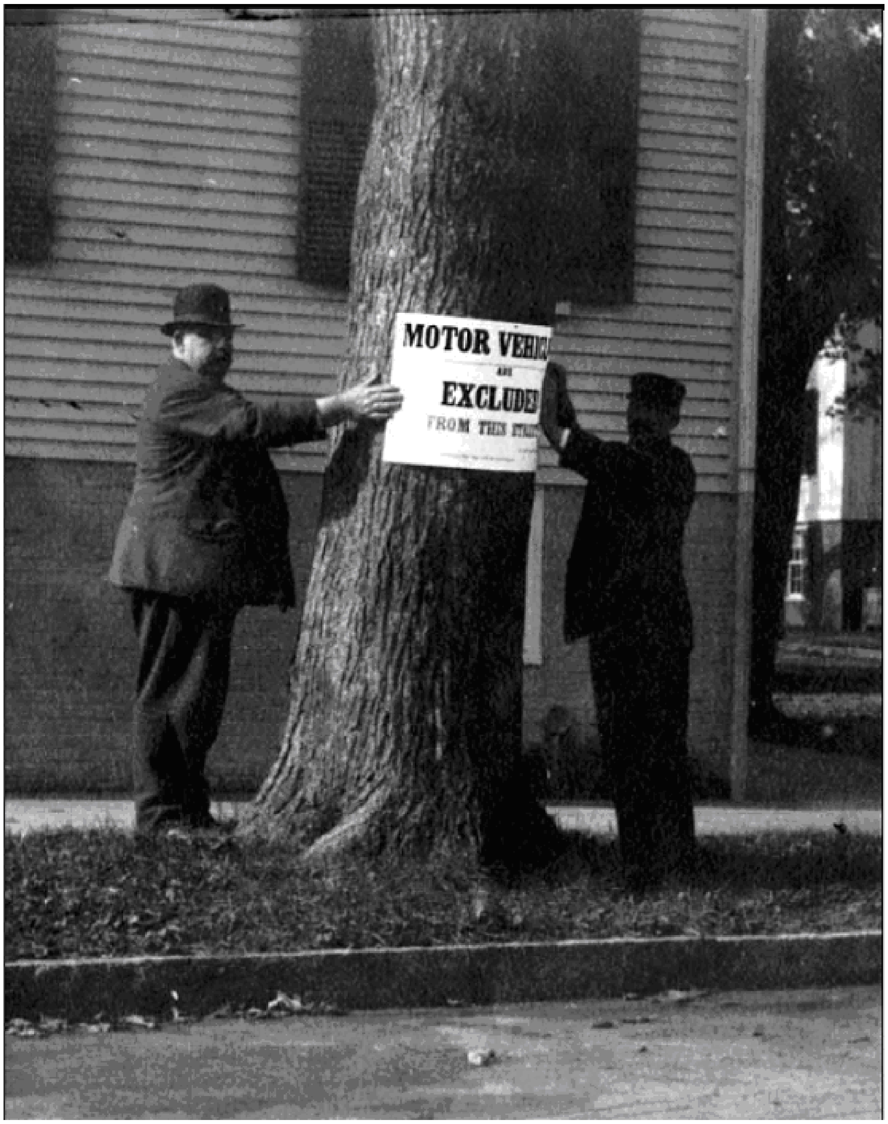
National Park Service
U.S. Department of the Interior

Congestion Management Systems

Congestion Management Systems:
Review of Current Practices



Source: Nantucket Comprehensive Community Plan, 2002

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Contents

Report Notes

This report was prepared by the U.S. Department of Transportation John A. Volpe National Transportation Systems Center, in Cambridge, Massachusetts. The project team was led by David Spiller, of the Service and Operations Assessment Division, and included Lissandra Garay-Vega, of the Service and Operations Assessment Division.

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Definitions

The following terms are used in this report:

BPM	Best Practice Model
e-CFR	Electronic Code of Federal Regulations
CMS	Congestion Management Systems
GIS	Geographic Information System
HOV	High Occupancy Vehicle
ITS	Intelligent Transportation Systems
LOS	Level-of-Service
LTP	Long Range Transportation Plan
MAB	Metropolitan Area Boundary
MPO	Metropolitan Planning Organization
NCHRP	National Cooperative Highway Research Program
NPS	National Park Service
OD	Origin-Destination
PEQUEST	Performance Queries for Surface Transportation
PPAQ	Post Processor for Air Quality
SOS	State of the System
TAZ	Transportation Analysis Zone
TIP	Transportation Improvement Plan
TMA	Transportation Management Area
UPWP	Unified Planning Work Program
USDOT	United States Department of Transportation
VMT	Vehicle Miles Traveled

Chapter 1: Introduction

This report summarizes Federal requirements, describes CMS concept, provides examples of various CMS implemented by different states and Metropolitan Planning Organizations (MPO) and provides guidance on issues to be considered in the development of a CMS for the National Parks.

National parks roads and parkways integrate highway engineering and landscape architecture in their designs to provide access to recreational areas, and to provide scenic recreational travel opportunities. Typically the engineering challenge is to build roadways through remote and rocky terrain while preserving the natural and cultural values of an area. Due to infrastructure constraints and to an increase in recreational and non-recreational visitation, many transportation facilities in the National Park Service (NPS) reach and in some cases exceed capacity, particularly during peak visitation season. In addition, parks in high-populated urban areas are impacted by the general growth in traffic in the surrounding transportation network, in which travelers use park roads as commuter routes. Inadequate access can diminish visitor experiences, present a threat to natural and cultural resources, and have negative impacts to the transportation systems surrounding the parks. The NPS is facing a transportation management and operational challenge that requires a cooperative effort between the NPS and local public and private transportation providers, local communities, and users among others. Recent Federal regulation requires the NPS to develop a comprehensive plan for Congestion Management Systems.

Congestion Management Systems (CMS)

CMS is defined as a systematic method that identifies measures of performance, provides information on current and forecast transportation system conditions, identifies strategies and monitors the system with the ultimate goal of improving mobility to levels that meet predetermined criteria. Strategies identified through CMS include demand management, operation improvement, and application of Intelligent Transportation Systems (ITS) technologies. Adding roadway or alternative transportation system capacity may be an option after considering traffic management strategies.

Federal Regulation: National Park Service and Congestion Management Systems

As of February 27, 2004, federal regulation regarding National Park Services (NPS) management systems requires the NPS to implement a congestion management system (CMS)[*]. For transportation facilities outside Transportation Management Areas (TMAs), NPS is responsible for:

1. Developing criteria to determine when a CMS should be implemented for a specific modal transportation system;
2. Including all applicable modal transportation systems serving the NPS;
3. Considering results of CMS to select cost-effective strategies to mitigate congestion while protecting natural and cultural resources and improving visitors' experience; and
4. Considering alternative modes of transportation, promoting multimodal connectivity and minimizing private vehicle travel.

When a NPS transportation facility is within a TMA, the TMA's CMS may include the transportation system serving the NPS. If this is not the case, NPS is responsible for including these facilities within its CMS.

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[*] Electronic Code Federal Regulations (e-CFR). Federal Regulation. Title 23 - Highways. Chapter I – Federal Highway Administration, Department of Transportation. Part 970– National Park Service Management Systems. *Section 970.214 – Federal Lands Congestion Management System (CMS).* Revised as of April 1, 2004. pp. 423-424 http://ecfr.gpoaccess.gov/

Congestion management systems to be developed must:

1. Identify congestion measures;
2. Identify causes of congestion;
3. Identify strategies considering demand management, operation improvements, public transportation, ITS, and additional capacity; and,
5. Evaluate the cost and effectiveness of strategies

Chapter 2: Congestion Management Systems: Current Practices

Project Approach and Method

A literature review was completed to understand the tools and methods currently used by states and MPOs to identify, measure and manage congestion. CMS documents for twelve agencies were reviewed. Additional information was obtained by contacting CMS personnel at the different agencies. Special attention was given to the following areas:

- *Road's classification to which CMS applies;*
- *Data collection methods and tools;*
- *Congestion metrics;*
- *Tools to forecast congestion (travel demand), and*
- *How CMS affects the Long Range Transportation Plan (LTP) and Transportation Improvement Program (TIP).*

In addition, a literature review of nine technical and research reports on congestion measures was completed.

