

**ANALYSIS OF LEVEL OF SERVICE F IN THE 2010 HCM AND BEYOND
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ABSTRACT

For a variety of reasons, it has been challenging for traffic professionals to develop performance measures for level of service F (congested) conditions and to describe the traffic congestion in terms that are well understood by decision-makers and the public. This paper will provide a status report on the current state of the practice with respect to this issue, including the following topics:

- ◆ Treatment of level of service F in the 2010 Highway Capacity Manual
- ◆ Current and historical efforts by transportation professionals to describe the severity of traffic congestion
- ◆ Techniques used to compare different alternatives under congested traffic conditions
- ◆ Differences in analysis of congested traffic conditions in an operational versus a planning environment
- ◆ The role of traffic simulation
- ◆ New research efforts that will address the issues above

The paper is based on the author's experience in dealing with this issue on practical applications, his experience as a member of the TRB Highway Capacity Committee, and his role as a panel member on NCHRP Project 7-22 (Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual), which is addressing level of service F for planning considerations.

INTRODUCTION

The concept of level of service was first introduced in the 1965 Highway Capacity Manual (1). Levels of service were rated from A to F with level of service A referring to uncongested conditions with light traffic and minimal delays. Level of service F indicated congested conditions with high levels of delay. At that time, level of service F was considered something to be avoided and if it was encountered, the typical action was to take steps to avoid or alleviate the capacity shortfall.

More recently, congested traffic conditions represented by level of service F have become more accepted in our society due to a number of factors:

- ◆ Decreasing amounts of funding for roadway projects in comparison to traffic growth
- ◆ Resistance to roadway widening due to right-of-way, local opposition, and environmental impacts
- ◆ Preferences for alternative transportation modes (transit, bicycling, walking)

The focus on level of service F conditions has changed. The previous issues were:

- ◆ Where is level of service F occurring (or going to occur)?
- ◆ How do we fix it?

Increasingly, these questions are being replaced by the following:

- ◆ How severe is the level of service F condition?
- ◆ If all of the proposed alternatives produced level of service F, which alternative produces the “best” level of service F?
- ◆ Is the level of service F that occurs with the project significantly better or significantly worse than the level of service without the project?
- ◆ If level of service F is occurring (or expected to occur) for roadway traffic, is there a transit alternative available in the same corridor?

Given the interest in reporting the severity of level F, the remainder of this paper provides insight into the state of the practice of transportation engineering in analyzing level of service F and possible future advances in this area.

CURRENT METHODS TO DEAL WITH LEVEL OF SERVICE F

Some of the current methods to deal with the reporting of the severity of level of service F include the following:

- ◆ Report volume to capacity ratios over 1.0 and use volume to capacity ratio as a measure of severity. This is common practice when capacity is easily calculated such as a table of roadway segments based on Average Daily Traffic (ADT) or in certain capacity procedures such as the Intersection Capacity Utilization (ICU) methodology.
- ◆ Report the average delay to vehicles and use average delay as a measure of severity. For example, many highway capacity software tools such as Synchro and the Highway Capacity Software (HCS) produced by McTrans will report a delay value for signalized intersections at level of service F.
- ◆ Provide an estimate of the length that the level of service F conditions would persist and use the length of time as a measure of severity. For example, some Caltrans Districts use F1, F2, and F3 to represent an estimate of level of service and the number of hours level of service F conditions would last. The length of time of the level of service F conditions is estimated based on volume to capacity ratio.
- ◆ Calculate the length of time that level of service F exists based on analysis of hours adjacent to the peak hour. In an operational analysis, the user can extend the analysis from the peak hour to hours adjacent to the peak hour with lower traffic levels. This analysis can ultimately lead to an estimate of the number of hours the facility would have to operate at capacity (i.e. level of service F) in order to accommodate all of the traffic demand.
- ◆ Assign letter grades beyond F to describe the level of severity (i.e. of service G is worse than level of service F and level of service H is worse than level of service G). This methodology is used in the Synchro signal timing program with the ICU methodology as the basis for level of service determination.
- ◆ Provide an estimate of the maximum length of queue that would occur due to the level of service F condition.

The next section of the paper looks at guidance from the 2010 Highway Capacity Manual (2) in comparison to these commonly-used procedures for reporting level of service F conditions.

