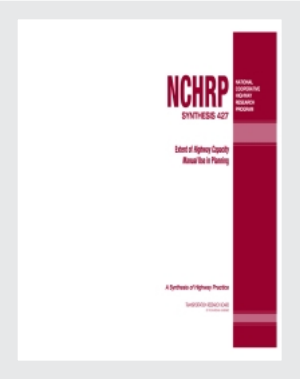

Extent of Highway Capacity Manual Use in Planning

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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Extent of *Highway Capacity Manual* Use in Planning

A Synthesis of Highway Practice

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FOREWORD

Highway administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to highway administrators and engineers. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire highway community, the American Association of State Highway and Transportation Officials—through the mechanism of the National Cooperative Highway Research Program—authorized the Transportation Research Board to undertake a continuing study. This study, NCHRP Project 20-5, "Synthesis of Information Related to Highway Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an NCHRP report series, *Synthesis of Highway Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Jon M. Williams
Program Director
Transportation
Research Board

The *Highway Capacity Manual* (*HCM*), a publication of the Transportation Research Board, is used for a variety of transportation facility and traffic engineering applications. This study reports on the current use of the *HCM* in transportation planning by federal, state, regional, and local agencies. The scope includes performance monitoring, problem identification, project prioritization, programming, and decision-making processes.

Information was gathered through a literature review, a survey of selected agencies, and in-depth interviews.

Richard G. Dowling and Aaron Elias of Kittelson & Associates, Oakland, California, collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

EXTENT OF *HIGHWAY CAPACITY MANUAL* USE IN PLANNING

SUMMARY

The purpose of NCRHP 20-05 (Topic 42-10) is to assess how state departments of transportation, small and large metropolitan planning organizations, and local governments are using or could use the *Highway Capacity Manual* (*HCM*) for planning analyses, or more specifically, for performance monitoring, problem identification, project prioritization, programming, and decision-making processes. Past efforts to extend and adapt the 2000 and 2010 editions of the *HCM* to planning analyses were reviewed. A survey methodology was then developed to identify practitioners' perspectives on the key constraints and needs for adapting the *HCM* to planning analyses. A web-based survey instrument was created using a web-based survey tool. A total of 31 individuals at federal, state, and local planning agencies and consulting firms were invited to participate in the web survey. These agencies were selected to obtain a cross section of planning practices in the United States. Several reminders were sent to each invited participant. Participants were contacted following the initial online survey to probe in more depth and to obtain a better understanding of their responses. Twenty-three agencies responded for a response rate of 71%.

A total of 30 individuals at the 23 planning agencies and consulting firms responded to and completed the web survey. The key findings of the survey are highlighted here. Note that at the time this survey was conducted (January and February 2011), the respondents were familiar with the 2000 edition of the *Highway Capacity Manual*. The 2010 *HCM* did not come out until March 2011.

The responses showed varying levels of *HCM* use in planning:

- 13% of respondents have never used the *HCM* for any kind of short-range planning (6% have never used the *HCM* at all).
  - 40% have never used the *HCM* for performance monitoring.
  - 43% have never used the *HCM* for short-range bicycle/pedestrian planning.
- 20% of respondents have never used the *HCM* for any kind of long-range planning.
  - 47% have never used the *HCM* for long-range bicycle/pedestrian planning.

Respondents had different levels of satisfaction with the *HCM* for planning:

- 67% of the respondents are satisfied or very satisfied with the *HCM* for land development decisions (site impact studies).
  - 63% to 77% are satisfied with the *HCM* for system and corridor planning.
  - Only 30% are satisfied with the *HCM* for bicycle and pedestrian planning.

The responses cited some major challenges to using the *HCM* for planning:

- 52% of the respondents agreed that one of the major challenges to using the *HCM* in planning is the lack of *HCM* analysis methods for advanced facility design and operation strategies such as high-occupancy vehicle/high-occupancy toll lanes, congestion pricing, and speed harmonization.

- A majority of respondents (>50%) *do not consider* the data requirements or complexity of the *HCM* to be a major challenge to using it in planning.

Respondents had several suggestions for improving the *HCM* for use in planning:

- The following are the top five preferred improvements to the *HCM*:
  - Development of an *HCM* Planning Applications Guide (77%)
  - Addition of travel time reliability performance measures to the *HCM* (63%)
  - Extension of the *HCM* to corridor and system analyses (63%)
  - Better integration of *HCM* analysis methods with travel demand models (60%)
  - Addition of systemwide planning measures of effectiveness such as vehicle-miles traveled, vehicle-hours traveled, person-miles traveled, and person-hours traveled (60%)

The 2010 *HCM* made several improvements designed to facilitate its use in planning applications:

1. Development of a multimodal approach to the analysis of urban streets and intersections
2. Inclusion of methods to predict capacity, speed, and travel time in each operations analysis chapter
3. The provision of service volume tables for freeway and urban street facilities
4. Guidance on constructing agency-specific service volume tables
5. The provision of recommended default values for difficult-to-obtain input data.

Although these improvements facilitated the use of the *HCM* in planning applications, they were not among the top five improvements identified in the survey.

One item that came out of the survey that is pertinent to the 2010 *HCM* is the request that the *HCM* be extended to corridor and system analyses. The 2000 *HCM* had some rudimentary methods (Chapter 29) for extending the *HCM* to corridor and system analyses, but the corridor method saw little or no use, requiring software implementation to make it practical for planning applications. There was also some discussion in the committee deliberations to the effect that microsimulation could be the appropriate tool for corridor analyses (although probably not feasible for planning analyses). Consequently, the macroscopic *HCM* corridor method was dropped from the 2010 *HCM*.

Some chapters were dropped between editions. Chapter 30 of the 2000 *HCM* provided guidance to demand modelers on how *HCM* capacities and speeds could be approximated in travel demand models. This chapter was dropped from the 2010 *HCM* because travel demand modelers were unlikely to refer to the *HCM*, a predominantly operations-oriented reference, for guidance on the planning applications of the *HCM*. The 2000 *HCM* had a chapter on corridor and areawide performance measures (Chapter 28), which also was dropped from the 2010 *HCM* because it was decided that the new edition would not address corridor and areawide analyses.

Several steps were taken to facilitate application of the 2010 *HCM* in planning studies; however, much more can be done. Indeed, the top five requests from the survey still remain to be completed. A Planning and Preliminary Engineering Applications Guide (PPEAG), for instance, would be a useful adjunct to the *HCM*, facilitating its use in planning analyses and increasing the accuracy and reliability of the traffic performance results predicted by planning studies.

HCM analyses require data on facility operating characteristics that are often difficult to obtain and not available at the planning and preliminary engineering stages of project development. The use of default values, representative of typical facility design and operations, enables *HCM* methods to be used in planning and preliminary engineering. *NCHRP Report 599: Default Values for Highway Capacity Analyses,* some of which was incorporated into the 2010 *HCM*, can be a valuable source of content for the PPEAG.

There is a need for and value in adapting *HCM* procedures to better incorporate them into existing system and corridor demand modeling tools, such as travel demand models. Additional research is needed to develop the methodological adaptations to incorporate improved *HCM* capacity analysis and performance procedures into conventional travel demand models and into advanced models using dynamic traffic assignment. Once the basic research is completed, the results can then be codified in a series of recommended procedures in the PPEAG.

CHAPTER ONE

INTRODUCTION

STUDY OBJECTIVE

A primary application of the *Highway Capacity Manual* (*HCM*) by transportation agencies is to assess current conditions and the effect of proposed improvement projects on capacity and quality of service. However, the *HCM* does not address how its results should be used in performance monitoring, problem identification, project prioritization, programming, and decision-making processes. Nor does it consistently provide measures that highway agencies need for this purpose. For example, transportation agencies might wish to use *HCM* results to rank proposed projects by delay reduction (expressed in vehicle-hours or person-hours) or by delay reduction per dollar of construction cost. In decision making, transportation agencies might choose to value delay reduction differently within different levels of service. All existing and future *HCM* methodologies could be reviewed and improved to ensure that they provide the performance measures transportation agencies need.

The objective of this project is to assess how state departments of transportation (DOTs), metropolitan planning organizations (MPOs), and local governments are using or could use the *HCM* for performance monitoring, problem identification, project prioritization, programming, and decision-making processes. The FHWA will be included in this information collection.

WORK PLAN

The study objective was accomplished through the following tasks.

Task 1: Review *HCM* Performance Measures for Planning Applications

The 2010 *HCM* and other literature were reviewed to identify the performance measures and planning applications for which the *HCM* currently provides a satisfactory method of evaluation. The focus was on the utility of the current *HCM* for performance monitoring, problem identification, project prioritization, programming, and decision-making processes. The review was then extended to consider the potential planning applications of the *HCM* and the feasibility of modifying or extending *HCM* methods to better serve those applications.

Task 2: Develop Survey Instrument

Since performance measures are a major topic that has been the subject of several research efforts, the survey instrument did not attempt to identify the prevalence or value of different performance measures to the survey subjects. The project instead relied on the literature review to generate an overview of current planning performance measure usage and value to planning practices. The survey instrument instead focused on current use of *HCM* methods in planning and obstacles to the fuller use of *HCM* methods in planning.

A draft web-based survey was created to facilitate data collection. The objective of the survey instrument design was to obtain as much accurate information as possible relevant to the project objective without requiring the survey subject to spend more than 15 minutes filling out the survey form.

The web-based form of the survey instrument was submitted for pretesting by designated staff at panel member agencies. The survey instrument was then revised based on the results of pretesting and was shortened as necessary to stay within an average 15-min response time for subjects.

Task 3: Identify Survey Subjects

A sample of state DOTs, MPOs, and local governments was identified to find interested parties to participate in this study. The objective was to obtain valid responses from 20 of 24 agencies surveyed.

Task 4: Conduct Survey/Interviews

Survey subjects were contacted to participate in the web survey and given a 2-week period to respond. Reminders were sent toward the end of the period, and one more contact attempt was made to secure a response from the missing subjects. At the end of 3 weeks, the survey was considered complete (as far as the initial list of survey subjects was concerned). The number of responses was then reviewed to determine if a sufficient number and cross section of respondents had been obtained. Additional survey subjects were identified as necessary to obtain the target cross section and number of responses.

Task 5: Compile Results

The responses received were checked for reasonableness. Subjects were contacted to resolve unclear or contradictory responses and to fill in missing responses. Follow-up phone calls or e-mails were made to those respondents to flesh out and better understand the context of their responses regarding the primary obstacles to using the *HCM* in planning practice. These follow-up interviews were used to identify the most commonly used *HCM* and non-*HCM* performance measures, and to identify other desired measures used by state and local agencies. The results were then summarized in simple graphic or tabular format.

Task 6: Prepare Final Report

A first draft, a second draft, and a final project report were prepared, along with written responses to panel comments on the first and second drafts. The project report documents the survey method, instrument, subjects, and results. The results were compiled and evaluated to arrive at conclusions regarding current and potential *HCM* usage in transportation planning practice.

CHAPTER TWO

REQUIREMENTS OF PLANNING

Planning is the formulation of a specific program, scheme, or method beforehand to accomplish a desired objective (*1*). In the United States, state and metropolitan transportation planning is a "cooperative process designed to foster involvement by all users of the system" that identifies a fundable program of transportation infrastructure improvements (*2*). The program of improvements is codified in one or more planning documents. State and local agencies then perform additional planning analyses and produce additional planning documents to deliver the transportation infrastructure improvements.

The *HCM* has long been a tool critical for the planning, programming, and preliminary engineering of highway improvement projects. The analysis methods described in the *HCM* can be used for some planning analyses without modification. However, for planning analyses that fall outside the narrow range of the *HCM*, it has been feasible to use only portions of the *HCM*. Analysts have had to make significant adaptations to the *HCM* methods to make it workable for planning applications because project planning, project programming, and preliminary engineering span a much larger range of conditions than those traditionally focused on within the *HCM*. The *HCM* primarily focuses on preliminary engineering applications, whereas planning covers a much broader range.

SPECTRUM OF TRANSPORTATION PLANNING PRACTICE

The term "transportation planning" covers a wide range of technical analysis situations (*3*). It includes regional planning to determine transportation system improvements needed in a 20- to 30-year time frame. It also includes a traffic impact analysis of a specific site development project that might be completed in less than a year.

Regardless of the breadth and depth of the planning analysis, almost all planning analyses require some kind of method to evaluate the traffic-carrying capacity provided by elements of the highway system and the effect of different demand levels on highway system performance. This is specifically true of mean travel time, speed, and delay. Capacity, speed, and delay are critical planning inputs for the calculation of the demand effects, economic effects, and environmental impacts of highway improvements and development.

Breadth of Transportation Planning

The FHWA briefing book on the transportation planning process (*4*) identifies the key planning documents that state, metropolitan, and local agencies must produce to qualify for federal funding of their transportation infrastructure improvements. Agencies, however, do a great deal more planning than just preparing documents per the federal requirements. The ITE *Transportation Planning Handbook* (*5*) identifies seven different planning application contexts:

1. Statewide Transportation Planning
2. Corridor Planning
3. Metropolitan Transportation Planning
4. Activity Centers and Site Impact Analysis
5. Rural Community and Tribal Planning
6. Transportation Terminals
7. Recreational Areas

Each of these application contexts results in one or more planning documents, often feasibility studies and transportation impact reports. State and local agencies also use these contexts to develop the documents needed to deliver transportation infrastructure improvement projects.

Finally, private sector and some public sector land development projects must secure the appropriate permits from one or more public agencies. The permitting process requires one or more planning documents, such as an environmental impact report, to support the permitting process.

Table 1 presents an overview of the federal, state, local, and private sector planning documents produced by state and local agencies. It shows the federally mandated and state-mandated planning documents that identify the planned transportation infrastructure improvements that must be prepared before a project can be funded. Additionally, it shows the project-specific documents required to deliver a public sector improvement project or to permit a private sector development project.

TABLE 1
KEY TRANSPORTATION PLANNING PRODUCTS OF STATE DOTS, MPOS, AND LOCAL AGENCIES

	Who Prepares?	Geographic Scale (up to)	Time Horizon	Update
Pre-Project Delivery, General Planning Documents				
MTP/LRTP	MPO	1,000s of sq. miles	20+ years	Every 4–5 years
TIP	MPO	1,000s of sq. miles	4+ years	Every 4 years
CMP	CMA/MPO	1,000s of sq. miles	Varies	Every 4 years
LRSTP	State DOT	10,000s of square miles	20+ years	Not specified
STIP	State DOT	10,000s of square miles	4+ years	Every 4 years
EIS/EIR	All	Varies	Varies	Per plan
CP/GP	Local agencies	10s of sq. miles	10–30 years	Every 10 years
CIPs	Local agencies	10s of sq. miles	5 years	Every year
Public/Private Sector Project Development and Delivery Documents				
PDD	State DOTs, Local agencies	Project specific	Varies	Per project
DPD	Local agencies	Project specific	Varies	Per project

Expanded/adapted from Figure 2, FHWA Transportation Planning Process.
MTP/LRTP = Metropolitan Transportation Plan/Long-Range Transportation Plan (may be supported with special corridor, scenario planning, and other studies); TIP = Transportation Improvement Program; CMP = Congestion Management Process/Plan/Program; LRSTP = Long Range Statewide Transportation Plan; STIP = Statewide Transportation Improvement Program; EIS/EIR = Environmental Impact Study/Environmental Impact Report; CP/GP = local agency Comprehensive or General Plan; CIP = Capital Improvement Program; MPO = metropolitan planning organization; CMA = Congestion Management Agency, which may be the MPO; PDD = project delivery documents (e.g., EIR, EIS, design plans); DPD = private/public land development permitting documents (e.g., EIR).

Pre-Project Delivery, General Planning Documents

The pre-project delivery general planning documents produced by state and local agencies are listed in an agency's Unified Planning Work Program or the State Planning and Research Program. These planning documents include the Metropolitan or Long-Range Transportation Plan (MTP or LRTP), the State Long-Range Transportation Plan (SLRTP), the Transportation Improvement Program (TIP), the State Transportation Improvement Plan (STIP), the Comprehensive or General Plan (local agencies), the Capital Improvement Program (local agencies), and the environmental impact statements and reports that go along with those planning documents. These documents may be supplemented with corridor studies, scenario planning studies, and other specialized planning and preliminary engineering studies.

The Unified Planning Work Program and the State Planning and Research Program list the transportation studies and tasks to be performed by the agency. These programs have a 1- to 2-year time horizon and are required to be updated annually.

The MTP or LRTP and the SLRTP describe the long-range and short-range program strategies and actions that will meet the agency's transportation system goals and objectives. These plans apply to entire regions covering all highway and transit systems within several thousands of square miles, for a 20-year horizon. They are required to be updated every 4 to 5 years. They may be supported by special public participation plans, state implementation plan conformity findings, scenario planning studies, interchange modification request reports, congestion management plans, and corridor system management plans. Agencies also undertake many less formal planning activities that do not result in specific documents.

The local TIP and the STIP identify the transportation projects and strategies from the LRTP or SLRTP that the agency plans to undertake over the next 4 years. The TIP/STIP is an agency's way of allocating its limited transportation resources among the various capital and operating needs of the area, based on a clear set of short-term transportation priorities. All projects receiving federal funding must be in the TIP/STIP. Under federal law, the TIP and STIP cover a minimum 4-year period of investment and are updated at least every 4 years. They must conform to the state implementation plan for air quality in nonattainment and maintenance areas.

Each of the agency's planning documents must include an environmental clearance document. Environmental clearance documents are also part of the agency's project delivery documents, which will be discussed in more detail.

Local agencies prepare Comprehensive or General Plans to address how the community plans to develop its infrastructure to support expected growth. The time horizon is usually buildout of the community, often a 20- to 30-year time frame.

The local agency Capital Improvement Program lists the major projects that the agency plans to implement in the next few years. These programs cover planned infrastructure investments over a 5-year period and are usually updated annually.

