes, K-factor = 0.09, and D-factor = 0.60.

Rural area assumptions: Free-flow speed = 70 mph, 12% trucks, 0% buses, 0% RVs, peak hour factor = 0.94, 0.2 ramps/mi, capacity adjustment factor for driver population = 1.00, 12-ft lanes, 6-ft lateral clearance, K-factor = 0.10, and D-factor = 0.60.

Similar tables can be developed by adjusting input values to reflect other assumptions.

The K-factor is the ratio of weekday peak hour two-way traffic to AADT. The D-factor is the proportion of peak hour traffic in the peak direction.

The eastbound and westbound results are presented in **Table 2** and **Table 3** respectively. **Figure 2** and **Figure 3** graph the demand volume and the LOS D threshold service volume. Even using the LOS D threshold, the highest V/C ratio is 0.45 and all portions of the freeway are expected to operate at LOS C or better in 2045. A check was made for all of the ramp facilities as well to compare the ramp volumes to the capacity of a single lane ramp and no issues were identified, with the highest ramp volume reaching 990 vehicle per hour in 2045.

Table 2: Cumberland Expressway Eastbound Capacity Screening Analysis (2045 Volumes)

Segment Start	Segment End	Lanes	Speed Limit (mph)	2045 DHV (veh/hr, all lanes)	2045 DHV (pcphpl)	Max Capacity for LOS D (pcphpl)	V/C Ratio	LOS Estimate
I-65	KY 3600	2	70	1100	550	1400	0.39	LOS A-C
KY 3600	US 31E	2	70	1060	530	1400	0.38	LOS A-C
US 31E	KY 90	2	70	1250	625	1400	0.45	LOS A-C
KY 90	KY 1519	2	70	930	465	1400	0.33	LOS A-C
KY 1519	US 68 (Glasgow Rd)	2	70	730	365	1400	0.26	LOS A-C
US 68 (Glasgow Rd)	US 68 (Greensburg St)	2	70	620	310	1400	0.22	LOS A-C
US 68 (Greensburg St)	KY 61	2	70	580	290	1400	0.21	LOS A-C
KY 61	KY 55	2	70	750	375	1400	0.27	LOS A-C
KY 55	US 127	2	70	750	375	1400	0.27	LOS A-C
US 127	KY 910	2	70	700	350	1400	0.25	LOS A-C
KY 910	KY 80	2	70	670	335	1400	0.24	LOS A-C
KY 80	KY 914	2	70	930	465	1400	0.33	LOS A-C
KY 914	US 27	2	70	550	275	1400	0.20	LOS A-C

Note: veh/hr = vehicles per hour; pcphpl = passenger cars per hour per lane; LOS = Level of Service; V/C = volume to capacity

Table 3: Cumberland Expressway Westbound Capacity Screening Analysis (2045 Volumes)

Segment Start	Segment End	Lanes	Speed Limit (mph)	2045 DHV (veh/hr, all lanes)	2045 DHV (pcphpl)	Max Capacity for LOS D (pcphpl)	V/C Ratio	LOS Estimate
US 27	KY 914	2	70	550	275	1400	0.20	LOS A-C
KY 914	KY 80	2	70	930	465	1400	0.33	LOS A-C
KY 80	KY 910	2	70	670	335	1400	0.24	LOS A-C
KY 910	US 127	2	70	700	350	1400	0.25	LOS A-C
US 127	KY 55	2	70	750	375	1400	0.27	LOS A-C
KY 55	KY 61	2	70	750	375	1400	0.27	LOS A-C
KY 61	US 68 (Greensburg St)	2	70	580	290	1400	0.21	LOS A-C
US 68 (Greensburg St)	US 68 (Glasgow Rd)	2	70	620	310	1400	0.22	LOS A-C
US 68 (Glasgow Rd)	KY 1519	2	70	730	365	1400	0.26	LOS A-C
KY 1519	KY 90	2	70	930	465	1400	0.33	LOS A-C
KY 90	US 31E	2	70	1250	625	1400	0.45	LOS A-C
US 31E	KY 3600	2	70	1060	530	1400	0.38	LOS A-C
KY 3600	I-65	2	70	1100	550	1400	0.39	LOS A-C

Note: veh/hr = vehicles per hour; pcphpl = passenger cars per hour per lane; LOS = Level of Service; V/C = volume to capacity

Figure 2: Eastbound 2045 Per Lane DHVs Compared to LOS D Service Volume Threshold