Scope of the CMS Network

In general, all roads classified as arterial or above are included in the CMS. Some agencies include collector roads given their significance and impact on the transportation network. Few agencies include local roads, transit networks and non-motorist facilities as part of the analysis network. However, some metropolitan areas such as New York consider all submodes of transportation for the transit network including commuter rail, buses, subway and ferry routes.

Performance Measures

The most used congestion measures are *Level-of-Service (LOS)* and the *volume-to capacity ratio (v/c)*. LOS at intersections is defined as the *average stopped delay per vehicle*. For roadway segments, LOS is defined in terms of *vehicular density* (passenger cars per mile per lane). The Highway Capacity Manual presents a calibrated relationship between LOS and v/c, therefore most agencies uses v/c as the primary measure of congestion given the ability to collect volume data in comparison with density data. **However, the threshold to define congestion varies**. Some agencies adjusted congestion thresholds depending on the characteristics of the study area. For example, in Michigan, policy approved thresholds are established and used by the MPO, for roadways within the Metropolitan Area Boundary (MAB). In areas outside the MAB, thresholds are established by the agency with jurisdiction over specific roadways. In addition, thresholds vary between agencies. For example, one agency may define a congested road segment at v/c equal to 0.8 while other agencies use 0.75 or 1.0.

Other measures of congestion used include *travel rate*, *delay rate*, and *vehicle hours of delay* among others. Travel rate is defined as the travel time divided by the segment length (in minutes per mile); delay rate is defined as the difference between the actual and acceptable travel rates (in minutes per mile) and vehicle hours of delay is defined as the product of road segment vehicle volume, road segment length, and the difference between the inverse of actual/ estimated travel speed and free flow speed (i.e., $VxLx[1/v_o-1/v_f]$).

Some agencies identify performance measures by mode or project scope. For example, to perform a system-wide evaluation an agency may use vehicle miles traveled by LOS for highways and passengers per revenue hour for transit. A corridor evaluation may be completed using link v/c, average travel speed and accident rates.

One of the first and nationally accepted research reports on performance measures was completed by Lomax in 1997 and documented in the National Cooperative Highway Research Program (NCHRP) report "Quantifying Congestion"[*]. The research suggested certain performance measures considering different characteristics of traffic congestion and system scope as summarized in Table 1.

Table 1
Methods to Measure Congestion
Source: Lomax 1997

Congestion Dimension	System Magnitude		
	Single Roadway	Corridor	Network
Duration	Hours facility operates below acceptable speed	Hours facility operates below acceptable speed	Set of travel time contours maps; bandwidth maps illustrating amount of congested time for system sections
Extent	Percent of congested VMT of congested road	% VMT in congestion; % of lane-miles of congested road	% of trips in congestion; person-miles or person-hours of congestion; % lane-miles of congested road
Intensity	Travel rate; delay rate; relative delay rate; minute-miles; lane-miles hours	Average speed or travel rate; delay ratio	Total delay in person-hours or delay per person-miles of travel
Reliability	Average travel rate* or speed ± standard deviation; delay ± standard deviation	Average travel time or speed ± standard deviation; delay ± standard deviation	Travel time contour maps with variation lines (relative to a major activity center); average travel time ± standard deviation

The research recommended the time-based measures presented in Table 2 to estimate congestion. Calculations require data items such as travel time between origin and destination, vehicle and person volumes, and roadway length.

Recent research on operational performance measures addresses reliability of operations and transportation systems as well as multimodal performance measures. One of the concerns in congestion management is the reliable predictability of the estimated travel time. Table 3 summarizes recent research on reliability performance measures.

[*] National Cooperative Highway Research Program. *NCHRP Report 398*: Quantifying Congestion. Transportation Research Board. Washington D.C., 1997.
*Travel Rate (minutes per mile) = [travel time(minutes)/segment length (miles)]

Table 2
Some of the Congestion Measures Suggested by Lomax 1997

Congestion Measure	Application and Limitations	Formula/Definition
Travel rate (minutes per mile)	• Can be averaged for a facility, mode, or area • Provides estimates of trip time reliability • Can be compared with a desired value representing an acceptable level of congestion	Travel Rate = Travel Time / Segment Length
Delay rate (minutes per mile)	• Estimates the difference between system performance and the expectations for those system elements • Useful to prioritize improvements	Delay Rate = Actual Travel Rate − Acceptable Travel Rate
Total delay (person-minutes)	• Estimates the impact of improvements on transportation systems • Useful in economic analysis that require information on cost effectiveness	Total Delay = Delay Rate * Person Volume * Segment Length
Relative delay rate (dimensionless)	• Can be used as a congestion index to compare the relative congestion on facilities, modes, or systems	Relative Delay Rate = Delay Rate / Acceptable Travel Rate
Delay ratio (minutes per mile)	• Allows one to compare or combine the relative congestion levels on facilities with different operating characteristics • Identify the magnitude of the mobility problem in relation to actual conditions	Delay Ratio = Delay Rate / Actual Travel Rate
Speed of person movement (person-mph)	• Allows one to compare the person movement effectiveness of various modes of transportation • Difficult to compare to a baseline value given the magnitude of its value	Speed of Person Movement = Personal Volume * Average Travel Speed
Corridor mobility index (dimensionless)	• Relative value that allows one to compare alternative improvements to traditional improvements	Corridor Mobility Index = Speed of Person / Normalized Value
Accessibility (percent or minutes)	• Useful to assess the joint performance of the transportation system and land use • Extensively used for assessing the quality and equity in transit service	Accessibility is defined as the number of opportunities for travel objective fulfillment (trip purposes) that can be reached/completed within acceptable travel time. A single acceptable travel time is used for each type of objective (trip purpose), mode and time of day irrespective of distance.

Table 3
Comparison of Reliability Measures Used and Proposed

Author	Proposed Reliability Measure	Comments
Turner (1996)	• Range of travel time (in a given facility or roadway segment) experienced during a large number of daily trips • Obtained by calculating the mean and standard deviation of travel times within a sample	• Useful to make comparison of conditions along the same facility • (Lomax 2000) suggested that this method could be used to calculate reliability for a variety of roadway systems such as area-wide networks, corridors and single roadways. • The range of travel time is based on a fixed benchmark using the 85th percentile; therefore the proportion of unreliable travel would always stay approximately the same. • Involves a two-tailed test while a one-tailed test seems more appropriate
Ikhrata and Michell (1998)	• Probability that users will arrive at their destinations within the expected travel time. Uses a reliability index defined as: $R = 1\ (\%trips_{within} - \%\ trips_{exceed})$	• Theoretical in nature • Preliminary studies indicates that because the methodology relies on the average travel time approximately one half of the observations will always fall within the average value and one half will exceed the average value
California Transportation Plan (1998)	• Variability between expected travel time (based on scheduled or average travel time) and the actual travel time (due to nonrecurring congestion)	• Coefficient of variability describes dispersion but does not describe how well the conditions on the corridor meet travel expectations.
Jackson (2000)	• Percent of travel on a corridor that takes no longer than the expected travel time plus certain acceptable additional time. • Where: <u>Travel Time</u>: time it takes a typical commuter to move from origin to destination <u>Expected Travel Time</u>: median travel time across the corridor during the time period to be analyzed, x <u>Acceptable Additional Time</u>: the amount of additional travel time (beyond the expected travel time) a commuter is willing to take during the commute (expressed as a percent of the expected travel time), ? Acceptable Travel Time = x + ?	• Preliminary analysis suggested that the Florida Reliability Method adequately measures reliability because it characterizes reliability as an indicator of how well conditions on the corridor meet traveler's expectations by establishing an acceptable travel time unique to the corridor.
Lomax (2001)	• Difference in delay experienced on incident days versus non incident days where delay is defined as: Total Segment Delay (veh.-min) = (Actual Travel Rate (min) – Acceptable Travel Rate min)) * Segment Vehicle Volume (veh.)	• Does not consider both recurrent and nonrecurring delay
Lomax (2003)	• <u>Percent variation</u>: "This measures the amount of extra time needed to be on time for 95% of the trips (late one day per month). Indexing the	• All measures provide the same information but are useful on different applications.

Remarks

When selecting measures of performance one should consider attributes and goals of the transportation system. Performance measures should be multimodal and able to cross time periods to allow direct comparisons. *Reliability* measures the variation in travel time, which is an important measure for trip planning and decision-making. Reliability is particularly important in traveler information systems when drivers are not necessarily concerned with the effects of the congestion level but with the reliability of the information (e.g., estimated travel time) provided.