Project Delivery Documents

The general planning documents lay the groundwork for state and local agencies to deliver transportation infrastructure projects. This is accomplished through a series of project delivery documents that are produced at each stage of the project development process. The major stages of project development are identification of project need; project initiation; project clearance; project plans, specifications, and estimates; and finally project construction. (See Figure 1 for more details.) The *Caltrans Project Development Procedures Manual* (*6*) describes one example of the typical stages of the project development life cycle. The transportation system performance is continuously monitored to feed back into the agency's continuing planning process (adapted from Dowling [*7*]).

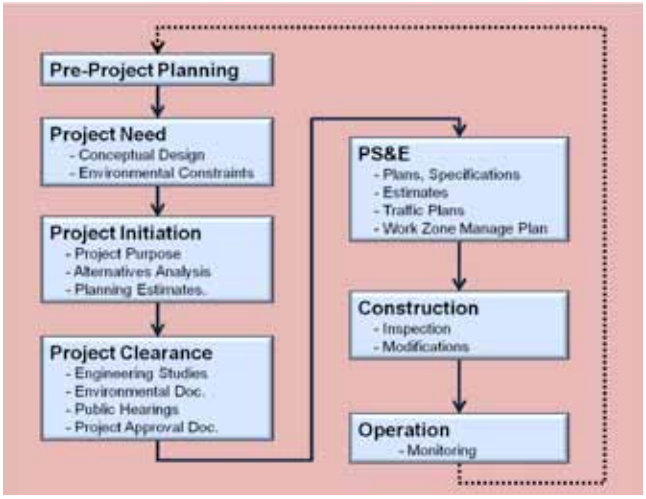

FIGURE 1 Project development life cycle. [*Source*: (*7*)].

The steps listed in Figure 1 are general terms that may not be used by all agencies. Many agencies will have different terminologies for a project's life cycle.

Pre-Project Development Planning

Even without a specific project in mind, planning processes are continuous. General planning documents such as the MTP or LRTP are created as part of the continuing planning process.

Identification of Project Need

Project needs are usually identified through one or more planning studies. At this stage of the project development process, the agency will review the planning studies, reports, and plans that identified the need for the project. It will identify potential environmental constraints and define the problem that the project will address. It will then establish a project development team, prepare a traffic concept report, develop concept geometrics for the project, and obtain public/local agency input. At this point, the project need is well defined, but the project itself is not yet defined in any great detail.

Project Initiation Document

Depending on specific agency policies and procedures, at this stage the agency will prepare a formal project initiation document. This document usually defines the need and project purpose, develops concept alternatives, presents a value engineering analysis of project alternatives, identifies potential design exceptions, presents planning estimates, and provides a preliminary environmental evaluation. The product of this stage is the Project Initiation Document. Higher-level project details start to emerge at this stage.

Project Clearance Documents

At this stage, the Project Clearance documents are prepared. Engineering studies, project control surveys, environmental scoping, and environmental studies are performed. Public hearings are held on the environmental document, responses to comments are prepared, and a preferred project alternative is selected. The products of this stage are typically the Draft and Final Project Approval Report, and the Draft and Final Environmental Document.

Plans, Specifications, and Estimates

Project plans, specifications, and estimates are prepared at this stage. These include the traffic plans and the work zone traffic management plan to be employed during construction. All traffic analysis is complete at this stage.

Contract/Construction

The final stage of the project development process is the contracting and construction of the project. Supplemental traffic analysis may be performed at this stage to address issues that arise during construction. The agency's inspectors ensure that the contractor correctly implements the traffic plans and the construction traffic management plan.

Project Operation

Although not strictly part of the project development process, monitoring project operation after opening will enable the agency to discover whether the project operates as predicted by the traffic analyses conducted during the project development process. Lessons learned from monitoring project operations can be used to improve the traffic analyses performed during a future project development process.

Land Development Permitting Documents

Land development permitting documents include environmental impact reports, conditions of approval, Comprehensive or General Plan amendments, zoning, permits, and project construction plans. The time frame and geographic scale of the planning analysis vary by development project.

The level of detail required in the transportation analysis is equivalent to that of transportation infrastructure project delivery by the public agency.

In the land development permitting process, the developer (or project sponsor) is responsible for most of the stages of the project development process shown in Figure 1. The public agency becomes involved primarily in Stage 3, the Project Clearance Stage. At this stage, the environmental clearance and permitting documents are prepared. Once the permits are secured, the developer takes care of the remaining stages (construction and operation), with monitoring/inspection of these latter stages by the public agency.

PERFORMANCE ANALYSIS REQUIREMENTS

The local, regional, and statewide planning documents required before initiating a transportation infrastructure improvement project all require a higher geographic level, longer time horizon, and a more comprehensive traffic performance analysis than is required during the actual stages of project development or land development permitting. Systemwide network performance measures are required, including mapping of system hot spots. In turn, as the agency proceeds through the project development or land development permitting process, each stage requires an increasingly detailed and focused level of traffic analyses. Less is known about the project design and its likely opening date at the early stages of the process. As the various stages of the process are completed, more becomes known about the project design and its likely opening date. Thus, at the start, the traffic analysis must be more general, consider more alternatives, and employ more assumptions than at later stages of project development (see Figure 2).

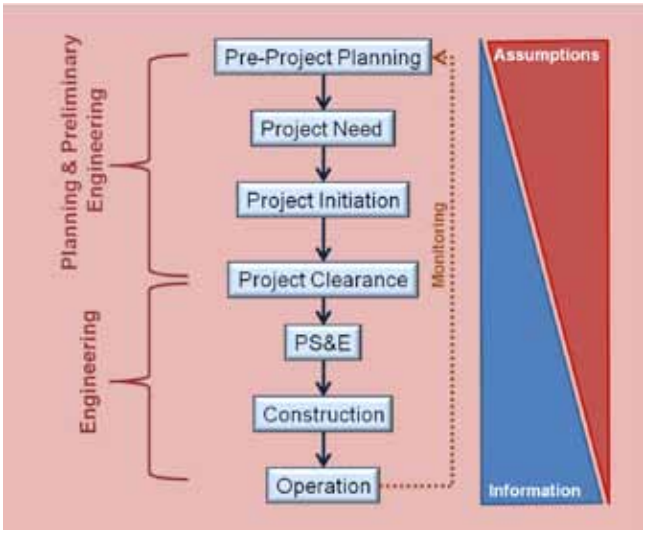

FIGURE 2 Information versus assumptions during project life cycle. [*Source*: (*7*)].

Table 2 highlights the traffic analysis requirements and typical analysis tools for each planning document and stage of the project delivery and development permitting process.

Pre-Project Development

Before project development begins, the transportation analyses need to be able to focus on system effects and the identification of problem segments (hot spots) in the transportation system. Demand effects of infrastructure improvements,

TABLE 2
TRAFFIC ANALYSIS NEEDS OF KEY PLANNING PRODUCTS AND STAGES OF PROJECT DEVELOPMENT

Pre-Project Development, General Planning Documents				
	Scale	**Horizon**	**Analysis Needs**	**Analysis Tools**
MTP/LRTP LSRTP/CMP CP/EIS/EIR	Systemwide	10–30 years	System and segment travel time and demand effects of congestion	Travel demand models, sometimes supported with mesoscopic and microscopic simulation models
TIP/STIP/CIP	Systemwide	4 years	Evaluated as part of longer range plan (e.g., MTP/LRTP)	Same as for MTP/LRTP
Stage of Project Development				
	Scale	**Horizon**	**Analysis Needs**	**Analysis Tools**
Initiation/Need	Facility	10–30 years	System and segment v/c	Travel demand model
Project Clearance and Development Permitting	Facility	1–30 years	Segment and intersection v/c, queue, level of service	Travel demand model *HCM*-based tools Simulation
PS&E	Facility	1–2 years	Traffic handling plans	*HCM*-based tools
Construction	Facility	1–2 years	Monitoring queues, delays, safety	*HCM*-based tools
Operations	Facility	Real time	Monitoring queues, delays, safety	Optimization tools using *HCM* methods

EIR = Environmental Impact Report; v/c = volume/capacity; PS&E = plans, specifications, and estimates.

especially route shifting, are a significant concern. The analysis tools must be highly efficient to generate segment-level results for a large transportation network in a practical amount of time, relying on relatively simple data for each segment of the network.

Currently, the *HCM* is not well suited to this task, although travel demand modelers have made several adaptations on their own to employ pieces of the basic *HCM* methods in their transportation network analyses. They have replaced the *HCM*'s complex capacity calculations and travel time estimation procedures with capacity look-up tables and monotonically decreasing speed flow curves. The form of the speed flow curve is selected to ensure that the traffic assignment process in the demand model will always reach closure (equilibrium).

The performance measures required at this level of analysis are system performance measures such as person- and vehicle-miles traveled (PMT and VMT), person- and vehicle-hours traveled (PHT and VHT), mean speed, and person- and vehicle-hours of delay (PHD and VHD). Intersection (point) and segment volume/capacity (v/c) ratios are also used to indicate system problem spots.

Project Initiation and Purpose

During the early stages of project development, primarily planning analyses are performed. These stages are characterized by a lack of specificity as to the project details. Many alternatives must be considered, and the agency is concerned about system effects on both demand and performance. In many cases, the results of previous planning analyses used to develop the long-range transportation plan are used to develop the information necessary to identify the project need and purpose, rather than performing new analyses for these early stages.

Project Clearance

At Stage 3, planning analyses start to intersect and overlap with engineering analyses. This may be labeled preliminary engineering. Project details have still not been finalized at this stage, but the outcome of this stage will produce the final project details before actual design begins. Because system effects are still a concern at the project clearance stage, travel demand models (which model demand effects well, but performance effects poorly) are often paired with the *HCM* (which does not model demand effects, but is better at performance effects). Where significant system congestion effects are a concern, a simulation model (which can handle system congestion better than the *HCM*) is used in lieu of the *HCM*.

At this stage, system performance measures (PMT, VMT, PHT, and VHT) are useful outputs for use in air quality analyses, including sustainability, climate change, and greenhouse gas emission analyses. Segment speeds and segment VMT are useful for noise analyses. Intersection delays and intersection v/c ratios are useful for level-of-service (LOS) analyses. The land development permitting transportation analyses are equivalent to the Stage 3 Project Clearance analyses described earlier.

Later Stages of Project Development

The later stages of project development—plans, specifications, and estimates; construction; and operation—all involve engineering analyses. At this point all project details are finalized and the project is constructed and operated.

The traffic analyses are much more detail oriented. During design and construction, quick-response methods are needed to quickly address specific design and construction traffic-handling issues. The *HCM*, with the use of some rules of thumb, is employed in these stages. During operation, the optimization of traffic signal controls becomes a key concern.

CHAPTER THREE

SUITABILITY OF THE *HIGHWAY CAPACITY MANUAL* FOR PLANNING

The 2000 and 2010 *HCMs* have various chapters and sections devoted to planning applications of the *HCM*. The *HCMs*' approach to dealing with planning applications has varied over the years. Various investigators have also attempted to better apply the *HCM* in planning through the development of methodologies, default values, and software.

HIGHWAY CAPACITY MANUAL, 2000 EDITION

The *HCM* 2000 included three chapters devoted to planning analyses of corridors and areas (*8*). In addition, the *HCM* 2000 had a planning method for evaluating isolated intersection volume/capacity ratios.

Chapter 28 provided recommended performance measures for the evaluation of systems of facilities. It identified six dimensions of system performance: quality of service, intensity of congestion, duration of congestion, extent of congestion, variability, and accessibility. It also introduced the system performance report card concept.

Chapter 29 developed a recommended method for combining *HCM* segment and point analysis methods into a corridor analysis procedure.

Chapter 30 recommended various procedures to enhance the accuracy with which travel demand models represent the capacity and performance of highway facilities. The recommended capacity and free-flow estimation methods are adaptations of the more complex *HCM* methods to facilitate their application in a planning analysis. The data requirements are designed to utilize the general facility characteristics data that are typically available in regional planning applications.

A "Quick Estimation Method for Signalized Intersections," provided in Appendix A of Chapter 10, describes a method for evaluating signalized intersection capacity utilization (the critical v/c ratio) and lane group LOS that does not require the analyst to know the signal timing or phasing in advance. Chapters 10 (Urban Streets), 11 (Pedestrians and Bikes), 12 (Highways), and 13 (Freeways) of the *HCM* 2000 also provide service volume tables, but downplay their value for actual applications and urge readers to develop their own tables.

The *HCM* 2000 freeway and urban street facility methods output mean speed of through traffic as the performance measure. This can be converted to travel time and delay. LOS is output by the arterial method, but not by the freeway method. Freeway speeds can be broken down by segment and time slice within a multihour peak period. Urban arterial speeds apply to the entire facility over the single analysis hour. Intersection delays can be obtained at the signals.

HIGHWAY CAPACITY MANUAL, 2010 EDITION

The *HCM* 2010 has made several improvements to facilitate planning applications (*9*). Much useful material for planning applications is provided in the first nine chapters, including applications, modal characteristics, capacity concepts, LOS concepts, alternative analysis tools, interpretation of results, an *HCM* primer, and a glossary. It also retains the *HCM* 2000 Quick Estimation Method for Signalized Intersections in Chapter 31.

Service volume tables were created for the freeway facility, multilane highway, two-lane highways, and urban street chapters (Chapters 10, 14, 15, and 16, respectively). The service volume tables enable planners and engineers to quickly determine the number of lanes needed to hit a target LOS according to basic characteristics of the planned facility (e.g., free-flow speed, average annual daily traffic, the demand peaking factor, and the directional demand factor). Guidance is given on the appropriate use of defaults and the construction of agency-specific service volume tables. Based on the LOS, it is conceivable that an analyst can work backward to determine the equivalent density or speed range for the facility, but the result is not expected to be reliable.

No planning applications methods are provided in the *HCM* 2010 for freeway weaving segments, freeway merge/diverge segments, or unsignalized intersections. Corridor and areawide analysis procedures were dropped in the *HCM* 2010. The use of alternative tools is suggested for corridor and areawide analyses.

The *HCM* 2010 freeway and urban street facility methods output mean speed of through traffic as the performance measure. This can be converted to travel time and delay.

Both urban street and freeway speeds can be broken down by segment and time slice within a multihour peak period. Intersection delays can be obtained at the signals, whereas freeway densities can be reported by freeway segment and time slice.

LOS can be reported for both the freeway facility and urban street facility. Segment- and intersection-specific levels of service can also be reported for both freeways and urban streets. A new multimodal LOS methodology was included that considers the needs of all users of urban streets at the intersection, link, segment, and facility levels. This is useful when considering person throughput.

Chapters covering operational analyses now include planning and default values, along with the service volume tables that were in the 2000 *HCM*. Additionally, v/c ratio is mentioned and better defined in all of these chapters.

The *HCM* 2010 dropped the corridor and system analyses chapters (28–30) that were in the *HCM* 2000. The *HCM* 2000 method for extending the *HCM* to corridor analyses (Chapter 29) was rudimentary and saw little or no use, because microsimulation models were already available to do detailed corridor analyses, and software implementation was required to make the *HCM* 2000 method practical for planning applications. The *HCM* 2010 also dropped the *HCM* 2000 Chapter 30, which provided guidance on how *HCM* capacities and speeds could be approximated in travel demand models. This chapter was dropped because travel demand modelers were unlikely to refer to the *HCM*, a predominantly operations-oriented reference, for guidance on the *HCM's* planning applications. *HCM* 2000 Chapter 28 on corridor and system performance measures was dropped in the 2010 *HCM* because the new edition would no longer address corridor or system analyses.

EFFORTS TO BETTER ADAPT THE *HIGHWAY CAPACITY MANUAL* TO PLANNING

Two NCHRP research projects have been conducted to improve the application of the *HCM* to planning analyses. The Florida Department of Transportation has published several manuals and software to aid planners and engineers in applying the *HCM* to planning and preliminary engineering analyses. Travel demand model researchers have been attempting to improve the fidelity with which travel demand models represent congestion on the highway network using dynamic traffic assignment. Some researchers and many cities in Southern California use the "intersection capacity utilization" method to quickly evaluate signalized intersection operations. Finally, several recently completed or ongoing NCHRP and SHRP research efforts are relevant to improving capacity analysis within a planning applications context.

NCHRP Report 387

NCHRP Report 387: Planning Techniques to Estimate Speeds and Service Volumes for Planning Applications was an early attempt to adapt the *HCM* to planning applications. Two planning techniques were developed for estimating speeds and service volumes (*10*). One technique, the Enhanced BPR (Bureau of Public Roads) Technique, was designed to be applied in a travel demand modeling environment. The other technique, the Enhanced ARTPLAN (arterial planning) Technique, was designed to improve on the 1994 *HCM* urban arterial method.

The Enhanced BPR Technique included equations for estimating facility free-flow speed and capacity plus separate speed-flow curves for unsignalized facilities and signalized facilities that were calibrated to data gathered as part of the study. The Enhanced ARTPLAN Technique, which was an extension of the 1994 *HCM* arterial analysis method to nonarterials and to situations where demand exceeded capacity, has since been superseded in subsequent editions of the *HCM* by improvements to the arterial and freeway facility analysis methods.

NCHRP Report 599

NCHRP Report 599: Default Values for Highway Capacity and Level of Service Analyses (*11*) provides guidance on the selection of default values for *HCM* analyses. The report describes the use of the current default values in the *HCM* and their application in planning practices, as well as the impact of the various default values on the analysis results in terms of the sensitivity of the results. It also recommends changes to the *HCM* 2000 default values based on data collected for the project. Finally, the report provides guidance on the estimation of appropriate values for situations where default values are not provided in the *HCM* or in the report itself. The research was conducted partially in response to a Highway Capacity Committee internal review identifying the need for improved default values, and the results were incorporated into the 2010 *HCM*.

Florida Department of Transportation Q/Level of Service Manual and Software

The Florida Department of Transportation has developed the Quality/Level of Service Handbook (Q/LOS Handbook) and the LOSPLAN2009 software to compute LOS for cars, mass transit, bicycles, and pedestrians for planning and preliminary engineering (*12*). The LOSPLAN2009 software is based on the *HCM* 2000.

The Q/LOS Handbook provides simplifying assumptions and default values to assist planners in applying the *HCM* 2000 methodology. Generalized service volume tables are provided to help planners quickly look up the appropriate

number of lanes for a facility given some basic information on demand and facility characteristics. This handbook will be updated in 2012 to reflect the 2010 *HCM*.