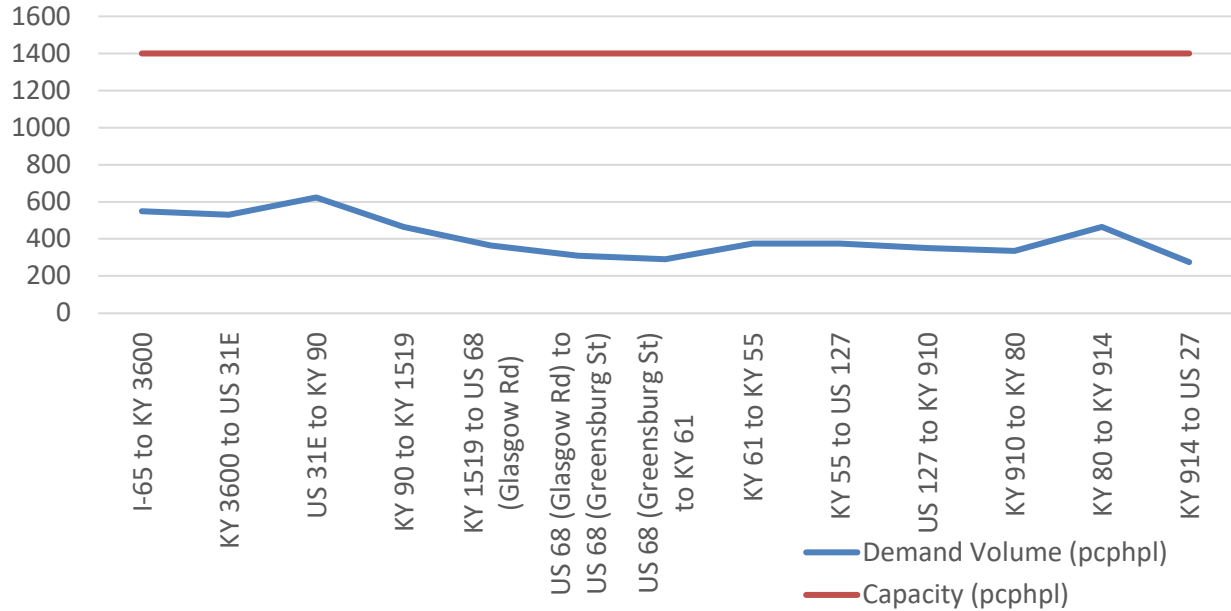
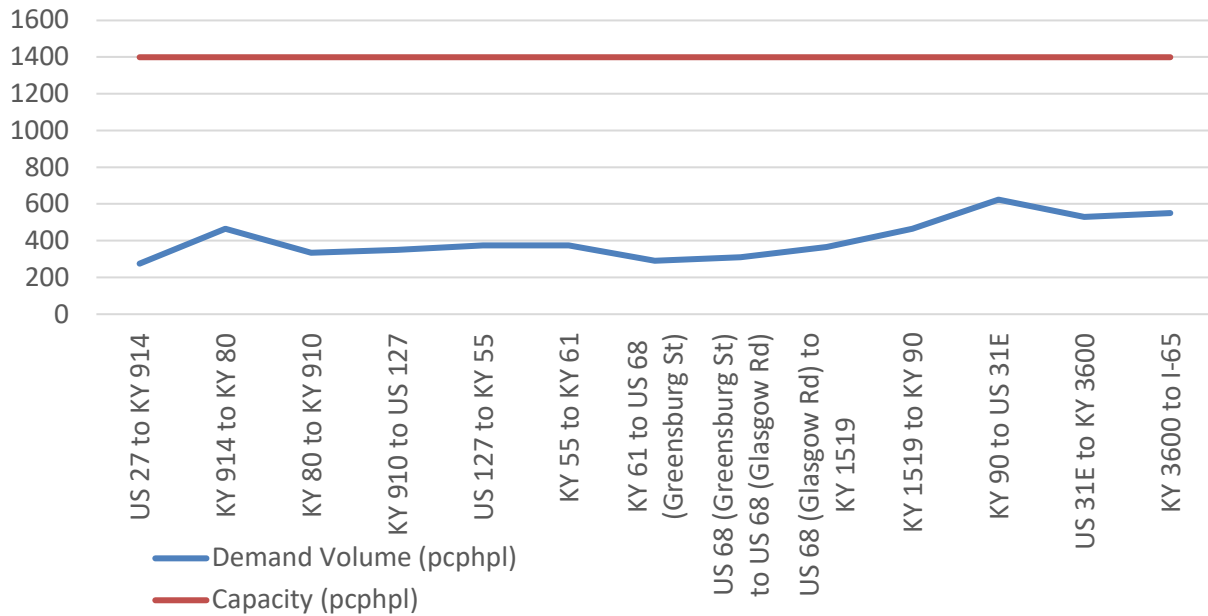


Figure 3: Westbound 2045 Per Lane DHVs Compared to LOS D Service Volume Threshold



Conclusions

Based on the screening analysis it was determined that a more detailed highway capacity analysis was not necessary.