Current Congestion Conditions

The main objective of a CMS is to identify current congestion levels in the transportation network. Congested roadway sections or intersections are identified using operational data such as travel time, travel speed and delay, evaluated against performance measures and thresholds. Many agencies complete traffic studies such as delay and speed studies and capacity analyses to identify current deficiencies and monitor the transportation network by comparing current and previous congestion levels. In most regions, the MPO staff completes this comparison process manually (following a standardized process) based on the volume to capacity ratio.

Some CMS use both collected data and modeling techniques to identify congested segments. Specifically, the traffic assignment step in the sequential travel demand modeling procedure is updated based on new volumes and operational data. Travel delay for each link is estimated using the new assignment volume to identify the most congested segments. A summary of congested links is often summarized using GIS-based delay maps. This approach is automated, data (e.g., traffic volumes, speed) are entered into the system and a computer algorithm is used to estimate traffic assignment and compute travel delay by link.

Other agencies collect and compare travel speed data with a recommended travel speed (threshold based on previous traffic studies) to identify the most congested road segments (by functional classification and area type) and intersections. Travel time and speed data are often collected using the floating vehicle method, from congestion duration studies or directly collected using automated vehicle counters. This process is also used to monitor the transportation network. Some agencies such as the Capital Area MPO in Texas use macros programmed in a Geographic Information System with mapping and spatial analysis capabilities to compare current and previous levels of congestion.

A computer-based approach is used by the Michigan DOT to identify deficiencies and monitor the performance of the transportation network. MDOT developed a CMS toolbox that allows problem identification by geographic area, roadway functional classification and route. The CMS toolbox is one component of the Transportation Management System toolbox, sharing a comprehensive and common database with other subsystems. Specifically, the "Deficient Segment Package" of the CMS toolbox uses traffic data and performance measures to produce a list of congested segments (including the magnitude of congestion). Another package is used to compare previous and current congestion levels.

In addition, detailed studies such as freight movement studies are completed to identify congestion-related problems on specific routes.

Travel Forecasts, Congestion Estimates

In general, travel forecasts and congestion forecasts are estimates using travel demand models developed by the agency based on historical traffic and socioeconomic data by land use. Some agencies use commercial software packages that integrate Geographic Information Systems with demand modeling and transportation system analysis functionality. These software packages allow users to create Geographic Information System (GIS) based highway and transit networks. The geocoded-network may include transportation network characteristics (e.g., number of lanes, tolls, parking, traffic signals per mile), socioeconomic characteristics (e.g., population, employment, floor space) and travel characteristics (e.g., traffic volumes, speeds and transit ridership data). The model generates a total number of journeys by Transportation Analysis Zone (TAZ) based on the characteristics of each zone. The planning application of the computer models produces trip tables to be processed by a destination/mode choice subroutine to create mode, trip purpose, and time of day for each Origin-Destination (OD) pair. After estimating and incorporating delay for each link (using link volume-delay performance functions), a trip assignment module allocates each trip to a specific route based on minimum user travel time (i.e., user equilibrium). Essentially the sequential procedure (trip generation, distribution, modal split, and traffic assignment) is used to estimate congested levels by link.

A new generation of travel forecasting models to estimate travel demand is also used by some agencies. For example, the Mid-Ohio Region Planning Commission developed a forecasting model based on daily trip characteristics. It is a micro-simulation model in which forecasts are based on individual households, persons and trips instead of using zonal totals or averages. For assignment purposes, the estimated number of trips are aggregated in zone-to-zone trip tables and allocated in the traditional manner.

Remarks

Travel demand forecasting is an essential part of CMS. Early publications (Thompson et. al., 1995; Olson & Babcock, 1991) describe methods to forecast traffic demand and economic impacts of scenic byways based on traffic trends, cyclical economic trends and seasonal variation. Recently, NCHRP[*] published a synthesis describing current experiences integrating tourism and recreational travel with transportation planning. The report highlights how state departments of transportation are recognizing the importance of considering recreational, cultural and historical facilities into the planning process. This effort results in better designs including strategies that improve visitor experience and benefit residents and travelers while preserving the environment. At the same time transportation agencies expressed the need for more and better tourism travel data such as origin-destination patterns, visitor traffic counts, and tourism employment data considering geographic and seasonal traffic characteristics. Collaboration among stakeholders including federal and local agencies, area business, citizen's groups and the public sector have shown success, particularly in dealing with congestion mitigation and state transportation improvement plans.

Tourism agencies highlighted the importance to consider various types of visitors (e.g., recreational visitors, others), their characteristics and needs. This is influencing how some DOTs are projecting future travel demand to better allocate resources. The NCHRP report suggests the need for future studies including the establishment of performance measures for park transportation systems, and the role of advanced transportation systems in national parks and their relationship to the park visitors' experience.

CMS Analysis Tools

The goal of a CMS is to systematically identify measures of performance, provide information on current and future conditions, identify and prioritize strategies, and to monitor the performance of the transportation system. Congestion management tools are approaches, computer models or methods developed to facilitate one or more of these purposes. Some agencies such the Michigan Department of Transportation and the New York Metropolitan Transportation Council developed CMS tools. Some of the tools developed are used to identify strategies, to better estimate future demand or to track effectiveness of the transportation system. This section presents some of the most relevant examples of CMS tools.

Michigan System Management Support Tool[†]

CMS is fully integrated with other management systems as part of an overall transportation management system. Users of the CMS toolbox are able to see accessibility and mobility conditions by area/route level analysis, by socioeconomic/demographic summaries, by tracking performance measures and using trend analysis. Geographical areas can be viewed at different levels of details from entire areas to specific road segments. CMS also provides summaries by National Functional

[*] NCHRP Synthesis 329 Integrating Tourism and Recreation Travel with Transportation Planning and Project Delivery. A Synthesis of Highway Practice. Transportation Research Board. Washington D.C., 2004.

[†] MDOT. Michigan's Congestion Management System. TRB Conference on the Application of Transportation Planning Methods. May 1997. http://www.mdot.state.mi.us/planning/cmsmanual/index.htm

Class, Priority Commercial Networks or for the National Highway System. An Oracle database supports all subsystems. The database consists of over 900 data and code tables (approximately 5 Gigabytes of data). It is a common data system that includes historical and forecasted data. The user interface is a Powerbuilder application. Each subsystem includes a Gateway, which combine "bubble help" and on-line help documents.

The CMS module allows problem identification by geographic area, functional classification and route. The CMS "Road Segment Package" and "Deficient Segment Package" identify deficient segments and the magnitude of congestion using two MOEs: a weighted average of years to unacceptable LOS and additional lane miles required to resolve deficiencies on the identified segments. Deficiencies are identified using the "Deficient Segment Package" based on travel demand models, inventory data, performance measures and thresholds. CMS staff suggest detailed analysis to identify causes of congestion and uses the CMS toolbox to evaluate alternatives to identify appropriate actions to improve mobility. Alternatives are related to the transportation plan goals and objectives. The result of CMS is a set of solutions that are included in the Long-Range Transportation Plan process. Using the "Location Builder Package" of the CMS toolbox, users are able to identify other facilities associated with the deficient roadway to include their associated cost in the selection of alternatives.

New York Metropolitan Transportation Council CMS Model*

The New York Metropolitan Transportation Council CMS estimates congestion, forecasts future conditions and evaluates strategies using the "Best Practice Model-CMS" (BPM-CMS). It uses two main software programs: the "Best Practice Model" (BPM)† and the "Post Processor for Air Quality" (PPAQ). The Best Practice Model is a GIS network-based simulation model. It has data for 28 counties in the NY-NJ-CT area. The study area is divided into 3,500 +/- Transportation Analysis Zones (TAZ). It is a journey-based travel demand-forecasting model (base year=2002). The model includes both highway and transit networks. The other component is PPAQ which is a computer software used to calculate emissions. It is used to complement the BPM or when the project cannot be represented in BPM (e.g., signal coordination projects). The PPAQ includes an additional module to estimate the effects of non-recurring congestion. "The Performance Queries for Surface Transportation" (PEQUEST) provides performance-reporting capabilities. Results include both emission and operational reports (link and county level) based on performance measures. Results can be displayed on GIS maps showing delay by links.