The LOSPLAN software suite was developed to enable planning analyses to be conducted of segment and intersection operations. It includes ARTPLAN, FREEPLAN, and HIGHPLAN software designed for planning analyses of arterials, freeways, and highways.

Dynamic Traffic Assignment

The TRB Committee on Transportation Network Modeling (ADB30) recently produced a "Primer for Dynamic Traffic Assignment" (DTA) (*13*). DTA is an attempt to model more accurately within travel demand models the dynamic performance of highway systems and the interaction among highway congestion, route selection, and departure time selection (peak spreading). The SHRP2-C05 project evaluated the concept of varying capacity in dynamic traffic assignment and applied it to assess the capacity benefits of various operational improvements (*14*).

DTA requires an efficient method for describing how network traffic conditions (travel times) vary by time. The current *HCM* procedures do not fit this requirement, so capacity analysis and travel time prediction is accomplished using various closed-form equations for predicting travel time and delay as a function of demands and basic facility characteristics. The focus of DTA research has been on understanding and modeling traveler behavior in a dynamic environment. However, on the highway capacity side, one of the key challenges to DTA has been finding a satisfactory approximation to the *HCM* procedure for computing signalized intersection delay that is both fast and relatively faithful to the reality of signal operations.

Intersection Capacity Utilization

The *HCM* Quick Estimation Method, several researchers (*15*), and many cities and counties in Southern California (*16*) have adopted the Intersection Capacity Utilization method for evaluating signalized intersection operation for planning purposes. The method is a modest elaboration of the earlier *TRB Circular 212* method (*17*).

The Intersection Capacity Utilization method computes intersection LOS based on the ratio of the sum of the critical movement demands to the capacity of the intersection, assuming a default lost time per cycle. No specifics are required on the signal timing plan in place at the intersection.

SHRP2-L08 – Adding Reliability to the *Highway Capacity Manual*

An ongoing project, Strategic Highway Research Program L08 (SHRP2-L08), is developing methods of predicting the reliability of travel time for the *HCM*. The objective of this project is to determine how data and information on the impacts of differing causes of nonrecurrent congestion (e.g., incidents, weather, work zones, and special events) in the context of highway capacity can be incorporated into the performance measure estimation procedures in the *HCM*. This project has produced a Phase 1 interim report, with a final report expected in November 2012.

SHRP2-C05 – Contributions of Operations Improvements to Capacity

The SHRP2-C05 project, Understanding the Contribution of Operations, Technology, and Design to Meeting Highway Capacity Needs, had the following objectives:

- Quantify the capacity benefits of operations, design, and technology improvements at the network level;
- Provide transportation planners with the information and tools to analyze operational improvements; and
- Develop guidelines for sustained service rates to be used in planning networks for limited access highways and urban arterials.

The final report is currently in publication at TRB (*14*).

SHRP2-C10 – Advanced Travel Demand Model

The SHRP2-C10 project, Partnership to Develop an Integrated Advanced Travel Demand Model and a Fine-grained Time-Sensitive Network, is intended to improve the ability of travel demand modeling procedures to answer policy questions related to operational improvements. The project will incorporate SHRP 2 Capacity products into the model capabilities, and will incorporate travel time reliability into the modeling capabilities (*18*).

NCHRP 8-83 – Forecasting for Project Level Planning

The NCHRP 8-83 project, Analytical Travel Forecasting Approaches for Project Level Planning and Design, will produce a guidebook describing methods, data sources, and procedures for producing travel forecasts for highway project-level analysis and design. It is expected to be completed in 2013 (*19*).

CHAPTER FOUR

HIGHWAY CAPACITY COMMITTEE EFFORTS

NCHRP and the Committee on Highway Capacity and Quality of Service have made several efforts to assess the degree to which the *HCM* meets the needs of planning analysis and how to adapt or extend the manual to better meet those needs.

HIGHWAY CAPACITY MANUAL 2010 FOCUS GROUPS

The contractor for the NCHRP 3-92 project to develop the 2010 *HCM* conducted focus group sessions of *HCM* users in Orlando, Florida; Baltimore, Maryland; and Portland, Oregon, in late 2007. A total of 31 individuals participated in the focus groups (*20*).

The contractor found that "There are a number of different types of *HCM* users, who have differing needs. Some users believe that the *HCM* has grown too complex and needs to be made less complicated where possible for planning purposes, without sacrificing too much accuracy. Other users see the need to add more detailed material to address real-world situations not currently being addressed. Decision makers are an audience not currently being addressed by the *HCM*, even though many decisions get made based on *HCM* analyses." Individual comments suggested that the *HCM* did not provide good guidance on when to perform a planning application (as opposed to an operations analysis) and that the planning results were not accurate. However, these were individual comments, not coming from more than one of the 31 participants.

HIGHWAY CAPACITY AND QUALITY OF SERVICE PLANNING AND PRELIMINARY ENGINEERING AUDIT (2003)

The Planning and Preliminary Engineering subcommittee of the TRB Committee on Highway Capacity and Quality of Service conducted an audit of how well the *HCM* 2000 met the needs of planning (*21*). The audit identified the following desirable characteristics of *HCM* planning applications:

- The planning application should be able to produce levels of service for an entire facility, section, segment, or control point (desirable but not a requirement).
- The planning application should be able to estimate the demand/capacity ratio, mean travel time, and/or delay, whether or not demand exceeds capacity.
- Planning application(s) should get the same results as operations analysis when using the same input data, assumptions, and defaults.
- Planning applications should only require basic input data.
  - For uninterrupted flow facilities: Facility type, area type, general terrain type, hourly demand, number of lanes at critical points, lengths of segments, and interchange spacing
  - For interrupted flow facilities: Facility type, area type, terrain type, hourly demand, number of lanes at critical points, lengths of segments, and number of intersections control points and type of control
- Some other data may be required for specific applications, but it is important that those be held to a minimum. Defaults are to be supplied for all additional required input data or a method provided for estimating the input (this latter conclusion was the focus of *NCHRP Report 599*).

The audit concluded that the *HCM* 2000 was highly useful to planners but had several important gaps and areas for improvement. Specific recommendations included the following:

- Conduct a chapter-by-chapter review of the 2000 *HCM* to determine whether it meets the Desirable Characteristics of *HCM* Planning Chapter Applications. The primary activities would be to supply missing default values for input and midprocedure parameters to ensure that there is a single planning methodology for all procedures that is consistent with the operational procedure.
- Implement the ideal software model for planning applications, in which the analyst can utilize default values for varying numbers of parameters, starting with the minimum data requirements for a planning application, according to the availability of facility-specific data for each planning application.
- Provide a demand-to-capacity ratio for all operational procedures of the *HCM* to be used only for LOS F conditions to provide an indication of the severity of congestion.

HIGHWAY CAPACITY AND QUALITY OF SERVICE POLICIES ON PLANNING APPLICATIONS

The TRB Committee on Highway Capacity and Quality of Service (HCQS) approved the following motions between 2001 and 2009 relevant to planning applications in the *HCM*. Note that all motions were subsequent to the *HCM* 2000 and before publication of the *HCM* 2010.

Motion 05-3

The Planning and Preliminary Engineering subcommittee is directed to work with each of the operational chapter subcommittees to (1) assess current deficiencies, if any, in the current *HCM* deployment of planning and preliminary engineering applications, and the applicability and form of these applications to be used in conjunction with the operational procedures, and (2) determine appropriate defaults, assumptions, and simplifications to be used in planning and preliminary engineering applications and provide guidance for their application and use. The motion carried unanimously.

Motion 05-08

The committee adopts the following "Desirable Characteristics of Planning Applications" as guidelines for the developing planning applications within the *HCM*.

1. The planning application(s) should be able to produce estimates of levels of service for the entire facility, section, segment, or control point.

2. Additional planning application(s) should be provided (if necessary) for estimating mean travel time and/or delay for facilities, segments, and points, or as needed to effectively determine size and configuration of these elements.

3. Planning application(s) that produce LOS results should produce an estimate of the hourly demand to hourly capacity ratio to quantify the degree of oversaturation.

4. Planning application(s) that produce LOS results should get the same LOS as operations analysis when using the same input data, assumptions, and defaults.

5. Planning applications should require the use of minimum basic input data necessary to provide meaningful results in a given procedure, such as facility type, area type, general terrain type, hourly demand, basic geometric configuration, segment lengths, interchange spacing or number of intersection control points, and type of control.

6. Defaults should be developed to represent a range of values to include minimum, average, and ideal conditions, and should also include representative values of model inputs depicting a variety of input conditions. Guidance should also be provided on methods for estimating input values, the appropriate use of default values, and other simplifying assumptions.

Motion 08-20

The HCQS committee recommends the inclusion of Service Volume Tables in the 2010 *HCM* in the following manner to provide guidance.

1. Volume 1 should include a description of the method to create Service Volume Tables, the need, the applications, and the planning and preliminary engineering applications.

2. Volumes 2 and 3 should contain Generalized Service Volume Tables for the following chapters: Freeway Facilities, Urban Streets, 2 Lane, and Multi-Lane, with sensitivity to what occurs in rural and urban settings. Service Volume Tables may be considered for inclusion in other chapters as appropriate.

3. Guidance for development of Service Volume Tables should include a discussion of results with sensitivities for input values and should be placed in Volume 4. The contractor should consider providing an interface for development of Service Volume Tables for local conditions.

Motion 08-21

For the purposes of planning and preliminary engineering analyses, it is important that the results of *NCHRP Report 599* be incorporated into the *HCM* as follows:

1. If *NCHRP Report 599* provides a specific default value for a particular parameter in an *HCM* procedure, then the recommended default value could be incorporated into the 2010 *HCM*.

2. If *NCHRP Report 599* does not provide a specific default value for a particular parameter in an *HCM* procedure, and the 2000 *HCM* provides a specific default value, then that default value could be incorporated into the 2010 *HCM*.

3. The guidance from *NCHRP Report 599* could be incorporated into the 2010 *HCM* to guide users in determining default values.

Motion 09-19

The following four research statements could be moved forward to the AASHTO Standing Committee on Research for consideration in the 2010–2011 NCHRP funding cycle:

1. Delay and Queue Model Validation (Signalized Intersection Subcommittee)

2. Effects of Operational Treatments on Two-lane Highway Traffic Operations (Two-Lane Highways Subcommittee)

3. Development of a Procedure for Predicting Traffic Performance in Work Zones (*HCM*-Wide Crosscutting Issues)

4. PPEAG (Planning and Preliminary Engineering Subcommittee).

RESEARCH NEEDS STATEMENTS

The HCQS committee has developed several research needs statements related to improving the planning application of the *HCM*. Some have been successfully funded and have resulted in NCHRP reports such as *NCHRP Report 599*. Others are still outstanding and unfunded. The following are two of the more relevant examples of unfunded, outstanding research problem statements developed by the committee:

- Planning Applications Guide to the *HCM* ($400,000), which was submitted to the AASHTO Standing Committee on Research, but did not receive sufficient ranking, and
- Planning Applications Method for Freeway Facilities ($175,000), which did not receive sufficient ranking within the Highway Capacity Committee to be carried forward to AASHTO.

Both of these research problem statements are included in the appendices for reference purposes.

CHAPTER FIVE

SURVEY METHODOLOGY

This chapter describes the preparation of the survey instrument, pretesting, the selection of survey subjects, and the procedures used to administer the survey. It discusses survey response rates and any potential sources for bias.

DEVELOP SURVEY INSTRUMENT

The survey instrument had the objective of obtaining feedback on current agency usage of *HCM* methods in planning and obstacles to the fuller use of *HCM* methods in planning.

A draft web-based survey instrument was prepared. The objective of the survey instrument design was to obtain as much accurate information as possible relevant to the project objective without requiring the survey subject to spend more than 15 minutes filling out the survey form. The web-based form of the survey instrument was submitted for pretesting by designated staff at panel member agencies, and was then revised based on the results of the pretest. Based on the pretest time trials, the survey instrument was shortened as necessary to stay within an average 15-min response time for subjects.

IDENTIFY SURVEY SUBJECTS

A sample of state DOTs, MPOs, and local governments was identified to find interested parties to participate in this study. Individuals at the following agencies responded to our requests for survey participation.

CONDUCT SURVEY/INTERVIEWS

Survey subjects were contacted to participate in the web survey and were given 2 weeks to respond. Reminders were sent toward the end of the period, and one more contact attempt was made to secure a response from the missing subjects. At the end of 3 weeks, the survey was considered complete (as far as the initial list of survey subjects was concerned). The number of responses was then reviewed to determine if a sufficient number and cross section of respondents had been obtained. Additional survey subjects were identified as necessary to obtain the target cross section and number of responses.

COMPILE RESULTS AND FOLLOW UP

Once all responses had been received, they were checked for reasonableness. Subjects were contacted to resolve unclear or contradictory responses and to fill in missing responses. Follow-up phone calls or e-mails were made to those respondents to flesh out and better understand the context of their responses regarding the primary obstacles to using the *HCM* in planning practice. These interviews were used to identify the most commonly used performance measures, both *HCM* and non-*HCM*, and to identify other desired measures used by state and local agencies. The results were then summarized in simple graphic or tabular format.

RESPONSE AND BIAS ASSESSMENT

Table 3 shows the number of invitations and responses received by the various agency types. In some situations,

Local governments	**State DOTs**
• Milwaukee, Wisconsin	• Ohio DOT
• City of San Francisco, California	• Florida DOT
• San Diego, California	• Caltrans
Three other local governments were contacted, but no response was received.	• Montana DOT
MPOs	• WYDOT, Wyoming DOT
• Metropolitan Transportation Commission (San Francisco, CA)	Three other state DOTs were contacted, but no response was received.
• Atlanta Regional Commission (ARC)	**Other**
• North Central Texas Council of Governments (Dallas-Fort Worth, TX)	• FHWA
• Southeast Michigan Council of Governments (Detroit, M)	• Institute of Transportation Engineers—Transportation Planning Council
• Binghamton Metropolitan Transportation Study (Binghamton, NY)	
• Thomas Jefferson Planning District Commission (Charlottesville, VA)	
• Gainesville Metropolitan Transportation Organization (Gainesville, FL)	
Two other MPOs were contacted, but no response was received.	

multiple people were contacted at the same agency. Large agencies such as Florida DOT have many divisions, necessitating more than one response to understand how different areas within the same agency use the *HCM*.

TABLE 3
ASSESSMENT OF RESPONSE BIAS

Agency Type	By Agencies Invited	Responses	Response Rate
City/County/Borough	6	3	50%
Regional Metropolitan Planning Organization	9	7	78%
State Department of Transportation	9	6	67%
Other	7	7	100%
Total	31	23	71%

CHAPTER SIX

SURVEY RESULTS

This section documents the results of the online survey and follow-up questions asked of participants for the extent of *HCM* use in planning. A total of 35 individuals from 31 agencies were invited to participate in this survey. From these invitees, 30 people from 23 agencies completed the survey. These responses are based primarily on the 2000 *HCM*, as the 2010 *HCM* had not yet been released at the time of the questionnaire.

Question 1: What type of agency do you work for?

Table 4 shows the breakdown of the agencies survey respondents worked for. The majority of respondents worked for state DOTs; a few were from consulting firms, MPOs, and the FHWA.

TABLE 4
DISTRIBUTION OF RESPONSES BY AGENCY TYPE (Q1)

Agency Type	Responses	Location
City/County/ Borough	3 (10%)	Milwaukee, WI San Diego, CA SFCTA—San Francisco
Regional Metropolitan Planning Organization	7 (23%)	MTC—Oakland, CA NCFRPC—Gainesville, FL NCTCOG—Arlington, TX ARC—Atlanta, GA BMTS—Binghamton, NY SEMCOG—Detroit, MI TJPDC—Charlottesville, VA
State Department of Transportation	13 (43%)	California, Ohio, Oregon, Wyoming, Florida, and Montana
Other	7 (23%)	Professor—South Dakota Consultants—San Diego, CA; Vienna, VA; Royal Oaks, MI FHWA—Atlanta GA; St Paul, MN; Washington, DC
Total	30 (100%)	

Question 2: How would you rate your familiarity with the *HCM*?

Familiarity with the *HCM* among the respondents ranged widely, from never having used it to expert users. Table 5 presents a breakdown of the responses to this question. Two respondents had never used the *HCM*. One was a transportation planner from the Thomas Jefferson Planning District who had never needed to use it. The other was a statewide and urban supervisor for the Montana DOT, who stated that the *HCM* is mostly used by the traffic engineering folks, whereas the planning division uses *HCM* software for congestion management.

TABLE 5
FAMILIARITY OF RESPONDENTS WITH THE *HCM* (Q2)

Familiarity with the *HCM*	Response
Little or None	9 (30%)
Average	9 (30%)
Advanced or Expert	12 (40%)
Total	30 (100%)

Question 3: How often do you or your agency perform the following short-range (<20 years) planning practices?

This question was asked to understand what planning practices respondents are involved in compared with those of their agency. The respondents provided at least two responses for each planning practice and time length, which shows that they are involved in diverse planning practices. Table 6, looking at the respondents' answers for their agency as a whole, shows that once again there is a wide range of responses. (It should be noted that one of the "never" responses in Table 6 for each planning practice was from a respondent who worked at a university.)

Question 4: How often do you or your agency perform the following long-range (20+ years) planning practices?

As with the short-range planning practices, respondents were diversified in the frequency with which they personally perform different long-range planning practices. Highway/transit systems planning and highway facility and corridor planning were most often performed by respondents, whereas development master planning and bike/pedestrian planning were performed less often. The agencies that respondents work for tended to perform all long-range practices more regularly, with fewer responses of "never." Table 7 provides more information.