THE 2010 HCM: OPERATIONS ANALYSIS

In an operational analysis as defined in the HCM, analysts who are interested in the severity of level of service F are guided to the following methodology: calculate the length of the level of service F condition based on analysis of hours adjacent to the peak hour where traffic levels are lower. This procedure can be summarized as follows:

- ◆ Conduct a peak hour analysis that results in a level of service F condition.
- ◆ Determine the capacity of the facility and the excess vehicles that would need to be accommodated in hours adjacent to the peak hour.

- ◆ Get traffic counts or forecasts for the hours adjacent to the peak hour and expand the length of the study period until all of the traffic demand can be accommodated with the capacity provided during the study period.
- ◆ Use measures of effectiveness for the entire study period to provide an indication of the severity of the level of service F condition.

It should be noted that some HCM procedures can produce a level of service F result with traffic levels below capacity. In these cases, the procedure summarized above would not apply.

THE 2010 HCM: PLANNING ANALYSIS

In previous versions of the HCM, no additional guidance was given for planning applications. The only option would have been to apply the procedure described above using default values applicable to a planning environment.

The 2010 HCM provides support for the use of volume to capacity ratios for planning applications. Therefore, analysts who use volume to capacity ratio to describe level of service F conditions can claim to be consistent with the HCM.

EVALUATION OF THE STATE OF THE ART

A comparison of the commonly-used methods to describe the severity of level of service F and the guidance given in the 2010 HCM leads to the following observations:

- ◆ Use of volume to capacity ratio to report the severity of level of service F is a commonly-used technique that is supported by the 2010 HCM in planning applications. However, the 2010 HCM provides less support for using volume to capacity ratios in operations applications. In order to use volume to capacity ratio, the user needs to define a capacity for the facility under analysis. For some facilities (for example basic freeway segments) the capacity value is a direct output of the capacity analysis. For other facilities (signalized intersections using the HCM operations methodology), capacity of the facility is not a direct output of the procedure and analysts must conduct further investigations or use alternate procedures to produce a volume to capacity ratio.
- ◆ Use of average delay values to report the severity of level of service F is not encouraged in the 2010 HCM, since a multiple-period analysis is recommended for congested conditions.
- ◆ Estimations of the length of time that level of service F conditions will occur or the maximum length of queue are supported in the 2010 HCM if the calculations are based on a multiple-period analysis, but this can be a very time-consuming procedure. Furthermore, maximum queue lengths in a planning context often extend to huge queue lengths, beyond any reasonable expectation of queue based on practical experience.

- ◆ The 2010 HCM does not support the use of levels of service beyond F (level of service G, level of service H, etc.).

In an overall evaluation, the user who wishes to follow the guidance of the 2010 HCM has the following options for reporting the severity of level of service F:

- ◆ Use volume to capacity ratios, especially in a planning context.
- ◆ Use length of level of service F condition or maximum back of queue, if these measures of effectiveness can be supported by appropriate calculations.

Difficulties experienced in the current way of handling level of service F include the following:

- ◆ There is a lack of consistency in reporting the severity of level of service F.
- ◆ Users who wish to use volume to capacity ratio sometimes experience difficulty in calculating a capacity for the facility under study.
- ◆ Use of average delay values is not well supported by the 2010 HCM.
- ◆ Use of length of level of service F condition and maximum back of queue can be time-consuming to calculate and maximum back of queue can result in unrealistic values that are not practical or believable.

BEYOND THE 2010 HCM

The Transportation Research Board's Highway Capacity Committee (responsible for the development of the 2010 HCM) has provided some insight in to the issues raised above (at least for planning applications) in an unpublished paper (3). However, this paper provides comments and recommendations that have not fully been incorporated into the 2010 HCM.

A more promising development (again for planning applications) is the recent initiation of National Cooperative Highway Research Program (NCHRP) research into some of the issues raised above. NCHRP 7-22, Planning and Preliminary Applications Guide to the Highway Capacity Manual, is expected to be under way soon and includes research into the reporting of level of service F in a planning environment.

REFERENCES

- (1) *Special Report 87: Highway Capacity Manual*. Highway Research Board, National Research Council, Washington, D.C., 1965.
- (2) *Highway Capacity Manual*. Transportation Research Board, National Research Council, Washington, D.C., 2010.
- (3) *HCM 2000 Planning and Preliminary Engineering Audit*, 2003.

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