Strategies and future conditions are evaluated in TransCAD using the sequential travel demand modeling procedure. Specifically, the GIS traffic and transit network and the socioeconomic data (current and forecast) are used as input into the BPM-CMS analysis tool. Traffic forecasts are based on regional population and employment forecasts (base year 2002, projections for every 5 years until 2025). Results are summarized as county level delays in terms of person and vehicle hours of delay. Also congestion maps illustrating link congestion measures are created. Results are subject to agency and public reviews and eventually to analysis as part of the Regional Transportation Plan.

Ranking Process: Project Priority and Consideration in the Planning Process

CMS provides a systematic way to prioritize projects for inclusion in the transportation planning process. Many agencies use the CMS process to identify expected deficiencies not addressed by other projects identified by the transportation planning process. In many cases, projects and strategies identified and evaluated by CMS have a greater possibility to be included in the Transportation Improvement Program than other projects. In general, projects identified by CMS are evaluated during the Regional Transportation Planning process. Detailed congestion studies are performed to evaluate effectiveness of proposed strategies. Based on the evaluations, potentially

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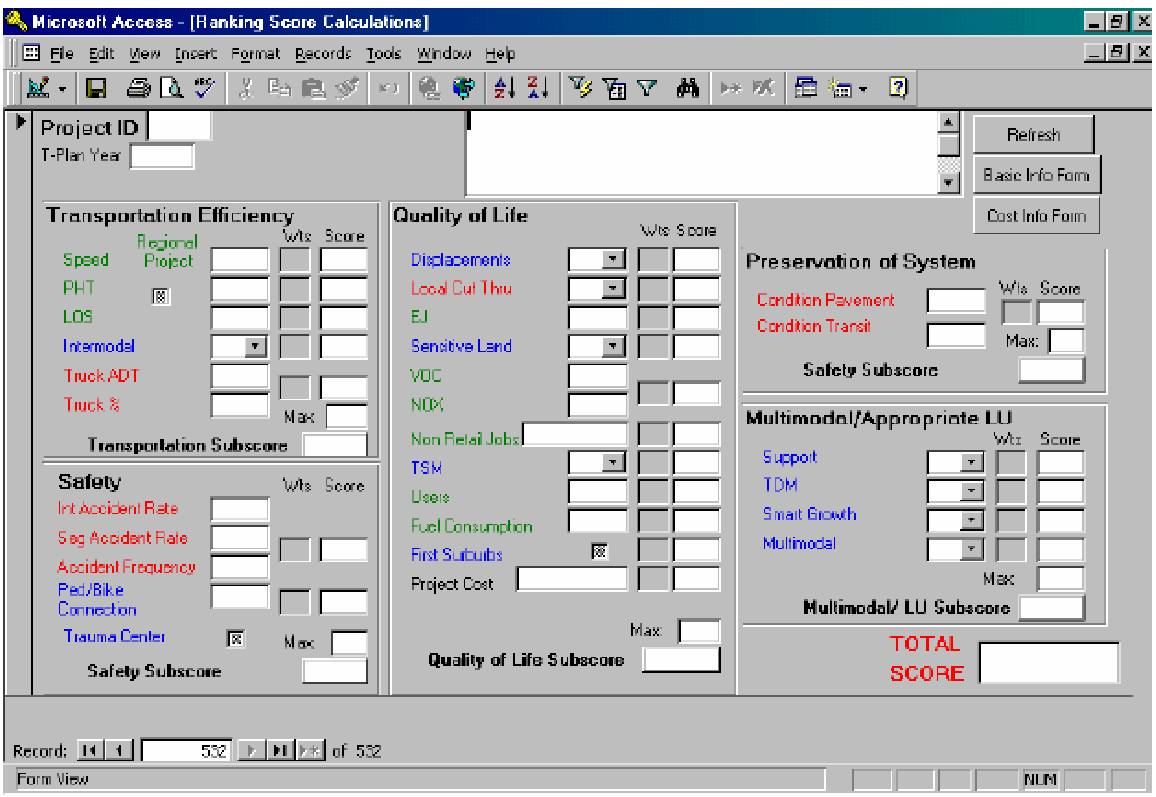
* New York Metropolitan Transportation Council. *Congestion Management System Description and Procedures.* http://www.nymtc.org/project/CMS/CMSfiles/cms_report.pdf

† The Best Practice Model is a journey–based travel demand-forecasting models that used GIS based highway and transit networks.

successful improvements are submitted and considered for inclusion in the Transportation Improvement Program.

Some agencies identify or rank strategies by order of preference and then use the TIP rating system. Other agencies such as Brevard MPO and the Mid-Ohio Regional Planning Commission have developed a systematic method or project priority criteria based on weighting measures of effectiveness. For example, the Mid-Ohio Regional Planning Commission[*] developed a ranking procedure (Microsoft Access tool) that helps to choose which project to include in the TIP based on weighting measures of effectiveness. Particularly, they identified categories based on project goals such as improve transportation efficiency and quality of life. After identifying measure of performance for each goal, they identified factors that should be included in determining project priorities and their suggested weights. Each factor is scored on a scale of 0 to 10. The score is multiplied by the factor to estimate the total score. A snapshot of the program is presented in the figure below. Scores for each goal are aggregated and reported as a sub-score by category as illustrated in Figure 1.

Figure 1
Mid-Ohio Regional Planning Commission CMS Ranking Tool



Data Needs and Methods

There are three basic data categories that may be included in a CMS: network characteristics, operational characteristics and socioeconomic data. Traffic network data includes inventory attributes such as number of lanes, number and location of traffic signals and parking facilities. Operational characteristics include speed data, travel time, traffic/passenger/pedestrian volumes, and vehicle miles traveled. Some of the data collected by agencies and used in the CMS include

[*] Mid-Ohio Regional Planning Commission. *Congestion Management System: Existing and Future Conditions Report*. A Companion Report to the 2030 Transportation Plan. June 2004.
http://www.morpc.org/web/departments/transportation/tplan/finalTPlan04CMS.pdf

traffic volume, vehicle classification data, density, ridership, turning movement, speed, delay, and travel time data. Recent input includes ozone readings to measure air quality performance. Most agencies collect volume and speed data. However, given the availability to obtain data from other sources, most MPO are not involved in data collection; they compile data such as traffic counts collected by other agencies. Most agencies use highway inventories, traffic, transit and demographic databases currently available for other purposes.

Lomax (1997) suggested that travel time-based measures are more appropriate congestion measures because they are well understood by all audiences and satisfy statistical requirements for most type of analysis. Calculations require data items such as travel time, vehicle and person volumes and roadway length.

Remarks
The following steps where identified by Lomax (1997) as an essential part of a congestion study design:

- Define study purpose and goals
- Define geographic scope
- Select measures of congestion
- Establish time period to study
- Define strata groups and roadway segments
- Establish congestion standards
- Develop data collection plan (or utilize surrogate estimation techniques)
- Select data collection technique (minimum sample size, level of accuracy)
- Collect and summarize travel time data
- Quantify congestion (comparison with free-flow conditions or acceptable value)

Cost
Brevard MPO developed a State of the System report (SOS) as the annual reporting function of their CMS. The annual report update of the SOS costs between $25,000 and $30,000 for consultant services, plus approximately $8,000 for MPO staff time. The cost of reproduction and distribution of the report is under $800 per year. The traffic count contract (major source of data collected countywide) is approximately $68,000 per year. However the counts are used for many purposes. Therefore, this is not considered part of the CMS. As mentioned in the data collection section, most MPO agencies use data currently collected by the state or transit agencies for other purposes; therefore they do not include this as CMS expenses.

The Mid-Ohio Regional Planning Commission does not have CMS listed as an item in their annual budget. They include a work element in their Unified Planning Work Program (UPWP) to maintain the regional demand models, which include CMS development. The budget is about $130,000 a year. They also use other Unified Planning Work Program work elements to do other CMS related tasks such as compiling traffic counts.

CMS Strategies
The following strategies have been considered by several agencies to improve mobility, accessibility and efficiency of the transportation system:

- Congestion pricing, financial incentives
- High Occupancy Vehicle (HOV) lanes
- Public and private transit, shift from automobile to other modes
- Alternative work schedules
- Incident management systems to reduce the effects of non-recurring congestion
- Traffic signal synchronization
- Freight management
- Parking management

- Advanced traveler information systems to reduce vehicle miles traveled (VMT) during peak period
- Capacity improvement

Congestion Management Initiatives in Recreational Areas

Concerned by the negative impacts created by traffic congestion, some of the most visited recreational destinations such as Cape Cod, Newport, Nantucket Island and some park units in the NPS are planning and implementing strategies to minimize congestion. Most of these facilities experience seasonal congestion, infrastructure and environmental constraints and accessibility challenges.