TABLE 6
SHORT-RANGE PLANNING PRACTICES PERFORMED BY RESPONDENTS' AGENCY (Q3)

Short-Range Planning Practices	At Least Once per Month	At Least Once Every 6 Months	At Least Once per Year	Never	Total
Highway/Transit Systems Planning	17 (56.7%)	6 (20.0%)	5 (16.7%)	2 (6.7%)	30 (100%)
Highway Facility and Corridor Planning	17 (56.7%)	7 (23.3%)	5 (16.7%)	1 (3.3%)	30 (100%)
Congestion Management	14 (46.7%)	6 (20.0%)	7 (23.3%)	3 (10.0%)	30 (100%)
Bicycle/Pedestrian Planning	17 (56.7%)	6 (20.0%)	4 (13.3%)	3 (10.0%)	30 (100%)
Development Decisions (site impact studies)	18 (60.0%)	5 (16.7%)	3 (10.0%)	4 (13.3%)	30 (100%)
Performance Monitoring	11 (36.7%)	8 (26.7%)	9 (30.0%)	2 (6.7%)	30 (100%)

TABLE 7
LONG-RANGE PLANNING PRACTICES PERFORMED BY RESPONDENTS' AGENCY (Q4)

Long-Range Planning Practices	At Least Once per Month	At Least Once Every 6 Months	At Least Once per Year	Never	Total
Highway/Transit Systems Planning	10 (33.3%)	7 (23.3%)	9 (30.0%)	4 (13.3%)	30 (100%)
Highway Facility and Corridor Planning	12 (40.0%)	6 (20.0%)	10 (33.3%)	2 (6.7%)	30 (100%)
Project Prioritization	11 (36.7%)	4 (13.3%)	12 (40.0%)	3 (10.0%)	30 (100%)
Bicycle/Pedestrian Planning	12 (40.0%)	3 (10.0%)	11 (36.7%)	4 (13.3%)	30 (100%)
Development Master Planning	8 (26.7%)	5 (16.7%)	9 (30.0%)	8 (26.7%)	30 (100%)

TABLE 8
AGENCY USE OF *HCM* FOR SHORT-RANGE PLANNING (Q5)

HCM Use for Short-Range Planning	At Least Once per Month	At Least Once Every 6 Months	At Least Once per Year	Never	Total
Highway/Transit Systems Planning	12 (40.0%)	6 (20.0%)	7 (23.3%)	5 (16.7%)	30 (100%)
Highway Facility and Corridor Planning	17 (56.7%)	4 (13.3%)	5 (16.7%)	4 (13.3%)	30 (100%)
Congestion Management	10 (33.3%)	6 (20.0%)	9 (30.0%)	5 (16.7%)	30 (100%)
Bicycle/Pedestrian Planning	9 (30.0%)	4 (13.3%)	8 (26.7%)	9 (30.0%)	30 (100%)
Development Decisions (site impact studies)	13 (43.3%)	4 (13.3%)	5 (16.7%)	8 (26.7%)	30 (100%)
Performance Monitoring	7 (23.3%)	7 (23.3%)	8 (26.7%)	8 (26.7%)	30 (100%)

Question 5: How often do you or your agency use the *Highway Capacity Manual* (*HCM*), *HCM*-like methods, or software based on the *HCM* for the following short-range (<20 years) planning practices?

Table 8 shows that the use of the *HCM* methods for short-range planning practices had a good distribution. Most respondents had personally never used the *HCM* for bike/pedestrian planning, but this is not true of their agencies as a whole, with only nine responses showing that an agency had never used the *HCM* for this planning application. The rest of the short-range planning practices are fairly evenly distributed across the four frequencies listed.

Question 6: How often do you or your agency use the *Highway Capacity Manual* (*HCM*), *HCM*-like methods, or software based on the *HCM* for the following long-range (20+ years) planning practices?

Table 9 shows that responses for agencies performing long-range planning practices using the *HCM* are similar to those for the short-range practices. Agency utilization of these practices is fairly evenly distributed among the different time ranges.

The first six questions were designed to better understand the planning practices currently being used by agencies and the prevalence of the *HCM*'s use. The remaining questions specifically ask the respondents their opinions and suggestions on the *HCM*.

Question 7: How satisfied are you with using the *Highway Capacity Manual* or *HCM*-based software for the following short-range (<20 years) planning applications?

Table 10 shows that respondents were generally satisfied with using the *HCM* for short-range planning practices. None of

TABLE 9
AGENCY USE OF *HCM* FOR LONG-RANGE PLANNING (Q6)

HCM Use for Long-Range Planning	At Least Once per Month	At Least Once Every 6 Months	At Least Once per Year	Never	Total
Highway/Transit Systems Planning	8 (26.7%)	4 (13.3%)	11 (36.7%)	7 (23.3%)	30 (100%)
Highway Facility and Corridor Planning	9 (30.0%)	4 (13.3%)	12 (40.0%)	5 (16.7%)	30 (100%)
Project Prioritization	6 (20.0%)	4 (13.3%)	12 (40.0%)	8 (26.7%)	30 (100%)
Bicycle/Pedestrian Planning	5 (16.7%)	4 (13.3%)	9 (30.0%)	12 (40.0%)	30 (100%)
Development Master Planning	6 (20.0%)	4 (13.3%)	7 (23.3%)	13 (43.3%)	30 (100%)

TABLE 10
SATISFACTION WITH THE *HCM* FOR SHORT-RANGE PLANNING (Q7)

Short-Range Planning Practices	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied	N/A
Highway/Transit System Planning	2 (6.7%)	0 (0.0%)	4 (13.3%)	14 (46.7%)	5 (16.7%)	5 (16.7%)
Highway Facility and Corridor Planning	0 (0.0%)	1 (3.3%)	3 (10.0%)	15 (50.0%)	8 (26.7%)	3 (10.0%)
Congestion Management	0 (0.0%)	1 (3.3%)	3 (10.0%)	13 (43.3%)	6 (20.0%)	7 (23.3%)
Bicycle/Pedestrian Planning	1 (3.3%)	1 (3.3%)	7 (23.3%)	6 (20.0%)	4 (13.3%)	11 (36.7%)
Development Decisions (site impact studies)	0 (0.0%)	0 (0.0%)	2 (6.7%)	15 (50.0%)	5 (16.7%)	8 (26.7%)
Performance Monitoring	0 (0.0%)	1 (3.3%)	7 (23.3%)	10 (33.3%)	5 (16.7%)	7 (23.3%)

Note: N/A = not applicable.

TABLE 11
SATISFACTION WITH THE *HCM* FOR LONG-RANGE PLANNING (Q8)

Long-Range Planning Practices	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied	N/A
Highway/Transit System Planning	2 (6.7%)	2 (6.7%)	6 (20.0%)	11 (36.7%)	2 (6.7%)	7 (23.3%)
Highway Facility and Corridor Planning	0 (0.0%)	3 (10.0%)	5 (16.7%)	14 (46.7%)	3 (10.0%)	5 (16.7%)
Project Prioritization	0 (0.0%)	2 (6.7%)	4 (13.3%)	11 (36.7%)	3 (10.0%)	10 (33.3%)
Bicycle/Pedestrian Planning	1 (3.3%)	4 (13.3%)	5 (16.7%)	6 (20.0%)	3 (10.0%)	11 (36.7%)
Development Master Planning	0 (0.0%)	1 (3.3%)	7 (23.3%)	6 (20.0%)	3 (10.0%)	13 (43.3%)

Note: N/A = not applicable.

the short-range planning practices had more than two dissatisfied or very dissatisfied responses combined. Respondents were most satisfied with using the *HCM* for highway facility and corridor planning, with 76.7% marking "satisfied" or "very satisfied."

Question 8: How satisfied are you with using the *Highway Capacity Manual* or *HCM*-based software for the following long-range (20+ years) planning applications?

Table 11 shows that respondents were less satisfied with using the *HCM* for long-range planning practices than for short-range practices, but those satisfied with *HCM* use were still in the majority. Bicycle and pedestrian planning was once again the planning practice for which respondents expressed the most dissatisfied responses, with a total of five or 16.7%. Highway facility and corridor planning was selected the most often for satisfaction, at 56.7% of all responses.

Question 9: What do you think are the primary challenges in using the *Highway Capacity Manual* (*HCM*) analysis methods for planning applications?

Table 12 and Figure 3 show the responses to the primary challenges faced by *HCM* users in planning. These two exhibits present all the responses combined, while Figures 4, 5, and 6 stratify the responses by inexperienced users, average users, and expert users, respectively. The top three challenges respondents agreed with when looking at all responses were "*HCM* lacks methods for evaluating operations strategies" (46.7%), "*HCM* does not have performance measures for different levels of congestion" (43.3%), and "*HCM* is insensitive to typical planning policy inputs" (40.0%). Respondents generally disagreed with the statement that the *HCM* is not needed for planning (80.0%) and that the *HCM* results are inaccurate or unreliable (60.0%).

TABLE 12
PRIMARY CHALLENGES TO *HCM* USE IN PLANNING (Q9)

Challenges	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
HCM is not really needed for planning	**9 (30.0%)**	**15 (50.0%)**	1 (3.3%)	4 (13.3%)	0 (0.0%)	1 (3.3%)
HCM requires too much data	4 (13.3%)	10 (33.3%)	6 (20.0%)	7 (23.3%)	0 (0.0%)	3 (10.0%)
HCM computations are too complex	**1 (3.3%)**	**14 (46.7%)**	6 (20.0%)	4 (13.3%)	2 (6.7%)	3 (10.0%)
HCM software is too complex	**3 (10.0%)**	**14 (46.7%)**	4 (13.3%)	4 (13.3%)	0 (0.0%)	5 (16.7%)
HCM results are inaccurate or unreliable	**2 (6.7%)**	**16 (53.3%)**	6 (20.0%)	2 (6.7%)	0 (0.0%)	4 (13.3%)
Performance measures produced using the *HCM* are not useful for planning	2 (6.7%)	12 (40.0%)	10 (33.3%)	3(10.0%)	1(3.3%)	2 (6.7%)
HCM is insensitive to typical planning policy inputs (e.g., complete streets, traffic calming, TDM)	2(6.7%)	3 (10.0%)	9 (30.0%)	9 (30.0%)	3 (10.0%)	4 (13.3%)
HCM lacks methods for evaluating operations strategies (e.g., HOV/HOT lanes, congestion pricing, ramp metering, speed harmonization)	0 (0.0%)	2 (8.7%)	4(17.4%)	**8 (34.8%)**	**4 (17.4%)**	5 (21.7%)
HCM does not produce performance measures useful for comparing different degrees of congestion (i.e., once LOS F, always LOS F)	2 (8.7%)	4 (17.4%)	5 (21.7%)	6 (26.1%)	4 (17.4%)	2(8.7%)
HCM treats demand as fixed (does not account for induced demand)	1 (4.3%)	2 (8.7%)	9 (39.1%)	3 (13.0%)	2 (8.7%)	6 (26.1%)
HCM and/or *HCM* software does not integrate well with travel demand forecasting software I use	2 (8.7%)	1 (4.3%)	7 (30.4%)	4 (17.4%)	1 (4.3%)	8 (34.8%)

Notes: Adjacent cells are highlighted in grey shading where more than 50% of respondents fell on one side or the other of neutral. The majority of respondents either agreed or agreed strongly, or they disagreed or disagreed strongly. N/A = not applicable.

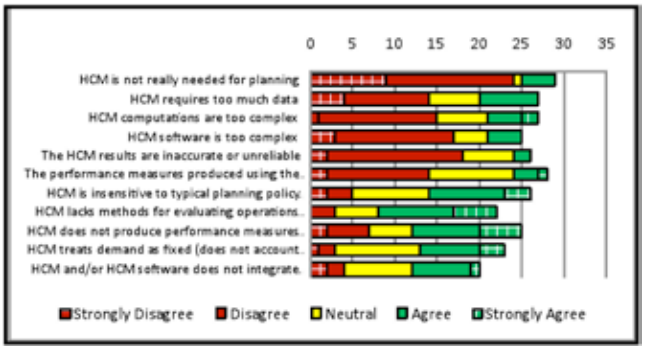

FIGURE 3 Primary challenges to *HCM* use in planning (all users) (Q9).

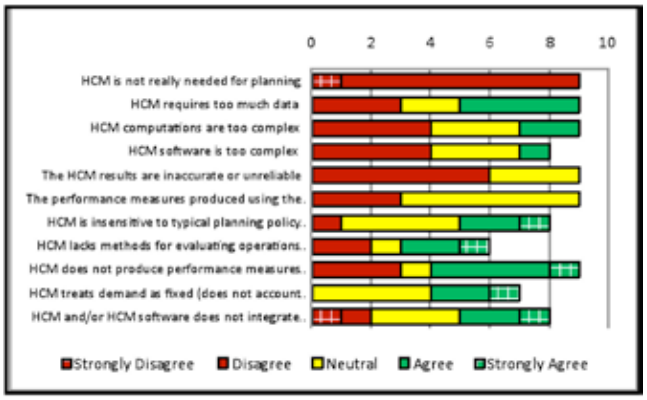

FIGURE 5 Primary challenges to *HCM* use in planning (average users) (Q9).

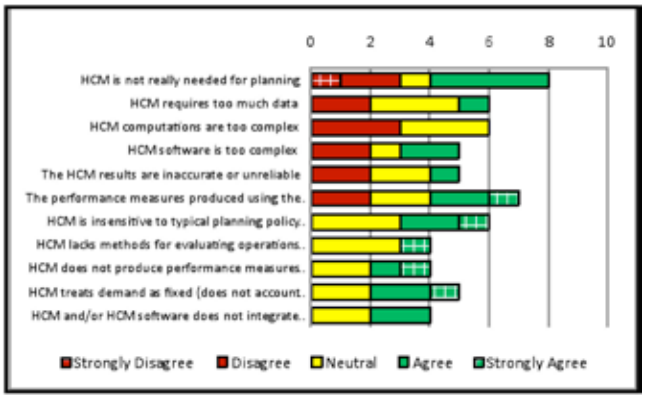

FIGURE 4 Primary challenges to *HCM* use in planning (inexperienced users) (Q9).

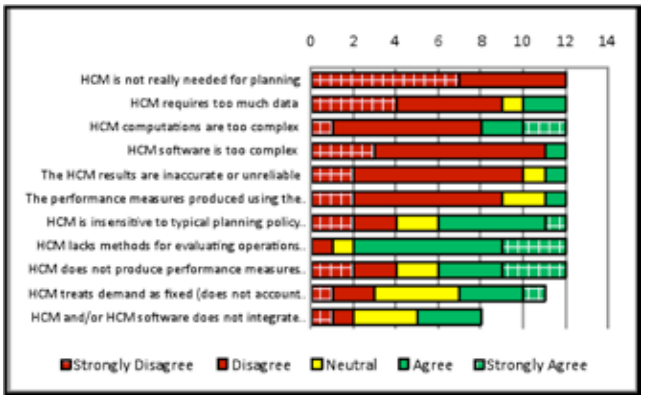

FIGURE 6 Primary challenges to *HCM* use in planning (expert users) (Q9).

State DOT workers tended to be more likely to be neutral or agree that no improvements were needed to the *HCM* (six responses, or 46%). The MPO group only had one neutral response to this question (14.3%). The total number of neutral or agreeing participants for all agency types was nine (30%). Expert users disagreed or strongly disagreed with the following statements:

- *HCM* is not needed for planning.
- *HCM* requires too much data.
- *HCM* computations are too complex.
- *HCM* software is too complex.
- *HCM* results are not accurate or reliable.
- The performance measures produced by the *HCM* are not useful for planning.

Inexperienced users were more evenly split on these statements. Inexperienced users were also neutral or in agreement with the following statements regarding the primary challenges to using the *HCM* in planning:

- *HCM* is insensitive to planning policy inputs.
- *HCM* lacks methods to evaluate advanced operations strategies such as high-occupancy vehicle lanes.
- *HCM* does not produce useful performance measures.
- *HCM* treats demand as fixed.
- *HCM* does not integrate well with planning models.

Expert users also generally agreed with these statements, but a few experts also disagreed or strongly disagreed that these are the primary challenges to using the *HCM* in planning.

Follow-up interviews asked respondents to provide additional details on their responses, such as the ones highlighted here:

- Needed performance measure are:
  - Quantity of travel – Person throughput
  - Accessibility – The ease with which people can gain access to the transportation system
  - Access management issues – How parking, transit, and various access management techniques affect travel both individually and as aggregate measures
- *HCM* is perceived by many planners as a traffic engineering tool exclusively.
- The signalized intersection procedure needs to be revamped to be useful for planning. What is needed is a widely accepted methodology that calculates signal timing automatically or a separate planning procedure based on a simpler methodology.
- The *HCM* method does not account/project backup from turn lanes well. Traffic from underdesigned turn lanes usually backs up into the through lanes and deteriorates the intersection performance. This is not well addressed in the *HCM*. Also, there are many issues that are not addressed in the freeway analysis and interchanges.
- It is important that the purpose of the planning application of the *HCM* be the evaluation of the efficiency of modes and the evaluation of mobility [mode/path choice]. It could be context sensitive.
- There is a need for more planning-level methods and guidance on selection of appropriate analysis level.
- I believe the lack of *HCM* application in planning has more to do with training practitioners how to effectively use the *HCM* and other related tools and less to do with the *HCM* being the problem.
- Planners are not well trained on the *HCM*.
- *HCM* inputs too easily manipulated; simpler method may be sufficient/better for planning purposes.
- I have never needed to use the *HCM* and I am completely unsure if it would be a resource for me.

Question 10: What do you think are the primary reasons for using the *Highway Capacity Manual* (*HCM*) analysis methods in planning applications?

Table 13 and Figure 7 present the respondents' primary reasons for using the *HCM* in planning applications. Almost all respondents agreed that the *HCM* is useful for short-range planning (86.7%), whereas 63.3% thought it was useful for long-range planning. The most disagreements turned up in the ease-of-use question, which had a total of 6 responses (20%) disagreeing, whereas 11 (36.7%) agreed that the *HCM* is easy to use for planning applications. Responses stratified by experience level are shown in Figures 8 through 10.

Inexperienced users gave more negative feedback about the *HCM*'s accuracy and usefulness for long-range planning than expert users. Inexperienced users were split as to the usefulness of the *HCM* LOS letter grades for decision makers. They were also split as to whether the *HCM* was used because of local requirements. Expert users were more definitely in agreement with both statements.

The respondents provided the following insights into their responses in the follow-up phone interviews.