Cape Cod, MA

Issues:

- Seasonal congestion and uncoordinated traveler information provided by multiple agencies

Strategies:

- Traveler Information Systems
- Enhance highway and local information signs (NPS and Mass Highway)
- Congestion pricing: financial incentives for beach access for bicyclists, pedestrians and shuttle users
- Temporary parking facilities: use of school parking lots during the summer
- Alternative modes of transportation in cooperation with local communities
- Enhance intermodal connectivity including access between town destinations and walk/bike trails
- Development of road, trail, intersection and parking standards to improve mobility while preserving natural resources

Newport, RI

Issues:

- Seasonal congestion
- Aging infrastructure, both streets and parking facilities
- Poor regional highway connections
- Public transportation limited to intercity and local bus system with low ridership
- Attractions are spread out over a wide area

Strategies:

- Encourage motorist to park and use shuttle buses, water taxis, ride bicycles or walk.
- Circulation changes including roadway directional changes and peak–period parking restrictions
- Other operational improvements such as signage and centralized parking facilities intended to improve navigational guidelines and minimize congestion
- ITS in National Park Units

Units using ITS:

Acadia National Park, Cumberland Gap National Park, Massachusetts Bay Parks, Yosemite, and Gateway National Recreational Area

CMS Strategies:

- Traveler information systems (e.g., VMS, radio, Internet, telephone) to:
- Direct traffic to less crowded entrances, attractions and parking facilities using real time information
- Provide directions and information on travel conditions (weather/road), and alternative transportation

Chapter 3: Summary

Congestion can be defined as the unacceptable performance of the transportation system in which the movement of people and goods is interrupted, and exceeds acceptable criteria. Many transportation facilities in the NPS reach and in many cases exceed capacity due to both recreational visitors and commuters. Federal regulation requires NPS to develop a comprehensive plan to manage congestion. This report summarizes important features of the Congestion Management Systems developed by some Metropolitan Planning Organizations and state transportation agencies. A literature review and several phone calls were completed to understand the tools and methods currently used to measure and manage congestion.

In general, CMS is a standardized process used by many agencies to identify measures of performance, provide information on current and future conditions, identify and prioritize strategies and to monitor performance of the transportation system. Some agencies include both highway and transit networks in the CMS. The CMS network is defined by the agency and in many cases include roadways classified as minor arterials and above. However, the impact and significance of other types of roads (e.g., collectors, local) could warrant their inclusion on the CMS analysis network. The CMS network includes transportation network characteristics, travel characteristics and socioeconomic data. This information is usually stored in a GIS database.

Most agencies use the *LOS* and the *volume to capacity* ratio as the primary congestion measures. However, each agency uses its own criteria to define congested conditions (e.g., congested at v/c =0.8 or v/c =0.75). Other measures used include *travel rate*, *delay rate* and *vehicle hours of delay*, *vehicle miles traveled by LOS*, and measures of travel-time reliability. Performance measures used may vary by mode (e.g., transit vs. highway network) and system scope (e.g., statewide vs. corridor). Recent research suggests the use of performance measures that reflect the duration, extent, intensity and reliability, the selection of measures considering the goals and attributes of the transportation system and the use of time-based and multimodal measures.

CMS identifies congested roadway sections or intersections based on operational data (e.g., travel time, speed, delay, traffic volumes) collected through traffic studies and evaluated against performance measures (typically v/c) and predetermined thresholds. Other approaches include the use of both collected data and modeling techniques, e.g., updating traffic assignment to reflect future travel demand conditions. Some agencies collect and compare travel speed data with recommended travel speed to identify deficient facilities. This process can be completed manually following a standardized process or by using computer-based tools. Commercial software such as TransCAD, Microsoft Access, Maptitude, and simulation models or customized computer models can enhance the problem identification and monitoring processes and the selection and evaluation of proposed strategies. Basic information included, managed and produced by these computer applications include a database of network and traffic data, performance measures and thresholds, list of strategies by problem area and facility type, ranking mechanism, previous state of the system, traffic forecast applications, and, reporting capabilities.

Information about CMS development and operational cost was not easily available. However, it is normal that MPOs and state transportation agencies use existing data sources compiled by others agencies (e.g., transit agencies, state Departments of Transportation (DOT) or collected for other purposes and therefore the data collection cost is not usually considered part of the CMS. In some cases, CMS is included as a work element in the Unified Planning Work Program (UPWP).

CMS is an important mechanism that facilitates the transportation planning process. It provides information on trends and system performance, generates and evaluates strategies, and applies project technical ranking to facilitate project implementation. A recent NCHRP report indicates that many state agencies are recognizing the importance of including recreational facilities in the planning process, highlighting the need for more and better tourism data (e.g., Origin-Destination (OD) patterns, visitors traffic counts, and tourism employment data). The report recognizes the need to establish performance measures to evaluate transportation systems and visitor experience in parks and other recreational areas.

Appendix A: References

Federal Regulation
Electronic Code Federal Regulations (e-CFR). Federal Regulation. Title 23 - Highways. Chapter I – Federal Highway Administration, Department of Transportation. Part 970– National Park Service Management Systems. Section 970.214 – Federal Lands Congestion Management System (CMS). Revised as of April 1, 2004. pp. 423-424 http://ecfr.gpoaccess.gov/

Performance Measures and Reliability Studies
1998 California Transportation Plan: Transportation System Performance Measures, Final Report, California Department of Transportation, Sacramento, August 1998.

Ikhrata. H. and P. Michell, "Technical Report of Southern California Association of Governors . Transportation Performance Indicators, Transportation Research Record 1606, Transportation Research Board, National Research Council, Washington, D.C.1998, pp. 103-114

Jackson, D.L., T.L. Shaw, G. Morgan, D. McLeod, and A. Vandervalk, Florida's Reliability Method, Florida Department of Transportation, Tallahassee, 2000.

Lomax, T. Urban Mobility Report 2000, Texas Transportation Institute, College Station, 2001.

Lomax, T., Turner, S.M, and D.L. Schrank Selecting Travel Reliability Methods, Texas Transportation Institute, College Station & Cambridge Systematics Inc. 2003.

National Cooperative Highway Research Program. NCHRP Synthesis 311. Performance Measures of Operational Effectiveness for Highway Segment and System. Transportation Research Board. Washington D.C., 2003.

National Cooperative Highway Research Program. NCHRP Report 398: Quantifying Congestion. Transportation Research Board. Washington D.C., 1997.

National Cooperative Highway Research Program. NCHRP Synthesis 329: Integrating Tourism and Recreation Travel with Transportation Planning and Project Delivery. Transportation Research Board. Washington D.C., 2004.

Turner, S.M., M.E. Best, and D.L. Schrank, Measures of Effectiveness for Major Investment Studies, Report SWUTC/96/467106-1, Southwest Region University Transportation Center, Texas Transportation Institute, College Station, 1996 http://swutc.tamu.edu/Reports/467106-1.pdf

Congestion Management System: State of the Practice
Capital Area Metropolitan Planning Organization. Congestion Management Systems: Work Plan Status Report.

Capital Area Metropolitan Planning Organization. Congestion Management Systems: State of the System Report. http://www.campotexas.org/

Corpus Christi Metropolitan Planning Organization. Congestion Management System Plan. November 1997 http://www.corpuschristi-mpo.org/documents/CongestionMSPlan.pdf

Florida Department of Transportation. Florida's Mobility Performance Measures Program. December 2000.
http://www.dot.state.fl.us/planning/systems/sm/conman/default.htm

Florida Department of Transportation. The Florida Reliability Method in Florida Mobility Performance Measures Program pp1-2

Greater Buffalo-Niagara Regional Transportation Council. Congestion Management System: Description and Procedures, February 2004. http://www.gbnrtc.org/

Hudson, Joan G. Congestion Management Systems Practices. Chapter 3 Federal Highway Administration – Good CMS Practices. Texas Transportation Institute. January 2002
Lai, P., Chelius, T. & Kremer, P. CMS for Non-Urbanized Areas: New Jersey Experience. Parson Brinckerhoff-FG & South Jersey Transportation Planning Organization. August 2002 http://www.njchoices.com/SJTPO/regional_plan.html

Maricopa Association of Governments. 1998 MAG Regional Congestion Study. Final Report 2000. http://www.mag.maricopa.gov/display.cmss

Mid-Ohio Regional Planning Commission. Congestion Management System: Existing and Future Conditions Report. A Companion Report to the 2030 Transportation Plan. June 2004. http://www.morpc.org/web/departments/transportation/tplan/finalTPlan04CMS.pdf

MDOT. Michigan's Congestion Management System. TRB Conference on the Application of Transportation Planning Methods. May 1997. http://www.mdot.state.mi.us/planning/cmsmanual/index.htm

MDOT. Michigan Management System Support Tool. Michigan DOT Statewide Transportation Planning Division. Strategic System Operation & Maintenance Section. 1998.

MDOT. Congestion Management System. Transportation Asset Management. http://www.michigan.gov/documents/congestion_16554_7.pdf

New York Metropolitan Transportation Council. Congestion Management System Description and Procedures. http://www.nymtc.org/project/CMS/CMSfiles/cms_report.pdf

Renaissance Planning Group. Brevard Metropolitan Planning Organization: 2003/04 State of the System Report. Draft Technical Report. June 2004

South Jersey Transportation Planning Organization. Congestion Management Systems Development and Operation. Appendixes A, B, and C. http://www.sjtpo.org/cmsinfo.html

South Jersey Transportation Planning Organization. Congestion Management Systems: Phase II Update Final Report and Technical Memorandum. June 2003 http://www.sjtpo.org/CMS-Final%20Report-June2003.pdf

Wilmington Area Planning Council. WILMAPCO Congestion 2004 Management System Summary. May 2004. http://www.wilmapco.org/

CM Initiatives in Recreational Areas

FHWA & Cambridge Systematics. Congestion Management News. Developing a Seasonal Congestion Management Strategy in Newport. Rhode Island. Volume 3. NO. 2. July 1997. pp 3-4. http://webservices.camsys.com/fhwa/cmn/cmn32.pdf

National Park Service. Fact Sheet. Intelligent Transportation Systems in National Park Units. Alternative Transportation Program. Washington D.C., 2003. pp 1-2. http://www.nps.gov/transportation/alt/documents/finalitsfactsheet.pdf

Appendix B: CMS State of the Practice Summary

State of the Practice Summary, CMS Network, Congestion Measures, Data, CMS Tools, CMS and TIP

State of the Practice Summary

CAMPO Capital Area MPO (Texas)	Network: Freeway, major and minor and arterials, (including signalized intersections) Performance Measure (current conditions): Peak Recommended Desirable Travel Speed by Area Type. Thresholds (peak-recommended travel speed by road type (e.g., freeway HOV lane, freeway mainlane, major arterial) and area type (e.g., CBD, suburban, rural) were recommended by a study completed by TTI. Data: GPS based travel time and speed studies on roadway segments and intersections (using probe vehicles and the floating vehicle technique), Congestion duration studies, Manual intersection counts, and Speed and volume data collected using automated vehicle counters. Identifying Congested Segments: MPO staff compares travel speed data with peak-recommended travel speeds to identify the most congested road segments and intersections. The MPO subcontracted TTI to conduct a study to identify and report causes of congestion of the most congested facilities. (manual) System Monitoring: Data collection and analysis program uses a data comparison platform programmed in Maptitute to compare existing and previous congestion levels. (manual) Future Conditions: AM and PM peak traffic estimates based on an acceptable level of congestion by type of facility using the Sequential Procedure. Congestion Management and Program Implementation: CMS could require the inclusion of traffic demand management techniques into the TIP or could influence the projects selection in the Long-Range Transportation Plan. All projects in the TIP must be CMS compliant.
Corpus Christi MPO (TX)	Network: Major and minor arterials. Performance Measures (current conditions): Average travel speed, Average travel time, Average travel rate, Total delay, LOS, Accident rate Data: Travel survey (household activity, commercial vehicles, transit ridership), Speed and delay studies, Traffic counts, and Aerial photographs. Cities and counties: land use, zone laws and regulations State: assistant in conducting surveys and data analysis Transit: transit trends, information on route selection and planning Identifying Congested Segments: Several studies conducted in the last few years are used to identify congestion routes. One of the studies identified the CMS network, which includes maps representing most congested streets based on traffic studies. These maps are updated regularly to analyze capacity and calibrate travel demand models. Other studies include: speed and delay studies, travel surveys, and a freight movement study. (manual) System Monitoring: Traffic counts collected annually, operational speed and delay data is used to estimate and compare current and previous conditions. (manual) Future Conditions: Traffic demand estimated by the Texas DOT Planning and Programming Division based on socioeconomic characteristics and land use. (macro simulation using Sequential Procedure) Congestion Management and Program Implementation: MPO established a CMS Committee, which is responsible for providing technical information on the performance of the network to enhance project prioritization and support the metropolitan transportation planning process including the MTP and TIP.

Maricopa Association of Governments (Phoenix, Arizona)	Network: Freeway, arterials, transit and bike facilities Performance Measures (current conditions): v/c, LOS, Passenger per mile (transit) Data: Traffic volumes, Aerial photography, Vehicle classification, Network characteristics and Signal timing data. Identifying Congested Segments: Traffic studies are used to identify congested facilities. Annual report on the status of congestion includes traffic volumes maps used to identify congestion by link. (manual) System Monitoring: Comparison of current and previous state of the system reports. (manual) Future Conditions: Based on socioeconomic forecast developed by the Department of Economic Security. Future lane congestion estimated based on 20 years, no build traffic conditions. Congestion Management and Program Implementation: CMS produces an annual report on the status of the system, suggests projects that will address congestion and estimates future changes in travel speed and travel time. Land use and transportation strategies for each zone are ranked by order of preference and then used in the TIP ranking process. The Technical Advisory Committee reviews CMS recommendations where modal priorities are submitted to the Transportation Review Committee and eventually considered for TIP. (manual)
Michigan DOT	Network: State jurisdiction roads and the National Highway System roadways, considering inclusion of local roads Performance Measures (current conditions): LOS, Travel Rate, and Delay Rate. Performance measures and thresholds are store in the TMS database. Policy approved thresholds are established and used by the MPO, for roadways within the Metropolitan Area Boundary (MAB). In areas outside the MAB, the thresholds are established by the agency with jurisdiction over specific roadways. (automated) Identifying Congested Segments: CMS is one component of the Transportation Management System toolbox. Organized in 7 packages, the CMS toolbox allows problem identification by geographic area, roadway functional classification and route. Totally integrated with 5 other TMS toolbox shares a comprehensive database including data, performance measures and thresholds. Using the "Deficient Segment Package", and based on the performance measures the CMS analysis tool identifies/produces a list of congested segments. (automated) System Monitoring: Current and previous congestion levels can be compared using the "Road Segment Package". (automated) Future Conditions: Statewide and urban forecast models based on historical traffic and socioeconomic data. Identifies deficient segments and magnitude of congestion as a weighted average of years to unacceptable LOS and additional miles required Congestion Management and Program Implementation: CMS computer-based tool identifies deficient road segments and the magnitude of congestion, CMS staff suggests detailed analysis to identify causes of congestion and to evaluate strategies. The results of the CMS is a set of solutions and its associated cost which are included in the Long-Range Transportation Plan.