- *HCM* planning methodologies are too gross to establish a meaningful nexus. The state uses the *HCM* operational methodologies for its MOEs.
- The demand models that I use incorporate the *HCM* operational methods, rendering the statement to the effect that the *HCM* is more accurate than planning models, moot.
- Some decision makers prefer the letter grades (typically agency engineers), whereas the public and board members often prefer a relative standard; that is, how much better or worse is the delay in the future and/or with the plan or project proposal.

TABLE 13
PRIMARY REASONS TO USE THE *HCM* IN PLANNING (Q10)

Reasons for Use	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
HCM is useful for short-range planning	0 (0.0%)	0 (0.0%)	2 (6.7%)	**16 (53.3%)**	**10 (33.3%)**	2 (6.7%)
HCM is useful for long-range planning	1 (3.3%)	1 (3.3%)	6 (20.0%)	**14 (46.7%)**	**5 (16.7%)**	3 (10.0%)
HCM provides more accurate highway performance predictions than travel demand forecasting tools	2 (6.7%)	1 (3.3%)	6 (20.0%)	12 (40.0%)	2 (6.7%)	7 (23.3%)
Decision makers and the general public prefer level of service presented as letters	0 (0.0%)	2 (6.7%)	11 (36.7%)	**10 (33.3%)**	**6 (20.0%)**	1 (3.3%)
HCM is required by custom, law, or reviewing agency	2 (6.7%)	2 (6.7%)	6 (20.0%)	9 (30.0%)	5 (16.7%)	6 (20.0%)
HCM is better than other available tools for generating the performance measures I need	1 (3.3%)	1 (3.3%)	12 (40.0%)	8 (26.7%)	3 (10.0%)	5 (16.7%)
HCM is sensitive to detailed project characteristics I need to consider such as stop signs and grade	0 (0.0%)	2 (6.7%)	8 (26.7%)	8 (26.7%)	4 (13.3%)	8 (26.7%)
HCM is easy to use for planning applications	0 (0.0%)	6 (20.0%)	9 (30.0%)	9 (30.0%)	2 (6.7%)	4 (13.3%)

Notes: Adjacent cells are highlighted in grey shading where more than 50% of respondents fell on one side or the other of neutral. The majority of respondents either agreed or agreed strongly, or they disagreed or disagreed strongly. N/A = not applicable.

- The *HCM* provides better short-term predictions than travel demand forecasting models (TDFM), but TDFM is still preferable for long-term predictions.
- Although we are commenting on and have experience with the year 2000 *HCM*, multimodal assessments will be part of the year 2010 *HCM*.

Question 11: What do you think would greatly improve your ability to use the *Highway Capacity Manual* (*HCM*) methods more often in planning analyses?

Table 14 and Figure 11 show respondents' answers to questions about what would greatly improve the ability to use the *HCM* in planning. The majority of responses (63.3%)

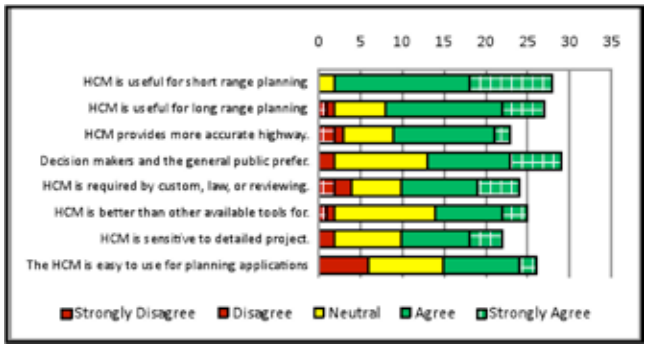

FIGURE 7 Reasons to use the *HCM* in planning (all respondents) (Q10).

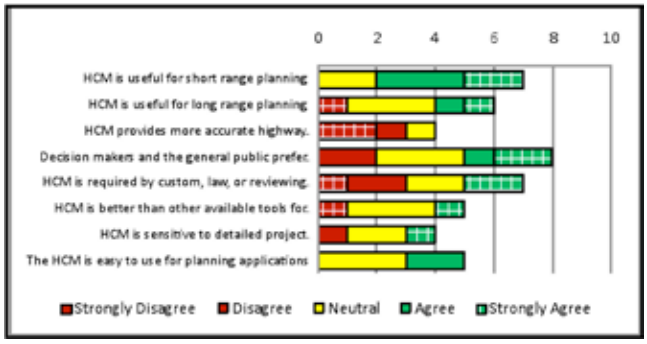

FIGURE 8 Reasons to use the *HCM* in planning (inexperienced users) (Q10).

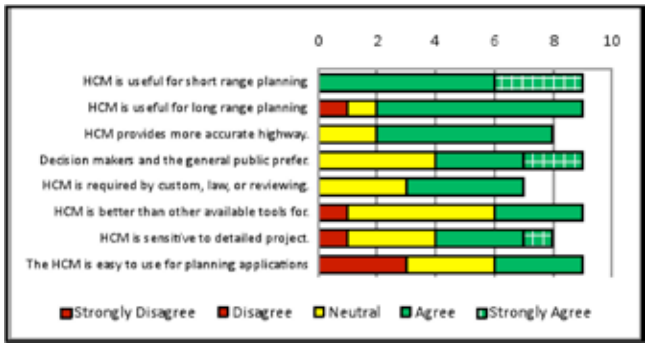

FIGURE 9 Reasons to use the *HCM* in planning (average users) (Q10).

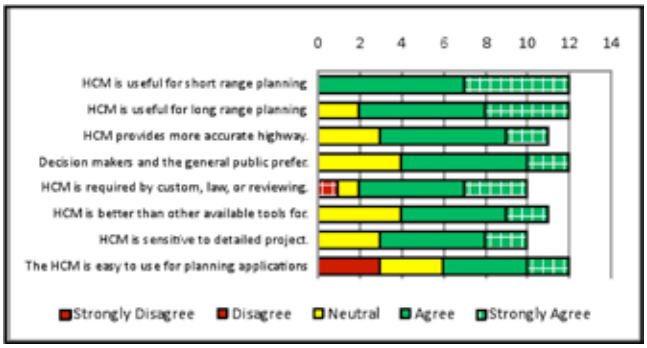

FIGURE 10 Reasons to use the *HCM* in planning (expert users) (Q10).

TABLE 14
HOW THE *HCM* CAN BE IMPROVED (Q11)

Improvements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
No improvements are needed	**5 (16.7%)**	**14 (46.7%)**	6 (20.0%)	2 (6.7%)	1 (3.3%)	2 (6.7%)
Developing an *HCM* Planning Applications Guide to assist agencies in using the *HCM*	0 (0.0%)	2 (6.7%)	3 (10.0%)	**17 (56.7%)**	**6 (20.0%)**	2 (6.7%)
Providing more default values for difficult *HCM* input data	2 (6.7%)	4 (13.3%)	7 (23.3%)	11 (36.7%)	3 (10.0%)	3 (10.0%)
Extending *HCM* Level of Service (LOS) beyond LOS F	2 (6.7%)	8 (26.7%)	7 (23.3%)	**6 (20.0%)**	**5 (16.7%)**	2 (6.7%)
Elimination of Level of Service	**10 (33.3%)**	**10 (33.3%)**	6 (20.0%)	2 (6.7%)	1 (3.3%)	1 (3.3%)
Adding other traditional planning MOEs such as VMT, VHT, PMT, and PHT	0 (0.0%)	4 (13.3%)	5 (16.7%)	**16 (53.3%)**	**2 (6.7%)**	3 (10.0%)
Adding a measure of travel time reliability to the performance measures produced by the *HCM* methods	0 (0.0%)	3 (10.0%)	5 (16.7%)	**16 (53.3%)**	**3 (10.0%)**	3 (10.0%)
Extending the *HCM* to multifacility (system, corridor) analyses	0 (0.0%)	2 (6.7%)	6 (20.0%)	**16 (53.3%)**	**3 (10.0%)**	3 (10.0%)
Simplifying *HCM* analysis procedures	1 (3.3%)	1 (3.3%)	10 (33.3%)	11 (36.7%)	3 (10.0%)	4 (13.3%)
Better integration of *HCM* analysis methods into travel demand forecasting software	0 (0.0%)	1 (3.3%)	5 (16.7%)	**12 (40.0%)**	**6 (20.0%)**	6 (20.0%)
Providing easy-to-use service volume tables	6 (20.0%)	0 (0.0%)	5 (16.7%)	14 (46.7%)	2 (6.7%)	3 (10.0%)

Notes: Adjacent cells are highlighted in grey shading where more than 50% of respondents fell on one side or the other of neutral. The majority of respondents either agreed or agreed strongly, or they disagreed or disagreed strongly. N/A = not applicable.

disagreed that no improvements were needed to the *HCM*. The biggest response to any one question about improving the *HCM* was about developing an *HCM* planning applications guide, with 76.7% of respondents agreeing this would greatly improve *HCM* use in planning. A large portion of responses (66.7%) were not in favor of eliminating the LOS classification system.

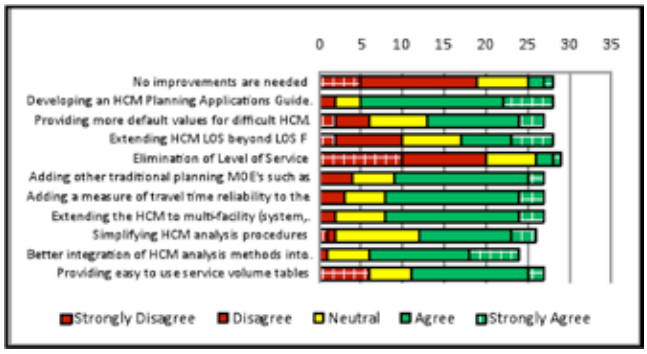

FIGURE 11 How can the *HCM* be improved for planning (all users)? (Q11).

Figures 12–14 show a stratification of responses by respondents' experience level grouped in the categories of inexperienced, average, and experienced, respectively. Although agreement and disagreement differs by degree of user experience, the patterns of the responses are generally similar across inexperienced to expert users. The strongest disagreement is registered by each user type for the elimination of the LOS classification system, and against the statement that the *HCM* is not needed for planning.

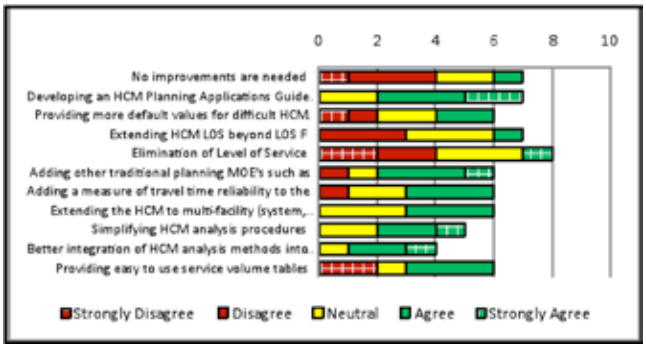

FIGURE 12 How can the *HCM* be improved for planning (inexperienced users)? (Q11).

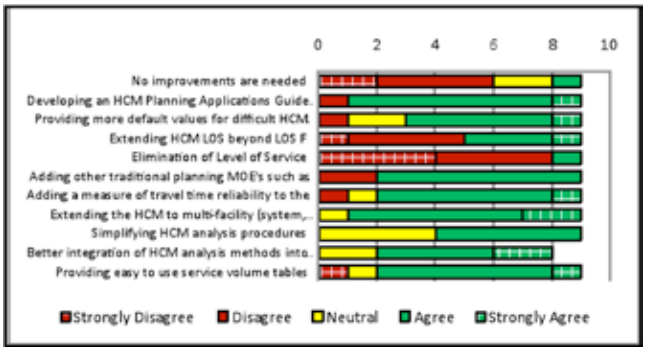

FIGURE 13 How can the *HCM* be improved for planning (average users)? (Q11).

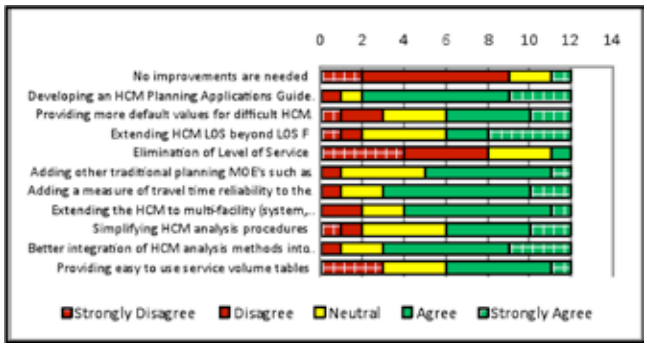

FIGURE 14 How can the *HCM* be improved for planning (expert users)? (Q11).

Expert users differ from the other users in agreeing with the need to expand the *HCM* LOS system beyond LOS F, whereas the average and less experienced users are split between agreement and disagreement.

Follow-up phone interviews were conducted to obtain more insights into the responses. Some of the salient comments are provided here, with more details available in the appendices.

- Default values need to be well grounded; don't develop default values for everything just for the sake of saying that you have them.
- Regarding better integration of the *HCM* into demand models, this has already been done by the demand model software vendors (to varying degrees); the weak link in the chain is the ability of model practitioners to understand and use them.
- Regarding service volume tables, this is a "credibility-killer" for the *HCM*.
- Educate other planners about the use of *HCM*.
- Provide default values based on region.
- Performance measures that account for differing driver behavior characteristics—rural vs. suburban vs. urban areas—congested vs. noncongested facilities.
- Add more high-level analysis methods, such as to report high/medium/low risk without reporting LOS or v/c ratio.
- The opportunity is not necessarily to extend or eliminate LOS – rather the opportunity is to help practitioners understand the opportunity of understanding the duration of the performance condition (time of onset, duration, and time condition is no longer observed). This provides a context and understanding which is not currently promoted in the assessment of current and potential conditions—in my opinion.
- We need more training on the *HCM* for planners.
- We need better customization capabilities for unique contexts.
- The *HCM* requires a lot of detail that is not readily available at the planning stage. To work for planners, the *HCM* could be simpler. While an engineering corridor analysis may only be 10 miles long, planning analysis could be hundreds.
- Alternate performance measures such as travel time, accessibility, and reliability would be useful measures of effectiveness to planners when using the *HCM*.
- Capacity estimates of different facilities and a multimodal street's effect on capacity would be a good addition to the *HCM*.
- Ability of the *HCM* to use outputs from traditional travel demand models would be helpful to planners.

During the follow-up phone interviews, respondents were asked for additional details on how to improve the *HCM* for planning applications. Their responses are summarized here and given in more detail in the appendices.

- A planning analysis, as opposed to a computational operations analysis, could mean lower resolution with more use of default values; not in tables with numbers inconsistent with the core methodology.
- Freight planning and operational analysis would be a useful addition. It would answer the questions of how to plan freight within different corridors as part of a systems analysis and how to handle lane distribution.
- Inclusion of active traffic and demand management strategies within the manual.

The interviews also sought insights into respondents' perspectives on the retention of the LOS letter grade system in the *HCM*. The people who were against its elimination tended to cite its wide range of use and understanding by planners, engineers, policymakers, and the general public. Respondents in favor of its elimination appeared to feel that planners and engineers could be more focused on demand-based assessments rather than operational results.

Creation of service volume tables was another topic on which more insights were sought in the follow-up phone interviews. Those in favor stated that service volume tables are good for quick and easy analyses, though they cautioned that they should not be used like "cookbooks." Those against service volume tables believed that they were often misused, misunderstood, and too simplistic to predict conditions accurately, and also believed that the tables, being based on auto volumes, may be a credibility killer for the *HCM* for roadways where the LOS is not based on auto volumes.

Question 12: Are there any additional comments or suggestions you would like to make about using the *Highway Capacity Manual* for planning purposes?

The final question asked for any additional comments about the use of *HCM* for planning applications. The responses are highlighted here.

- Planning needs to consider such things as queuing and merging.
- Although the need for planning applications is certainly understandable, it should not come at the expense of the *HCM*'s reputation among engineers!
- Use of *HCM* in transit planning is becoming more essential as more priority bus/bus lane projects are considered nationwide.
- Web-based—multimedia visualization and examples—peer exchange.
- Opportunities to use service volume tables are useful.
- *HCM* could be better integrated with regional travel demand modeling software.
- *HCM* is mostly used by our traffic engineering folks. In the planning division, we use *HCM* software for congestion management.

CHAPTER SEVEN

CONCLUSIONS

This chapter summarizes the results and conclusions of the study and provides recommendations for further research.

SUMMARY OF RESULTS

The survey obtained 30 responses from the 35 individuals contacted, for a response rate of 86%. State departments of transportation represented 43% of the responses, with regional metropolitan planning organizations, local agencies, FHWA, consultants, and others comprising the rest of the responses (Question 1).

Forty percent of respondents considered themselves expert users of the *Highway Capacity Manual* (*HCM*). Thirty percent considered themselves average users of the *HCM*. Thirty percent identified themselves as having little to no experience with the *HCM*.

At the time the survey was conducted, the 2010 *HCM* had just been published. Consequently, all but a few survey participants were familiar with only the 2000 *HCM*, and commented accordingly. The results of this survey can be considered to be primarily applicable to the 2000 *HCM* where the two editions differ. Where both editions are similar, the survey results can be considered to apply to the 2010 *HCM* as well.

Short-Range Planning

Short-range planning was defined as planning analyses with time horizons of less than 20 years. More than 50% of the respondents stated that their agency frequently (at least once per month) performs short-range planning analyses of highway and transit facilities, congestion management, bicycle and pedestrian planning, and development decisions (Question 3). The agencies surveyed performed performance monitoring less frequently. More than 40% of the respondents frequently use the *HCM* (at least once per month) for short-range planning of highway and transit facilities and for development decisions (Question 5). However, more than 50% of respondents rarely (less than twice a year) or never use the *HCM* for short-range bicycle/pedestrian planning, or for performance monitoring (Question 5).

The majority (50% or greater) of respondents are satisfied or very satisfied with the *HCM* for most short-range planning activities (highway and transit system planning, corridor planning, congestion management, development decisions, performance monitoring). Respondents were less certain of its value for short-range bicycle and pedestrian planning (Question 7).