WILMAPCO (Delaware)	<u>Network</u>: Rural and urban arterials, some collector roads <u>Performance Measures (current conditions)</u>: Roadway segment v/c, Intersection LOS, Percent under posted speed, Transit v/c <u>Data</u>: Traffic volumes, Travel time data, Average Daily Truck Volume, Transit ridership, Inventory of non-motorist facilities, Park & Ride, Lot inventory, and Demographic data <u>Identifying Congested Segments</u>: Based on performance measures, the CMS Subcommittee and the Technical Advisory Committee identify congested corridors considering the number and frequency of adjacent congested segments and current travel patterns . (manual) <u>System Monitoring</u>: Uses road segments travel time, mean peak speed changes and traffic volumes to track traffic flow by route. It also track changes in the Average Monthly Transit Ridership. <u>Future Conditions</u>: DelDOT Traffic Demand Model used to estimate travel demand based on forecasted demographic characteristics(macro simulation model using Sequential Procedure) <u>Congestion Management and Program Implementation</u>: CMS Technical Advisory Committee identifies congested corridors considering congestion density. Potential strategies have been assembled in a toolbox designed to provide adequate solutions for each corridor based on performance measures (automated). Each strategy has specific mitigation methods. Results of the CMS include a matrix of congested corridors and possible strategies and mitigation methods for each corridor. CMS helps to identify possible projects to be moved into further stages of planning/development including LRP and TIP.
New York Metropolitan Transportation Council	<u>Network</u>: Highway Network: minor arterials and above Transit Network: commuter rail, buses, subway and ferry routes <u>Performance Measures (current conditions)</u>: LOS, Vehicle hours of delay, Person hours of delay <u>Data</u>: NYMTC Household Interview Data (population household and employment data by TAZ), Traffic counts, Transit ridership (all transit services in region), Travel time and Speed data <u>Identifying Congested Segments</u>: Current conditions are estimated using collected traffic data (e.g., traffic counts and speed data) combined with modeling techniques. Particularly, current data is used to update the traffic assignment used in the “Best Practice Model” (BPM). The assigned volumes are used into the “Post Processor for Air Quality (PPAQ) to estimate the delay by link and county-wide. Congested links are displayed in GIS maps. (automated) <u>System Monitoring</u>: The “BPM-CMS” tool is used to identify congested facilities based on performance measures and to compare current and previous conditions. (automated) <u>Future Conditions:</u> GIS traffic and transit network and socioeconomic characteristics used as input into the BPM-CMS analysis tool. Results include emission and operational reports displayed on GIS maps.

Greater Buffalo-Niagara Regional Planning Council	<u>Network</u>: Highway Network: minor arterials and above Transit Network: all public transit routes (bus and light rail) <u>Performance Measures (current conditions):</u> LOS, Vehicle hour of delay, Person hours of delay, Transit load factor <u>Data</u>: Speed, Traffic Counts, TMC, Vehicle classification, and transit data. Considerations to improve data collection technology <u>Identifying Congested Segments</u>: Performance measures reported by facility type (e.g., intersections, freeways) and different analysis periods (AM, PM, Mid-day, and Off-peak) are used to reflect the duration of congestion. Results are presented in a GIS maps. <u>System Monitoring</u>: CMS continually collects traffic data to track changes in regional traffic, delay and congestion based on performance measures. <u>Future Conditions</u>: Demographic forecasted data used as input into a TransCAD network-based simulation model (macro simulation using Sequential Procedure) <u>Congestion Management and Program Implementation</u>: CMS provides technical information on system performance and cost/benefits of congestion management strategies to be considered in LRTP and TIP. Federal funds may be used for the implementation of proposed strategies. Once an improvement has been defined it is considered into the TIP process.
Brevard MPO (Florida)	<u>Network</u>: Arterial and collectors, few local roads, same traffic network used for the Long Range Transportation Plan <u>Performance Measures (current conditions)</u>: Vehicle miles of travel, Duration of congestion, Transit ridership, Crash history (crashes are assigned to the corresponding CMS segment) <u>Data</u>: Traffic counts, Crash records, Ridership, Road inventory, and Ozone readings. Additional data: hurricane evacuation. <u>Identifying Congested Segments</u>: Traffic studies completed annually and documented in the State of the System Report. The report provides information on congested roadways and countywide mobility trends. Special reports are completed for two roadways of the Florida Interstate Highway System. <u>System Monitoring</u>: Comparison of current and previous state of the system reports. Results are reported by county and by planning areas within each county. (manual) <u>Future Conditions</u>: Future traffic demand estimated using the county's traffic model based on updated countywide population and employment forecast. (Sequential Procedure) <u>Congestion Management and Program Implementation</u>: CMS provides updated information on trends and conditions, segment technical ranking, and recommends strategies to the MPO. The ranking is based on weighting several factors including severity of existing congestion and prior funding commitments. Priorities are considered for inclusion into TIP.

Hillsborough County MPO (Tampa, FL)	Network: highway and transit networks Performance Measures (current conditions): Corridor: Link v/c, corridor weighted v/c, Average travel speed, Accident rates. System wide: Vehicle miles traveled by LOS, Passenger by revenue hour, Transit service headway Data: Traffic counts, Transit data including farebox counts by route, Vehicle occupancy (surveys), Vehicle classification, Accident records, Route miles and Headway data Identifying Congested Segments: Traffic studies are used to identify congested corridors. The CMS Steering Committee (made up of local transportation personnel, emergency response agency, and other agencies) select corridors that are not likely to ever be widened and select two to three for more detailed study. Future Conditions: Travel demand is estimated using the Florida Standard Urban Transportation Modeling Structure (macro simulation model using Sequential Procedure) Congestion Management and Program Implementation: CMS projects are considered during the annual ranking process for candidate projects. The MPO complete corridor studies to supplement the CMS methodology. Consistency with the CMS has an impact on how high a projects rank in the annual MPO priority project.
South Jersey Transportation Planning Organization (New Jersey)	Network: Highway Network: freeway, expressway, arterial, collector, and local roads (including roads from surrounding counties) Transit Network: rail facilities, bus routes Performance Measures (current conditions): v/c (most used), Vehicle miles traveled by LOS, Peak period vehicle unacceptable delay, Vehicle-hour traveled Data: Existing traffic counts, Population and employment data by area, NJDOT GIS-based road layer, NJ CMS, South Jersey Travel Demand Model (summer during Friday PM peak and weekends), Surveillance and Monitoring Program would collect data that cannot be obtained from other sources Identifying Congested Segments: data from the SJ Travel Demand Model is used to identify congested corridor and CMS needs based on v/c. System Monitoring: the “CMS Tracker” is a Microsoft Access application that allows monitoring network performance. The tool includes information such as v/c categories, a consistency check list between RTP problems and CMS needs by county including roadway name, area type, deficient segment and deficient intersections. It allows organizing the data and results not to automatically evaluate and track problems based on performance measures. CMS needs are evaluated on a periodic basis to determine if current or future conditions warrant further study and to identify data collection locations.

Agency	CMS Network
Michigan DOT	State jurisdiction roads and the National Highway System roadways, considering inclusion of local roads
Florida DOT	State highway system
New York Metropolitan Transportation Council	Highway Network: minor arterials and above Transit Network: commuter rail, buses, subway and ferry routes
Maricopa Association of Governments – Phoenix, Arizona	Freeway, arterials, transit and bike facilities
Brevard MPO	Arterial and collectors, few local roads, same traffic network used for the Long Range Transportation Plan
Greater Buffalo-Niagara Regional Transportation Council	Highway Network: minor arterials and above Transit Network: all public transit routes (bus and light rail)
Corpus Christi MPO	Major and minor arterials
Campo (Capital Area Metropolitan Planning Organization)	Freeway, major and minor and arterials, (including signalized intersections)
Hillsborough County MPO Tampa, FL	Major corridors (arterials and collectors)
Wilmington Area Planning Council (WILMAPCO)	Rural and urban arterials, some collector roads
Mid Ohio Regional Planning Commission	Freeways, major and minor arterials, collectors and local roads
South Jersey Transportation Planning Organization (SJTPO)	Highway Network: freeway, expressway, arterial, collector, and local roads (including roads from surrounding counties) Transit Network: rail facilities, bus routes

Congestion Measures

Agency	Congestion Measures
Michigan DOT	LOS, Travel Rate, Delay Rate
Florida DOT	Person mile traveled, average speed, reliability, delay, connectivity to intermodal facilities, ridership, % system heavily congested, density
New York Metropolitan Transportation Council	LOS, vehicle hours of delay, person hours of delay
Maricopa Association of Governments – Phoenix, Arizona	v/c, passenger per mile
Brevard MPO	Vehicle miles of travel, duration of congestion, transit ridership, crash history
Greater Buffalo-Niagara Regional Transportation Council	LOS, vehicle hour of delay, person hours of delay, transit load factor
Corpus Christi MPO	Average travel speed, Average travel time, Average travel rate, Total delay, LOS, Accident rate
Campo (Capital Area Metropolitan Planning Organization)	Peak recommended desirable travel speed by area type, v/c
Hillsborough County MPO Tampa, FL	Corridor: Link v/c, corridor weighted v/c, Average travel speed, accident rates. System wide: vehicle miles traveled by LOS, Passenger by revenue hour, Transit service headway
Wilmington Area Planning Council (WILMAPCO)	Roadway segment v/c, Intersection LOS, Percent under posted speed, Transit v/c
Mid Ohio Regional Planning Commission	LOS, vehicle miles traveled by LOS, Vehicle hour traveled by LOS
South Jersey Transportation Planning Organization (SJTPO)	v/c, Vehicle miles traveled by LOS, Peak period vehicle unacceptable delay, Vehicle-hour traveled