Long-Range Planning

Long-range planning was defined as planning analyses with time horizons of at least 20 years. The majority (more than 50%) of the respondents said that their agencies perform long-range planning (highway and transit facility planning, project prioritization, bicycle and pedestrian planning, development master planning) less than once per month (Question 4). The *HCM* is used less than twice a year or never in the majority of long-range planning studies (Question 6).

With the exception of highway facility and corridor planning, fewer than 50% of respondents were satisfied or very satisfied with the *HCM* for long-range planning. Significant portions of the respondents (23% to 43%) considered the *HCM* not applicable to long-range planning for highway/transit systems, project prioritization, bicycle and pedestrian planning, and development master plans (Question 8).

Primary Challenges to Use of *HCM* for Planning

All respondents expressed a consensus (with consensus being defined as more than 50% agreeing to a statement or more than 50% disagreeing to the counter statement) (Question 9) that—

1. *HCM* is needed for planning,
2. *HCM* computations are NOT too complex,
3. *HCM* software is NOT too complex, and
4. *HCM* results are accurate and reliable, but
5. *HCM* lacks methods for evaluating operations strategies [e.g., high-occupancy vehicle (HOV)/high-occupancy toll (HOT) lanes, congestion pricing, ramp metering, speed harmonization].

Expert users definitely disagreed that the *HCM* was not really needed for planning, or that the *HCM* was too complex or requires too much data (Question 9). They tended to

agree that the major challenges to using the *HCM* in planning are the following:

- *HCM* lacks methods for evaluating operations strategies (e.g., HOV/HOT lanes, congestion pricing, ramp metering, and speed harmonization).
- *HCM* does not produce performance measures useful for comparing different degrees of congestion [i.e., once level of service (LOS) F, always LOS F].
- *HCM* treats demand as fixed (does not account for induced demand).
- *HCM* and/or *HCM* software does not integrate well with travel demand forecasting software.

Less experienced users tended to follow the same trends as the experienced users in identifying the primary challenges to using the *HCM* in planning (Question 9), but felt less strongly about their conclusions. Their responses were more scattered.

Primary Reasons to Use *HCM* in Planning

The majority of respondents agreed that the *HCM* is useful for both long- and short-range planning, and that one of the reasons is that decision makers and the general public prefer the LOS letter grades produced by the *HCM* (Question 10).

A minority of the inexperienced users disagreed that the public prefers LOS letter grades. None of the average users or expert users disagreed with this statement.

What Would Improve the *HCM* for Planning

The majority of respondents supported the following improvements to make the *HCM* more useful for planning (Question 11).

- Developing an *HCM* Planning Applications Guide to help agencies use the *HCM* (77% of respondents)
- Adding a measure of travel time reliability to the performance measures produced by *HCM* methods (63%)
- Extending the *HCM* to multifacility (e.g., system and corridor) analyses (63%)
- Adding other traditional planning measures of effectiveness such as vehicle-miles traveled, vehicle-hours traveled, person-miles traveled, and person-hours traveled (60%)
- Better integration of *HCM* analysis methods into travel demand forecasting software (60%)

CONCLUSIONS

Planning and preliminary engineering encompass a wide range of planning and project development activities. The *HCM* is currently quite useful and widely used for the middle stage of the project development process: project clearance and land development impact analyses. Relatively few additional adaptations are required, although the recommendations of *NCHRP Report 599*: *Default Values for Highway Capacity Analysis* would be a useful addition.

Regarding the earlier stages of project development, specifically master plans (e.g., Long-Range Transportation Plan) used by agencies to identify and prioritize projects, and project needs assessment, there are several opportunities for improving the accuracy of those early stage analyses through better incorporation of *HCM* procedures into the planning tools used during those stages.

There are opportunities to improve the environmental impact analyses that are performed during the project clearance stage by developing guidance on how to better coordinate *HCM* analyses with demand model forecasts and provide for equilibration of the results. Analyses that the *HCM* could better support include regionwide air quality, greenhouse gas, and sustainability/climate change analyses. This will provide a "first step" level of improvement to planning analyses.

The next step to improving planning analyses requires basic research into identifying methods for incorporating *HCM* quality capacity and performance analyses directly into the travel demand forecasting process. Dynamic traffic assignment shows great potential along these lines but must overcome various technical hurdles to better model the operation of signals within the demand model network.

Finally, the *HCM* needs better mechanisms for outreach. This will allow more input from practicing engineers and planners about useful additions to future *HCM* editions.

RESEARCH NEEDS

Five research needs were determined from this survey. The first four can be research and development for a Planning and Preliminary Engineering Applications Guide (PPEAG). The fifth, incorporation of *HCM* techniques within travel demand models, will require more research before the results can be included in the PPEAG.

Update *HCM* Planning Application Survey for *HCM* 2010

The planning applications survey for the current synthesis project was conducted just as the 2010 *HCM* was being distributed to practitioners; therefore, the survey respondents were not yet familiar with the contents of the 2010 *HCM.*

Finally, the utility of the *HCM* for planning and preliminary applications could be reassessed from the perspective of agency users once users become familiar with the 2010 *HCM.* The 2010 edition was a major update, with many things being improved or added, and it would be useful to

know how it is being used and perceived by today's engineers and planners.

Develop an *HCM* Planning and Preliminary Engineering Applications Guide

As cited by the vast majority of survey respondents, a PPEAG might be a useful adjunct to the *HCM*. It could facilitate *HCM* use in planning analyses and increase the accuracy and reliability of the traffic performance results predicted by planning studies. The guide could cover the following concerns:

- The spectrum of types of analyses that are appropriate for different *HCM* applications
- The appropriate uses for different parts of the *HCM* (e.g., regional systems planning and finer grained site impact)
- How the science of planning is connected to the *HCM* at each scale of planning
- Use of the *HCM* in scenario planning
- Multimodal transportation analysis tools
- Better integration of the *HCM* with travel demand forecasting models

Incorporate *NCHRP Report 599* into the Planning and Preliminary Engineering Applications Guide

Survey results suggest that the inclusion of default values for various inputs is the second highest priority. The *HCM* is already well established and extensively used for land development site impact analyses, so the PPEAG need not devote much effort to that particular planning application. *NCHRP Report 599*: *Default Values for Highway Capacity Analyses* could serve as the basis for this portion of the PPEAG.

Although many of the specific recommendations of *NCHRP Report 599* have been included in the 2010 *HCM*, much could not be incorporated. The PPEAG could be able to include and more widely disseminate more useful material from *NCHRP Report 599* for planning applications.

The guide might provide an understanding of the full spectrum of analyses that are appropriate for different applications of the *HCM*. Once this is accomplished, appropriate uses for different parts of the manual can be determined so that the user does not misuse the manual. There is a science to planning, and how the *HCM* connects with planning at each level must be fully understood to create a useful guide.

Develop Guidance on Using *HCM* in Parallel with Travel Demand Models

Interpretation of the survey results shows that developing guidance on using the *HCM* with travel demand models is the third highest priority for improving the *HCM* for planning applications. During the project clearance stage of project delivery, the analyst must work with both travel demand models and the *HCM* to get the systemwide performance measures and the project-specific performance measures necessary for environmental analysis and preliminary engineering of the project. Significant improvements in planning/preliminary engineering practice can be made by improving on the current ad hoc methods for using demand model forecasts in *HCM* analyses. Methods and guidance for applying those methods are necessary to feed back the *HCM* results into the demand forecasts and equalize the results.

As a few respondents to the survey noted, some demand models already incorporate aspects of the *HCM*. The PPEAG might provide planners with alternative methods for using the *HCM* and models in parallel when integration is infeasible. This guidance would significantly improve the environmental analysis of transportation improvement projects.

Develop Methods for Integrating *HCM* Analysis into Travel Demand Models

The final priority item for improving the *HCM* is to develop methods for integrating *HCM* analyses into travel demand models. There is great need for and great value to adapting *HCM* procedures to better incorporate them into existing system and corridor demand modeling tools, such as travel demand models. Additional research is needed to develop the methodological adaptations to incorporate improved *HCM* capacity analysis and performance procedures into conventional travel demand models and into advanced models using Dynamic Traffic Assignment. Once the basic research is completed, the results can then be codified in a series of recommended procedures in the PPEAG.

As a few respondents to the survey noted, some demand models already incorporate aspects of the *HCM*. The PPEAG might improve on the integration of the *HCM* with demand models, provide guidance on the integration, and help better standardize the integration to promote more consistent analytical results.

REFERENCES

1. "Planning," The Free Dictionary [Online], Available: http://www.thefreedictionary.com/planning.
2. "The Transportation Planning Process," FHWA-HEP-07-039, FHWA, Washington D.C., 2007.
3. Alexiadis, V., K. Jeannotte, and A. Chandra, *Traffic Analysis Toolbox Volume I: Traffic Analysis Tools Primer*, FHWA-HRT-04-038, FHWA, Washington, D.C., July 2004.
4. *The Transportation Planning Process Key Issues*, FHWA-HEP-07-039, FHWA, Washington, D.C., 2007 [Online]. Available: http://www.planning.dot.gov/documents/BriefingBook/BBook.htm.
5. *Transportation Planning Handbook*, 3rd ed., ITE, Washington, D.C., 2009.
6. *Caltrans Project Development Procedures Manual*, California Department of Transportation, Sacramento [Online]. Available: http://www.dot.ca.gov/hq/oppd/pdpm/pdpmn.htm.
7. Dowling, R., *Guide on the Consistent Application of Traffic Analysis Tools and Methods*, Draft, FHWA, Washington, D.C., 2011.
8. *Highway Capacity Manual*, TRB, National Research Council, Washington, D.C., 2000, 1,134 pp.
9. *Highway Capacity Manual*, Transportation Research Board of the National Academies, Washington, D.C., 2010, 1,650 pp.
10. Dowling, R., W. Kittelson, and J. Zegeer, *NCHRP Report 387: Planning Techniques to Estimate Speeds and Service Volumes for Planning Applications*, Transportation Research Board, National Research Council, Washington, D.C., 1997.
11. Zeeger, J.D., et al., *NCHRP Report 599: Default Values for Highway Capacity and Level of Service Analyses*, Transportation Research Board of the National Academies, Washington, D.C., 2008, 124 pp.
12. *2009 Quality/Level of Service Handbook*, Florida Department of Transportation, Systems Planning Office, Tallahassee, 2009.
13. Chiu, Y.-C., et al., *Transportation Research Circular E-C153: A Primer for Dynamic Traffic Assignment*, Transportation Network Modeling Committee (ADB30), Transportation Research Board of the National Academies, Washington, D.C., 2010, 52 pp.
14. Kittelson, W., et al., *Understanding the Contribution of Operations, Technology, and Design to Meeting Highway Capacity Needs*, SHRP2 C05, Final Report, TRB, Washington, D.C., 2012, in press [Online]. Available: http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2164 [accessed Aug. 2011].
15. Husch, D. and J. Albeck, *Intersection Capacity Utilization, Evaluation Procedures for Intersections and Interchanges*, Trafficware Corp., Sugar Land, Tex., 2003.
16. Gould, J., "Comparing the 1985 *HCM* and the ICU Methodologies," *ITE Journal*, ITE, Washington, D.C., Aug. 1990.
17. *Transportation Research Circular 212, Interim Materials on Highway Capacity*, TRB, National Research Council, Washington, D.C., 1984.
18. "Partnership to Develop an Integrated, Advanced Travel Demand Model and a Fine-grained, Time-Sensitive Network," Transportation Research Board of the National Academies, Washington, D.C. [Online]. Available: http://www.shrp2c10.org/SHRPC10Portal/Home.aspx. Accessed Aug. 2011.
19. "Analytical Travel Forecasting Approaches for Project-Level Planning and Design," NCHRP 08-83 [Online]. Available: http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2958 [accessed Aug. 2011].
20. Kittelson & Associates, "NCHRP 3-92: Production of the 2010 *Highway Capacity Manual*, Working Paper #2: Focus Group Survey Results," Portland, Ore., 2008.
21. Ruehr, E., *HCM* 2000, Planning and Preliminary Engineering Audit White Paper, Nov. 2003.

APPENDIX A

Survey Instrument

The following pages provide the survey questionnaire converted into an MS Word document from the web-based survey. As this is a converted web document, do not be concerned with formatting as it will look different in the online edition.

Introduction and Preliminary Information

Dear Transportation Planning Professional:

The Transportation Research Board (TRB) is preparing a synthesis on the Extent of Highway Capacity Manual (*HCM*) Use in Planning. This is being done for NCHRP, under the sponsorship of AASHTO, in cooperation with the FHWA.

The objective of this survey is to assess the ways in which the *HCM* is being used, or could be used, by state departments of transportation, metropolitan planning organizations, and local governments for performance monitoring, problem identification, project prioritization, programming, and decision-making processes. FHWA will also be included in this information collection.

This survey is being sent to state departments of transportation, metropolitan planning organizations, and local governments. Your cooperation in completing the questionnaire will ensure the success of this effort. If you are not the appropriate person at your agency to complete this survey, please forward it to the correct person.

Please compete and submit this survey by February 28, 2011. We estimate that it should take no more than 15 minutes to complete. A follow-up phone interview will be conducted with you starting in March to help us fully understand how your agency utilizes the *Highway Capacity Manual.* If you have any questions, please contact our principal investigator Richard Dowling, rdowling@dowlinginc.com, (510) 839-1742. Any supporting materials can be sent directly to Richard Dowling by e-mail or at the postal address shown at the end of the survey.

QUESTIONNAIRE INSTRUCTIONS

To view and print the entire questionnaire, click on the following link and print using "CTRL + P"

To save your partial answers, click on the "Save and Continue Later" link in the upper right hand corner of your screen. A link to the partial survey will then be e-mailed to you.

To view and print your answers before submitting the survey, click forward to the page following question 12. Print using "CTRL + P".

To submit the survey, click on "Submit" on the last page.

Contact Information

Please enter the date (MM/DD/YYYY).

_____

Please enter your contact information.

Basic Questions

1.) What type of agency do you work for?

( ) City/County/Borough

( ) Transit Operator

( ) Other subregional agency (e.g., congestion management agency, toll facility operator, etc.)

( ) Regional Metropolitan Planning Organization

( ) State Department of Transportation

( ) Federal Highway Administration

( ) Other:

2.) How would you rate your familiarity with the *Highway Capacity Manual?*

( ) I Have Never Used It

( ) Basic

( ) Average

( ) Advanced

( ) Expert

Overview of Planning Practices Performed

3.) How often do you or your agency perform the following short-range (<20 years) planning practices?

	You, Personally?				*Your Agency?*			
	At Least Once per Month	*At Least Once Every 6 Months*	*At Least Once per Year*	*Never*	*At Least Once per Month*	*At Least Once Every 6 Months*	*At Least Once per Year*	*Never*
Highway/Transit Systems Planning	( )	( )	( )	( )	( )	( )	( )	( )
Highway Facility and Corridor Planning	( )	( )	( )	( )	( )	( )	( )	( )
Congestion Management	( )	( )	( )	( )	( )	( )	( )	( )
Bicycle/Pedestrian Planning	( )	( )	( )	( )	( )	( )	( )	( )
Development Decisions (site impact studies)	( )	( )	( )	( )	( )	( )	( )	( )
Performance Monitoring	( )	( )	( )	( )	( )	( )	( )	( )

4.) How often do you or your agency perform the following long-range (20+ years) planning practices?

	You, Personally?				*Your Agency?*			
	At Least Once per Month	*At Least Once Every 6 Months*	*At Least Once per Year*	*Never*	*At Least Once per Month*	*At Least Once Every 6 Months*	*At Least Once per Year*	*Never*
Highway/Transit Systems Planning	( )	( )	( )	( )	( )	( )	( )	( )
Highway Facility and Corridor Planning	( )	( )	( )	( )	( )	( )	( )	( )
Project Prioritization	( )	( )	( )	( )	( )	( )	( )	( )
Bicycle/Pedestrian Planning	( )	( )	( )	( )	( )	( )	( )	( )
Development Master Planning	( )	( )	( )	( )	( )	( )	( )	( )

Overview of Planning Practices Performed Using *HCM* Methods

5.) How often do you or your agency use the *Highway Capacity Manual* (*HCM*), *HCM*-like methods, or software based on the *HCM*, for the following short-range (<20 years) planning practices?

	You, Personally?				*Your Agency?*			
	At Least Once per Month	*At Least Once Every 6 Months*	*At Least Once per Year*	*Never*	*At Least Once per Month*	*At Least Once Every 6 Months*	*At Least Once per Year*	*Never*
Highway/Transit Systems Planning	( )	( )	( )	( )	( )	( )	( )	( )
Highway Facility and Corridor Planning	( )	( )	( )	( )	( )	( )	( )	( )
Congestion Management	( )	( )	( )	( )	( )	( )	( )	( )
Bicycle/Pedestrian Planning	( )	( )	( )	( )	( )	( )	( )	( )
Development Decisions (Site Impact Studies)	( )	( )	( )	( )	( )	( )	( )	( )
Performance Monitoring	( )	( )	( )	( )	( )	( )	( )	( )

6.) How often do you or your agency use the *Highway Capacity Manual* (*HCM*), *HCM*-like methods, or software based on the *HCM* for the following long-range (20+ years) planning practices?

	You, Personally?				*Your Agency?*			
	At Least Once per Month	*At Least Once Every 6 Months*	*At Least Once per Year*	*Never*	*At Least Once per Month*	*At Least Once Every 6 Months*	*At Least Once per Year*	*Never*
Highway/Transit Systems Planning	( )	( )	( )	( )	( )	( )	( )	( )
Highway Facility and Corridor Planning	( )	( )	( )	( )	( )	( )	( )	( )
Project Prioritization	( )	( )	( )	( )	( )	( )	( )	( )
Bicycle/Pedestrian Planning	( )	( )	( )	( )	( )	( )	( )	( )
Development Master Planning	( )	( )	( )	( )	( )	( )	( )	( )

Satisfaction with Using the *HCM* in Planning Analyses

7.) How satisfied are you with using the *Highway Capacity Manual* or *HCM*-based software for the following short-range (<20 years) planning applications?

	Very Dissatisfied	*Dissatisfied*	*Neutral*	*Satisfied*	*Very Satisfied*	*N/A*
Highway/Transit System Planning	( )	( )	( )	( )	( )	( )
Highway Facility and Corridor Planning	( )	( )	( )	( )	( )	( )
Congestion Management	( )	( )	( )	( )	( )	( )
Bicycle/Pedestrian Planning	( )	( )	( )	( )	( )	( )
Development Decisions (Site Impact Studies)	( )	( )	( )	( )	( )	( )
Performance Monitoring	( )	( )	( )	( )	( )	( )

8.) How satisfied are you with using the *Highway Capacity Manual* or *HCM*-based software for the following long-range (20+ years) planning applications?

	Very Dissatisfied	*Dissatisfied*	*Neutral*	*Satisfied*	*Very Satisfied*	*N/A*
Highway/Transit System Planning	( )	( )	( )	( )	( )	( )
Highway Facility and Corridor Planning	( )	( )	( )	( )	( )	( )
Project Prioritization	( )	( )	( )	( )	( )	( )
Bicycle/Pedestrian Planning	( )	( )	( )	( )	( )	( )
Development Master Planning	( )	( )	( )	( )	( )	( )

Challenges Facing *HCM* Use in Planning Applications

9.) What do you think are the primary challenges in using the *Highway Capacity Manual* (*HCM*) analysis methods for planning applications?

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*	*N/A*
HCM is not really needed for planning	( )	( )	( )	( )	( )	( )
HCM requires too much data	( )	( )	( )	( )	( )	( )
HCM computations are too complex	( )	( )	( )	( )	( )	( )
HCM software is too complex	( )	( )	( )	( )	( )	( )
The HCM results are inaccurate or unreliable	( )	( )	( )	( )	( )	( )
The performance measures produced using the HCM are not useful for planning	( )	( )	( )	( )	( )	( )
HCM is insensitive to typical planning policy inputs (e.g., complete streets, traffic calming, TDM, etc.)	( )	( )	( )	( )	( )	( )
HCM lacks methods for evaluating operations strategies (e.g., HOV/HOT lanes, congestion pricing, ramp metering, speed harmonization, etc.)	( )	( )	( )	( )	( )	( )
HCM does not produce performance measures useful for comparing different degrees of congestion (once LOS F, always LOS F)	( )	( )	( )	( )	( )	( )
HCM treats demand as fixed (does not account for induced demand)	( )	( )	( )	( )	( )	( )
HCM and/or HCM software does not integrate well with travel demand forecasting software I use	( )	( )	( )	( )	( )	( )

Are there any other challenges you feel affect your use of the *HCM* analysis methods in planning applications? Please specify in the text box provided:

Primary Reasons for Using *HCM* Methods in Planning Applications

10.) What do you think are the primary reasons for using the *Highway Capacity Manual* (*HCM*) analysis methods in planning applications?

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*	*N/A*
HCM is useful for short-range planning	( )	( )	( )	( )	( )	( )
HCM is useful for long-range planning	( )	( )	( )	( )	( )	( )
HCM provides more accurate highway performance predictions than travel demand forecasting tools	( )	( )	( )	( )	( )	( )
Decision makers and the general public prefer level of service letter grades	( )	( )	( )	( )	( )	( )
HCM is required by custom, law, or reviewing agency	( )	( )	( )	( )	( )	( )
HCM is better than other available tools for generating the performance measures I need	( )	( )	( )	( )	( )	( )
HCM is sensitive to detailed project characteristics I need to consider such as stop signs and grade	( )	( )	( )	( )	( )	( )
The HCM is easy to use for planning applications	( )	( )	( )	( )	( )	( )

Are there any other planning applications that you would use the *Highway Capacity Manual* for? Please specify in the text box provided:

_____

_____

_____

_____

Possible Improvements to the *HCM* for Planning Applications

11.) What do you think would greatly improve your ability to use the *Highway Capacity Manual* (*HCM*) methods more often in planning analyses?

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*	*N/A*
No improvements are needed	( )	( )	( )	( )	( )	( )
Developing an HCM Planning Applications Guide to assist agencies in using the HCM	( )	( )	( )	( )	( )	( )
Providing more default values for difficult HCM input data	( )	( )	( )	( )	( )	( )
Extending HCM LOS grades beyond LOS F	( )	( )	( )	( )	( )	( )
Elimination of Level of Service	( )	( )	( )	( )	( )	( )
Adding other traditional planning MOE's such as VMT, VHT, PMT, and PHT	( )	( )	( )	( )	( )	( )
Adding a measure of travel time reliability to the performance measures produced by the HCM methods	( )	( )	( )	( )	( )	( )
Extending the HCM to multi-facility (system, corridor) analyses	( )	( )	( )	( )	( )	( )
Simplifying HCM analysis procedures						
Better integration of HCM analysis methods into travel demand forecasting software						
Providing easy to use service volume tables						

Are there any other improvements you feel would increase your ability to use the *Highway Capacity Manual* in planning analyses? Please specify in the text box provided:

_____

_____

_____

_____

Additional Comments

12.) Are there any additional comments or suggestions you would like to make about using the *Highway Capacity Manual* for planning purposes?

_____

_____

_____

_____

Review Your Responses

Thank You!

Thank you for your insights into how the Highway Capacity Manual is utilized within transportation planning. We will review your responses and make a follow-up phone interview to help us better understand how your agency utilizes the HCM *in planning. If you have any questions or comments, please feel free to contact*

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APPENDIX B

Responses to Follow-up Interviews

This section provides more details on the responses obtained from the follow-up phone interviews. Two questions were asked of all respondents in the phone interview. Then additional questions were asked to obtained insights into some of the specific responses from each survey participant.

What do you feel is specifically missing from the *HCM* in terms of capacity and LOS analysis in planning applications?

- Since we don't use the *HCM* directly, I am not as familiar with it as I should be. At least in the last 10 years. Many of my comments may already be addressed and I am just not aware of it. But a process that requires less detail, like geometric, time of day characteristics and signal timing, would be helpful. Something that utilizes the output of traditional regional travel demand models.
- Using v/c and similar measures for different degrees of LOS is mentioned, but the discussion should be expanded and detailed for different types of facilities.
- Capacity estimates for different facilities under several different scenarios. Also, measures of service important to planners such as travel time, running speed, and total trip delay.
- The problem is not what's missing in the *HCM*, but what's in there that should have been left out. "Planning analysis" (compared to operational) should mean lower levels of resolution/more use of default values where appropriate, not tables with numbers that are as inconsistent with core methodology as they are inaccurate 90+% of the time merely because "planners tell us they want them." (The *HCM* first and foremost needs to have credibility with engineers, and there are reasons why many planners are not taken seriously by engineers.)
- Alternate performance measures and methods are needed such as travel time, accessibility, and reliability as well as for alternate modes. There is also a need to factor in the reduction in capacity due to queue spillbacks/interactions at signalized intersections.
- It should more accurately deal with length of turn lanes at intersections and the effect of insufficient length on the capacity. More accurately deal with measurement of demand volume on saturated road segments. FDOT procedure deal with the issue somewhat. No of cycle failures at an intersection may be a better way to establish LOS standard. Effect of multi-modal (complete roads) should be more accurately reflected on the capacity; i.e., effect of dedicated bicycle lane, buses and stops, and pedestrians. Somehow context sensitive solution should be incorporated into the capacity analysis. Effect of heavy trucks should be reflected better on the conditions and the driver expectancy. Another opportunity to expand the discussion of the manual is in Chapter 16 under Interpretation of Results. While the manual addresses generally what to make of LOS and v/c deficiencies, it does not offer, in my opinion, caution in evaluating LOS of minor side street movements. For example, a minor side street movement may have an LOS of E or F based on delay, wherein that delay is a necessary product of the need to provide adequate green time to the mainline movements, particularly through movements. This may occur even though side street v/c ratios are well below 1.0. Users of the *HCM* should be cautioned to consider the level of side street demand in comparison to mainline demand while deciding if improvements should be considered or required, or even if improvements would be effective or feasible.
- Gainesville's transit system is successful mainly due a coerced ridership population, University of Florida students. Parking accommodation at both trip ends can affect LOS measurement. Zoning codes have traditionally accommodated LOS tools by requiring "Christmas shopping" levels of parking capacity. With drive-thrus, home deliveries, smart growth, etc., this is changing to having parking accommodation maximums which will facilitate the promotion of multimodal options [bike, pedestrian, and transit].

  I still question why capacity analysis, and roadway facility modification decision making, is based on peak hour performance. If the peak period is longer, then duration of congested conditions should be fully accounted for (measured). With our willingness to add roadway capacity with our current LOS methodologies, there has been minimal need/opportunity/encouragement to develop transit-oriented densities in post-WWII urbanization and suburbanization.

  While not necessarily in the *HCM* realm trip cost-per-mile could be a factor for LOS, given rising and volatile fuel costs. Our urban form has been based on cheap and plentiful fuel. This could change.

- The *HCM* needs a context for how you plan on a system level. With the incorporation of system level procedures, it is important to focus on what are the limitations and practical applications of the *HCM* might be. Questions like how big a system are

we talking about, a couple of streets, city, region, state? Need to have a clear understanding of what we are using the *HCM* for and what are the limitations we may have.
- Reliability.
- The ability to simplify the analysis. Since *HCM* is based upon operational analysis, that requires details unknown in the future planning horizon; the computation procedures are too complex when trying to get a general idea of future conditions. Also, during the planning the system (length of corridor, number of intersections or interchanges) is large. Instead of examining 10 miles of corridor the analysis is being done on 200 miles of corridor. *HCM* is set up to look at smaller segments, making the analysis of a lengthy corridor very cumbersome.
- Perhaps we need better measures to address time of day phenomena, we need to get away from daily performance measures, as time of day models and dynamic traffic assignments are becoming more and more widely accepted. Temporal & diurnal distributions of traffic, along with peak spreading, are important for *HCM* & LOS to better consider and address.
- Better accounting for trip generation and mode choice in urban environments.

Is there any other content in the *HCM* that you feel is missing that would make it more practical for planners?

- Perhaps separate the manual into two parts, planning and engineering.
- I think we still fall very much short of the ideal where the *HCM* could be used in planning applications by using default parameters to get an approximate answer. The signalized methodology is the biggest issue. There should be defaults for cycle lengths and phase times.
- For each *HCM* facility methodology, suggested items of importance for planners.
- The problem is not what's missing in the *HCM*, but what's in there that should have been left out. "Planning analysis" (compared to operational) should mean lower levels of resolution/more use of default values where appropriate, not tables with numbers that are as inconsistent with core methodology as they are inaccurate 90+% of the time merely because "planners tell us they want them." (The *HCM* first and foremost needs to have credibility with engineers, and there are reasons why many planners are not taken seriously by engineers.)
- More refined default values would be helpful especially for lower population areas.
- Perhaps a chapter that provides guidance on conducting local studies that measure variables such as start-up lost time, end of phase lost time, lane utilization, etc., and the proper application of the results of those study to the actual analysis.
- Consider:

  measuring mobility rather than capacity;

  incorporating mode choice as a factor; and

  incorporating route choice options [transportation network articulation (grid vs. cul-de-sac feeding arterials)] as a factor.

  The driving population is very diverse and dynamic [young, old, commuters, tourists, freight (loaded/unloaded), with/without passengers, etc.]

- Freight planning and operational analysis would be a good addition to the *HCM*. Topics covered should involve something like how do you plan freight within different corridors tied together in a systems analysis, and how is lane distribution for freight units handled.

  Another addition for planners would be how to tie in ATDM measures to the planning process.

- Inclusion of ATM strategies.
- Generalized service volume tables for use on general planning activities.
- Travel time reliability as a performance measure could be an additional element for *HCM* to contribute to.

Miscellaneous Follow-up Questions

This section provides the detailed responses to specific follow-up questions designed to elicit insights into the responses.

North Central Texas Council of Governments (NCTCOG) Respondent

1. I see that you perform all the short-range planning practices listed but rarely or never use the *HCM* for them. What would you say are the primary reasons you do not use the *HCM*? What do you currently use instead?
   a. We use variations of the *HCM* procedures, but do not follow *HCM* by the book. We do not generally have detailed enough data to perform some of the procedures.

2. You indicated that you strongly disagree with elimination of level of service from the *HCM*. Why do you think LOS elimination would not be a good improvement for the *HCM*?
   a. For planning purposes, LOS is a valuable performance measure that is easily understood by elected officials and the general public. I can see why it may not be quantitative enough for many engineering applications though.

3. You indicated that you would like to see default values based on region. What are your thoughts on current *HCM* defaults and why do you feel they should be regionalized?
   a. If not regionalized, at least indicate that studies have been done to indicate that these values do not vary enough across the country and that the use of general defaults are adequate. For example, the speed/flow/density curves, we see different travel behaviors in different corridors and we may not have enough geometric detail to plug values in, so regional defaults could take into account local behavior due to variables that we may not have enough data to model.

Wyoming DOT Respondent

1. You indicated that you perform short-range highway facility and corridor planning at least once every 6 months but never use the *HCM* while some in your agency do. Why do you not use the *HCM* and what do you use instead?
   a. Most short-range facility/corridor planning that the Planning Department is involved in takes place in the urban areas, where we use our modeling software.

2. Your agency seems to rarely use the *HCM* for various planning applications, what are the reasons for not using it and what methodologies do you use instead?
   a. Our population in Wyoming (560,000) and most traffic volumes throughout the state are not approaching capacity. Most planning decisions are driven by factors other than capacity, traffic projections are made through our traffic data collection and analysis software, and any localized capacity issues are usually dealt with from our Traffic Program.

VRPA Technologies Respondent

1. While you and your agency perform bike/pedestrian planning in both short and long range, you never use the *HCM* for these applications. What are the primary reasons for not using the *HCM*? What do you use instead?
   a. We have not worked on pedestrian or bike projects where capacity is an issue, so there is no need for a capacity analysis and no need to use the *HCM* or any other tool. When the new quality of service procedures are out, we will probably use them for our pedestrian and bike projects.

2. Why do you feel that the *HCM* not accounting for induced demand is not a major challenge facing the *HCM*?
   a. Induced demand seems to be out of the scope of the *HCM*. It is a whole new subject area and I think it should be discussed outside of the *HCM*.

3. You indicated that you strongly disagree with the elimination of the LOS methodology. What are the primary reasons you feel that it should be kept? Can you give us some example applications where LOS was critical to have that we can pass on to the panel overseeing this study?
   a. The LOS concept has been adopted by a much wider group of people than just transportation professionals and *HCM* users. While it could potentially be dropped from the *HCM*, people would continue to use it. Its wide level of use among environmental planners, civil engineers, and policy makers indicates that it is a useful concept.

South Dakota School of Mines Respondent

1. What do you think are the main reasons the *HCM* is not easy to use for planning applications?
   a. Too many generalizations. Insufficient performance measures.

2. Is there a planning tool that you feel is easier and/or better to use than the *HCM*?
   a. UTPS four step planning based models, Emme2, VISUM, QRS, AIMSUM.

3. You were strongly against providing easy to use service volume tables. Why do you feel these tables would not be good for the *HCM*?
   a. Too many generalizations and default assumptions. One may not get the same SVs if one used a detailed operational analysis.

Ohio DOT Respondent

1. You indicated that you strongly disagree with the elimination of the LOS methodology. What are the primary reasons you feel that it should be kept? Can you cite some examples in your practice where LOS was critical so that we can pass it on to the panel?
   a. If we eliminate LOS, than what would be used to establish design guidance in its place? (starting with the AASHTO *Green Book*, Figure 2-32 in the 2004 edition)

2. Do you think there are any limitations to using an LOS methodology?
   a. Not sure what you're getting at with this question. (I did mention in my comments the need to have relative as well as absolute standards around depending on the audience.)

3. You were strongly against providing easy to use service volume tables. Why do you feel these tables would not be good for the *HCM*?
   a. This is a "credibility-killer" for the *HCM* for those roadway types where LOS is not based on volume to begin with.

Oregon DOT Respondent

1. You indicated dissatisfaction with using the *HCM* for congestion management and bike/pedestrian planning. What are the main issues you feel the *HCM* has in regards to these two planning practices?
   a. Congestion management—*HCM* analytical procedures break down when projected demand exceeds capacity or when queues spill back outside of turn lanes or between intersections. There also do not seem to be very satisfactory methods for estimating shifts in demand due to congestion.

      Bike/pedestrian planning—the 2000 *HCM* methods are not applicable to most situations in Oregon where bike/pedestrian volumes are not very high.

2. Your response to what would greatly improve your ability to use the *HCM* was to "add more high level analysis methods. Such as to report hi/medium/low risk without reporting LOS or v/c ratio." Could you give an example of what you mean by this and how you envision the *HCM* incorporating it?
   a. In planning studies there can be a tendency for analysis to be done at a greater level of detail than necessary when a simpler method would have saved time and money. It would be helpful if there were more emphasis on selecting the least intensive method to answer the question being asked. There could be an emphasis on following a tiered approach, starting with the least amount of detail and increasing the level of detail only as necessary.

Florida DOT Respondent #1

1. You indicated that you strongly disagree with the elimination of the LOS methodology. What are the primary reasons you feel that it should be kept?
   a. This practice could be improved; the exact inputs used in the computations could be revisited. As they exist right now, I think they're fine. What measures of mobility would be superior to LOS, Travel time reliability, TTI, persons hour delay? All of these can tell their own story but none posses the comprehensive assessment that is in an LOS grade.

2. Do you think there are any limitations to using an LOS methodology?
   a. Sure, LOS is a good planning and preliminary engineering measure but does not provide the level of detail needed for other types of engineering and operational needs.

3. You strongly agreed with extending the *HCM* to multi-facility analysis. Isn't this similar to what FSUTMS does? If so, would you prefer to get *HCM* results into FSUTMS or have the *HCM* work like FSUTMS?
   a. I am not a modeler nor do I work in traffic operations, I work primarily as a planner. When I think of a multifacility analysis I think of an area wide LOS, or having the ability to assess the capacity of multiple parallel facilities.

4. You indicated that you would like to see easy to use service volume tables in the *HCM*. Would you have any concerns about using these and if so what would they be?
   a. Currently the FDOT service volume tables are commonly used for a quick and easy analysis. Similar to FDOT service tables, I would like to see *HCM* tables account for adjustment factors. Some people think that our service volume tables are biased, hopefully that same perception would not exist for the *HCM* tables.

Florida DOT Respondent #2

1. What are the most pressing issues for freeway analysis and interchanges that you feel are not addressed in the *HCM*?
   a. It would be beneficial for the weaving MOE's to evaluate weaving sections having multiple origin-destinations. Also, the *HCM* lacks prediction of backups in the mainline due to the ramp termination conditions or cross street delay by not being able to process the volume on time. Again, current *HCM* doesn't address a situation where a ramp has 3 lanes. Triple lefts and trip rights are more common these days in urbanized areas. Influence area as a maximum of 2,500' may not be the max length for weaving section. Current configuration (A, B, C) do not cover all possible weaving combinations.

2. You agreed more strongly that *HCM* is useful for long-range planning than you did for short-range planning. What is the reason for agreeing more strongly with the statement about long-range planning?
   a. To mention few, in addition to the above, it does not predict weaving along arterials, backup from turn lanes into the through lanes and driveways effect near intersections. Very limited information regarding the roundabout analysis. It would be beneficial to integrate the signalized and unsignalized intersections speeds/service volumes with the arterial streets speeds.

3. You strongly disagreed with the elimination of LOS, why do you feel eliminating LOS will not improve the *HCM*?
   a. The LOS is a common term or measure that is used by many in the public or even in planning process and in comprehensive Plans, LRTP, concurrency …etc. As mentioned before, it should be one of the factors considered in addition to others such as delay, time of travel…etc.

4. You were also against service volume tables as a feature to improve the *HCM*. What do you feel would be the issues with service volume tables?
   a. Misuse. Misunderstand. Too simplistic to predict conditions…etc.

Florida DOT Respondent #3

1. You indicated that you occasionally do pedestrian/bike planning but do not use the *HCM*. What do you use instead and why do you use it rather than the *HCM*?
   a. Bike/pedestrian planning is done with guidelines, standards and criteria outlined in the following publications:

      - Florida Bicycle Facilities Planning and Design Handbook
      - Florida Pedestrian Facilities Planning and Design Handbook
      - Manual on Uniform Minimum Standards for Design, Construction, and Maintenance for Streets and Highways
      - MUTCD
      - FDOT Plans Preparation Manual (PPM)
      - Guide for Development of Bicycle Facilities

      The *HCM* tends to deal with the computational procedures for capacity and width of accommodations for bike and pedestrian in context of the highway or arterial roadway which in traffic engineering is useful. It is important to differentiate between the engineering phases and planning phases and it is during the planning phase a context sensitive approach to accommodating the bikes and pedestrians within the corridor is more desirable. *HCM* is engineering not planning so I do not use it in planning for bike and pedestrian facilities.

2. You disagreed with extending the *HCM* beyond LOS F as an improvement to the *HCM*. Why do you feel this would not be an improvement and what do you think would be the best way to measure varying degrees of congestion?
   a. *HCM* focuses on individual link performance of the highway. *HCM* fails to distinguish varying degrees of oversaturation for a highway system. To determine how highway system wide improvements can incrementally reduce congestion a microsimulation model is necessary. This is especially true when analyzing interchanges on limited access highway facilities. When the highway reaches LOS F other modal solutions may relieve the highway congestion. The type of long-range planning done in the FDOT Systems planning office considers all modes (aviation, seaport, rail, transit, and highway). *HCM* is a good first step to determine if a LOS F condition exists on a highway facility. After that, microsimulation is the best way to measure varying degrees of congestion.

Florida DOT Respondent #4

1. Since you are a public transportation supervisor, how do you feel the *HCM* could be improved to better accommodate the needs of public transportation planners and engineers?
   a. I would focus on the consistency for all that we do in the planning analysis. If the *HCM* is selected by the agency, FDOT for example, FDOT will inform all the MPOs, Regional Planning Councils, and local partners about the standard policy for projects evaluation and analyses.

North Central Florida Regional Planning Council (NCFRPC) Respondent

1. You strongly disagreed that the elimination of LOS would improve the *HCM*. Why do you feel elimination of LOS would not be a positive improvement?
   a. LOS offers measurable gradations for monitoring facility usage that decision-makers can use to evaluate transportation network needs and program modifications and/or alternatives, such as mode shifts.

2. You were also against the addition of service volume tables. Why would you be against the addition of these tables?
   a. The Florida Department of Transportation's Quality/Level of Service Handbook includes generalized LOS tables. The levels of service and service volumes in these tables are generated from default values for the average facilities on the State Highway System. [I interpret this as the analysis of no road in Florida that can be applied to all roads.] These generalized tables are the lowest level analytical tool accepted by FDOT. I have concern that this convenient and popular tool is over-used in transportation decision-making. To expand this to the *HCM* is disconcerting.

      On the other hand, if the issue was that *HCS* would generate service tables similar to FDOT's LOSPLAN (ARTPLAN, HIGHPLAN & FREEPLAN), then it's acceptable, provided field data inputs are used (minimizing use of default values).

3. One improvement you noted would be to have performance measures that account for differing driver behavior (rural/sub-urban – congested-non-congested). Do you have an example of a type of performance measure that you would like to see included that accounts for these characteristics?
   a. LOS is a qualitative A-to-F scale of perception of the traveling condition to which we have applied mathematical performance measures. The driving environment is a factor to this perception. The driving environment is a continuum from urban-to-suburban-to-rural. In addition, time-of-day could be a factor.

      In a rural driving environment, there is an expectation of no to minimal congestion throughout the entire day. In a suburban driving environment, there is an expectation of no to minimal congestion, except for morning and evening "rush hours." In an urban driving environment, there is an expectation of no to minimal congestion in the late night to the morning commuter period; heavy congestion in the morning and evening commuter periods; and moderate congestion during the remaining hours. These varying expectations indicate a need for a "context sensitivity" factor.

      A possible way to determine "context sensitivity" factors is surveying drivers whose commutes are predominantly rural-oriented, suburban-oriented and urban-oriented and evaluate the results. The surveying technique could employ the use of videos showing the varying traffic conditions, including daytime and nighttime congestion conditions.

4. You mentioned web based peer exchange as a suggestion of the *HCM*. How would you envision something like this working?
   a. For nearly two decades, I have participated on FDOT's Level of Service Task Team as the small MPO representative. This participation has enabled me to provide input on LOS analysis tools/techniques, including the ongoing provision of "real world" conditions that have lead to tweaking of the LOS tools.

      In addition to its roadway network, the Gainesville Metropolitan Area features a robust, but limited, transit system and several in-street bicycle facilities and off-street bicycle/pedestrian trails. Due to familiarity of multimodal transportation conditions, I participated in the development of FDOT's *Multimodal Transportation Districts and Multimodal Areawide Planning Handbook*.

      From the two scenarios above, I would suggest transportation forums and/or charrettes in which specific "real world" transportation conditions can be evaluated. The evaluation **and feedback** would help determine whether the transportation analysis is done properly and also whether the methodology is appropriate and sufficient for measuring the traffic conditions.

Atlanta Regional Commission (ARC) Respondent

1. You indicated that you were against the elimination of the LOS methodology. What are the primary reasons you feel that it should be kept?
   a. LOS appears to be a fairly well-known and broadly-accepted measure in the civil engineering profession, with some sort of a visual effect attached to it.

Southeast Michigan Council of Governments (SEMCOG) Respondent

1. You disagreed with the idea of extending the *HCM* beyond LOS F. Why do you feel this would not improve the *HCM* and what do you think might be a better way to measure varying degrees of congestions?
   a. How many more letters are we going to use? More letters are not going to work in my opinion. What will work is some continued way of identifying how long the congestion lasts—all day, how many hours. As this is used in the planning, the tradeoffs could be how much money will it cost to widen vs. how many hours of the day is it congested. This analysis could provide you with the information to look at other solutions that may be more cost effective.

San Francisco County Transportation Authority (SFCTA) Respondent

1. You were very dissatisfied with the *HCM* for highway and transit system planning. What do you see are the biggest problems in using the *HCM* for this planning application?
   a. We find the trip generation methods, both for autos and transit, to not be adapted for San Francisco. We use our travel demand forecasting model for these purposes.

2. You strongly disagreed that the *HCM* was better than other tools for generating performance measures you need. What other tools do you use and why do you feel they are superior?
   a. We use our travel demand forecasting model to look for changes in overall demand, mode split, transit ridership, and non-motorized demand. For specific transit projects, we often use a microsimulation model like VISSIM that can determine transit travel time reductions, non-motorized delay, reliability, and can incorporate important San Francisco features such as transit signal priority. We think these metrics and tools are superior because they are tailored to the SF urban environment.

3. You indicated a strong agreement with elimination of the LOS methodology from the *HCM*. What do you see as ideal for taking its place?
   a. We would like to see a focus on demand based assessments as opposed to the operational focus of LOS. In addition, we would like to see ways to better account for transit and non-motorized features in TODs. SF is moving towards an auto-trip generation metric for evaluating new projects.

4. You were strongly against providing more default values for difficult *HCM* input data, what do you see as the issues with more defaults?
   a. The *HCM* needs to be customized for specific environments. While default values can help, they may imply a level of accuracy that may or may not exist.

FHWA Respondent #1

1. The FHWA performs all the short-range planning practices we listed more than once a month. However, they only use the *HCM* occasionally for bike/pedestrian planning, development decisions, and performance monitoring. Why is the *HCM* not used extensively for these applications?
   a. FHWA tends to not perform these measures directly but uses information from the states. Since they do not do them directly, they do not use the *HCM*.

2. For your responses you seem to think that better training in the use of *HCM* material could eliminate a number of complaints planners might have with the *HCM*. What do you feel would be the best way to educate people on using the *HCM*?
   a. Education in the use and limitations of the *HCM* will improve how the *HCM* is used by planners and engineers alike. Using multiple outlets for training on *HCM* use such as at universities, TRB, professional capacity building programs, FHWA/DOT outreach, and webcasts would be best to spread the word about proper use of the *HCM*. FHWA would be open to working with TRB in a partnership for outreach.

3. You indicated opportunities to use service volume tables as useful to planners when using the *HCM*. Do you foresee any issues with utilizing service volume tables in the *HCM*?
   a. Believes service volume tables will be useful for planners but only if they know the correct context in which to apply them. Too many people use the *HCM* as a cookbook without thinking about it. If people think why they are using the tables beforehand and fully understand the limitations then it will be a good tool to have for certain applications.

FHWA Respondent #2

1. Performance monitoring was listed as a short-range planning practice that the FHWA performs yet you indicated that the *HCM* is not used. What do you use instead and why is it used rather than the *HCM*?
   a. I was not sure how to answer this—we use processed field data from traffic management systems to create performance report—so we are measuring directly instead of calculating results

2. You strongly agreed that the *HCM* is easy to use for planning applications. What do you feel makes it easy to use?
   a. At early project scoping standard *HCM* calculation meet the need for sizing/facility decisions.

APPENDIX C

Highway Capacity Committee Research Problem Statements

This section includes a relevant research problem statement developed by the Florida Department of Transportation that is targeted to improve the planning application of the *Highway Capacity Manual* (*HCM*).

AASHTO STANDING COMMITTEE ON RESEARCH
AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

NCHRP Problem Statement

I. PROBLEM NUMBER

To be assigned by NCHRP staff.

II. PROBLEM TITLE

Planning and Preliminary Engineering Applications Guide to the *Highway Capacity Manual*

III. RESEARCH PROBLEM STATEMENT

A *Highway Capacity Manual* applications guide was developed for the 2000 *HCM* and is being updated for the 2010 *HCM*. This guide addresses a broad set of potential *HCM* applications with emphasis on applications related to design and operations. There is a corresponding need to develop an applications guide with emphasis on planning and preliminary applications. This guide is needed to address the broad use of *HCM* procedures in planning and preliminary applications such as corridor studies, roadway widening projects, and traffic impact analyses. In addition, guidance is needed for three common issues that go beyond the scope of the 2010 *HCM*:

- Analysis of oversaturated conditions in a planning and preliminary engineering context, including use of volume to capacity ratios and other techniques to compare the severity of oversaturated facilities.
- Use of alternative tools in a planning environment, including use of default values and the level of calibration/validation needed for using alternative tools in a planning and preliminary engineering context.
- Use of highway capacity analysis to provide input to sustainability and livability studies, such as air quality, noise, and greenhouse gas emission analyses. This would include documentation of the traffic data input needs for these types of analyses (speed, travel time, delay, vehicle composition, etc.) and provide guidance on how best to use the *HCM* to determine these data.

In addition to providing an educational tool, the proposed research would enhance the value of the 2010 *HCM* by providing a reference for conducting planning and preliminary engineering analyses. It is expected that FHWA, state departments of transportation, and other agencies could refer to the *Planning and Preliminary Engineering Applications Guide to the HCM* to describe recommended or required procedures for conducting highway capacity analyses for various planning and preliminary engineering studies. Following are examples of the issues that would be addressed:

- When is it appropriate to use default values in various planning and preliminary engineering applications?
- For oversaturated conditions (i.e., level of service F), what are potential techniques to describe the severity of congestion?
- When is it appropriate to use alternative tools (e.g., traffic simulation) in a planning and preliminary engineering context?
- How can sketch planning tools (such as level of service tables) be used in planning and preliminary engineering studies?
- How can the results of *HCM* analyses be used (either directly or modified as necessary) to provide input to analyses of sustainability, air quality, noise, and greenhouse gases?

IV. LITERATURE SEARCH SUMMARY

Literature searches on TRIS online and the Research in Progress database yielded the following results:

- There is no ongoing or completed research that is similar to the effort proposed in this problem statement, development of a Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual.
- Searches related to guides in the areas of planning and highway capacity lead to numerous guides that have been developed for specific facilities that touch on planning issues, but none that are as broad as the proposed effort.
- Searches related to the specific issues addressed in the proposed research (traffic simulation/alternative tools, oversaturated conditions, and sustainability/greenhouse gases) lead to numerous research projects on these issues that may be valuable during the research, but none that provide a comprehensive guide.
- NCHRP Project 20-5, Synthesis Topic 42-10, Extent of Highway Capacity Manual Use in Planning, was recently approved and will be under contract in early 2011. The subject project will make use of the findings from that synthesis.

Regardless of previous research efforts (many of which will be useful in the proposed effort), the incorporation of planning and preliminary engineering guidance into the *Highway Capacity Manual* through an applications guide will result in a unique opportunity to provide the latest techniques to the community of approximately 10,000 users of the *Highway Capacity Manual*.

V. RESEARCH OBJECTIVE

The objective of the recommended research is to develop a *Planning and Preliminary Engineering Applications Guide to the HCM*. The guide would be prepared by developing sample problems that address typical planning and preliminary engineering analyses that are encountered in actual applications of the *HCM*. Key stakeholders would be surveyed to select representative situations for analysis. The sample problems would include at least one problem related to oversaturated conditions, at least one problem related to the application of alternative tools, and at least one problem related to air quality, noise, and greenhouse gas analysis. The format and layout of the guide would follow the current *HCM Applications Guide* that is oriented toward operational and design analyses.

The product of the research would be a guide book that would act as an educational tool and supplement to the 2010 *HCM* to be produced in both hard copy and appropriate electronic format.

The following individual tasks are envisioned to complete this research:

1. Literature review to include the *HCM Applications Guide* and key FHWA and state transportation department documents on planning and preliminary engineering studies
2. Survey of stakeholders to determine recommended practices, sources of documentation, and sample problems
3. Development of sample problems
4. Preparation of draft *Planning and Preliminary Engineering Applications Guide to the HCM*
5. Review and comment with key stakeholders
6. Preparation of final *Planning and Preliminary Engineering Applications Guide to the HCM*

VI. ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Recommendation of Funding: $400,000

Research Period: 2 years

VII. URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION

This problem statement addresses three areas of the transportation profession that are emerging issues that have not been addressed elsewhere. Currently, transportation professionals in the planning and preliminary engineering environment are writing their own rules with respect to traffic simulation/alternative tools, analysis of oversaturated conditions, and analysis of the effects of transportation improvements on sustainability/greenhouse gases. While the 2010 *HCM* will form the basis of some solutions to these issues, they go beyond the scope of the *HCM* and are more appropriately addressed in an applications guide.

Improved understanding of these issues and standardization of techniques to address them is expected to provide huge benefits in terms of making better decisions regarding the billions of dollars that are spent annually on major roadway improvement projects. For example, if a $40 million interchange improvement project achieves a 10% savings due to a more efficient design to handle oversaturated conditions or greenhouse gas impacts, a $4 million savings is achieved. This would result in a 10:1 benefit-cost ratio for the research dollars spent on this effort, achieved in just one practical implementation.

The results of this research project will produce a *Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual*. As in the case of the *Highway Capacity Manual* itself, the *Planning and Preliminary Engineering*

Applications Guide will be subject to review and approval by TRB's Committee on Highway Capacity and Quality of Service, which will provide additional oversight and assurance that the products will be applicable for use in the transportation profession. Following publication, it is anticipated that FHWA, state departments of transportation, and local agencies will adopt or recommend use of the *Planning and Preliminary Engineering Applications Guide* for use on analysis of transportation improvement projects.

Following are specific steps to be followed during implementation:

1. Completion of research project
2. Review and approval by TRB Committee on Highway Capacity and Quality of Service
3. Publication by TRB
4. Distribution (through TRB) to FHWA, state departments of transportation, and the transportation engineering community
5. Acceptance and adoption of all or portions of the *Planning and Preliminary Engineering Applications Guide* by various transportation agencies for use on transportation improvement projects

One potential barrier to implementation is lack of knowledge regarding the *Planning and Preliminary Engineering Applications Guide* following its publication. The TRB Committee on Highway Capacity and Quality of Service has a subcommittee dedicated to user liaison and has historically been proactive in publicizing the production of a new *HCM* or key research product. Continued efforts in this area will be needed, possibly with the help of the sponsors of this research project.

VIII. PERSON(S) DEVELOPING THE PROBLEM

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IX. PROBLEM MONITOR

To be determined

X. DATE AND SUBMITTED BY

September 15, 2011

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Abbreviations used without definition in TRB Publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETY-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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