Data

Agency	Data
Florida DOT	Roadway Characteristic Inventory, Traffic Characteristic Inventory, National Personal Transportation Survey, Transit, Land Use databases, and Special data collection studies (Reliability)
New York Metropolitan Transportation Council	NYMTC Household Interview Data (population household and employment data by TAZ), Traffic counts, Transit ridership (all transit services in region), Travel time and Speed data
Maricopa Association of Governments – Phoenix, Arizona	Traffic volumes, Aerial photography, Vehicle Classification, Geometric Data, and Signal Timing data
Brevard MPO	Traffic counts, Crash records, Ridership, Road inventory, and Ozone readings. Additional data: hurricane evacuation
Greater Buffalo-Niagara Regional Transportation Council	Speed, Traffic Counts, TMC, Vehicle classification, and transit data. *Considerations to improve data collection technology
Corpus Christi MPO	Travel survey (speed delay, household activity, commercial vehicles, Transit ridership), Speed and delay, Traffic counts. Cities and counties: land use, zone laws and regulations State: assistant in conducting surveys and data analysis Transit: transit trends, information on route selection and planning
Campo (Capital Area Metropolitan Planning Organization)	GPS based travel time data studies an roadway segments and intersections (using probe vehicles and the floating vehicle technique), Congestion duration studies, Manual intersection counts, Speed and volume data collected using automated vehicle counters
Hillsborough County MPO Tampa, FL	Traffic counts, Transit data including farebox counts by route, Vehicle occupancy (surveys), Vehicle classification, Accident records, Route miles and Headway data
Wilmington Area Planning Council (WILMAPCO)	Traffic volumes, Travel time data, Average daily truck volume, Transit ridership, Inventory of non-motorist facilities, Park & Ride, lot inventory, and Demographic data
Mid Ohio Regional Planning Commission	Local Jurisdiction, ODOT, consultants – Traffic counts/AADT ODOT – trends in vehicles miles traveled, route miles, and lane miles available Regional Household Survey (daily trip characteristic)
South Jersey Transportation Planning Organization (SJTPO)	Existing traffic counts, Population and employment data by area, NJDOT GIS-based road layer, NJ CMS, South Jersey Travel Demand Model (summer during Friday PM peak and weekends), Surveillance and Monitoring Program would collect data that cannot be obtained from other sources

Agency	Traffic Estimates
Michigan DOT	Statewide and urban forecast models based on historical traffic and socioeconomic data. Identifies deficient segments and magnitude of congestion as a weighted average of years to unacceptable LOS and additional miles required
Florida DOT	Statewide estimations based on HCM and Department's Level of Service Handbook
New York Metropolitan Transportation Council	GIS traffic and transit network and socioeconomic characteristics used as input into the BPM-CMS analysis tool. Results include emission and operational reports displayed on GIS maps.
Maricopa Association of Governments – Phoenix, Arizona	Based on socioeconomic forecast developed by the Department of economic Security. Future lane congestion estimated based on 20 years, no build traffic model
Brevard MPO	Future traffic demand is estimated using the county's traffic model based on updated countywide population and employment forecast. (Sequential Procedure)
Greater Buffalo-Niagara Regional Transportation Council	Demographic forecasted data used as input into a TransCAD network-based simulation model (macro simulation using Sequential Procedure)
Corpus Christi MPO	Traffic demand estimated by the Texas DOT Planning and Programming Division based on socioeconomic characteristics and land use. (macro simulation using Sequential Procedure)
Campo (Capital Area Metropolitan Planning Organization)	AM and PM peak traffic is estimated based on an acceptable level of congestion by type of facility using the Sequential Procedure.
Hillsborough County MPO Tampa, FL	Travel demand is estimated using the Florida Standard Urban Transportation Modeling Structure (macro simulation model using Sequential Procedure)
Wilmington Area Planning Council (WILMAPCO)	MDOT, DelDOT Traffic Demand Model used to estimate travel demand based on forecasted demographic characteristics (macro simulation model using Sequential Procedure)
Mid Ohio Regional Planning Commission	Travel demand model based on travel behavior (micro simulation using Sequential Procedure)
South Jersey Transportation Planning Organization (SJTPO)	Travel demand estimated using South Jersey Travel Demand Model

Appendix B *(cont.)*
CMS Tools

Agency	CMS Tools
Michigan DOT	CMS is one component of the Transportation Management System toolbox. Organized in 7 packages, the CMS toolbox allow problem identification by geographic area, roadway functional classification and route. Totally integrated with 5 other TMS toolbox sharing a comprehensive database including data, performance measures and thresholds
New York Metropolitan Transportation Council	The "Best Practice Model", a TransCAD network-based simulation module is used to estimate and report performance measures using a GIS traffic and transit network and socioeconomic characteristics. In addition the PPAQ model is used to estimate emissions.
Maricopa Association of Governments – Phoenix, Arizona	Electronic database including detailed traffic information. Completed a comprehensive data collection initiative to update the electronic database and forecast models.
Brevard MPO	Includes ozone reading as an additional piece of information in the State of the System Report to identify if air quality performance meets federal requirements
Greater Buffalo-Niagara Regional Transportation Council	Micro simulation (journey –based) model of travel demand
Campo (Capital Area Metropolitan Planning Organization)	Congestion Monitoring and Analysis Program collects region wide data annually and use a data comparison platform programmed in Maptitude to monitor the system (comparing previous and existing congestion levels).
Hillsborough County MPO Tampa, FL	Identified corridor and system wide performance measures by mode, the data required to assess quality, quantity, accessibility, and utilization as well as the difficulty to obtain such data.
Wilmington Area Planning Council (WILMAPCO)	Potential strategies have been assembled in a toolbox designed to provide adequate solutions for each corridor based on performance measures. Each strategy has specific mitigation methods. Traffic management strategies have priority over adding capacity. A matrix is developed including each corridor and the applicable strategy.
Mid Ohio Regional Planning Commission	Uses a Microsoft Access tool to choose which project to include in the TIP based on weighting measures of effectiveness.
South Jersey Transportation Planning Organization (SJTPO)	Developed a demand model for the area. Defined four areas for analysis including urbanized, rural, seasonal and urban center and identified performance measures and thresholds accordingly.

Appendix B *(cont.)*
CMS and TIP

Agency	CMS & TIP
Michigan DOT	CMS identifies deficient road segments and the magnitude of congestion, suggests detailed analysis to identify causes of congestion and to evaluate strategies. The results of the CMS is a set of solutions and its associated cost which are included in the Long-Range Transportation Plan.
New York Metropolitan Transportation Council	Strategies are generated and evaluated during the Regional Transportation Planning process considering public input. Detailed congestion studies are performed to judge cost-effectiveness. Specific improvements are submitted for consideration into TIP.
Maricopa Association of Governments – Phoenix, Arizona	Land use and transportation strategies for each zone are ranked by order of preference and then used in the TIP ranking process. The Technical Advisory Committee reviews CMS recommendations where modal priorities are submitted to the Transportation Review Committee and eventually considered for TIP.
Brevard MPO	CMS provides updated information on trends and conditions, segment technical ranking, and recommends strategies to the MPO. The ranking is based on weighting several factors including severity of existing congestion and prior funding commitments. Priorities are considered for inclusion into TIP.
Greater Buffalo-Niagara Regional Transportation Council	CMS provides technical information on system performance and cost/benefits of congestion management strategies to be considered in LRTP and TIP. Federal funds may be used for the implementation of proposed strategies. Once an improvement has been defined it is considered into the TIP process.
Corpus Christi MPO	MPO established a CMS Committee, which is responsible for providing technical information on the performance of the network to enhance project prioritization and support the metropolitan transportation planning process including the MTP and TIP.
Campo (Capital Area Metropolitan Planning Organization)	CMS could require the inclusion of traffic demand management techniques into the TIP or could influence the project selection in the Long-Range Transportation Plan. All projects in the TIP must be CMS compliant.
Hillsborough County MPO Tampa, FL	CMS projects are considered during the annual ranking process for candidate projects. The MPO complete corridor studies to supplement the CMS methodology. Consistency with the CMS has an impact on how high a projects rank in the annual MPO priority project.
Wilmington Area Planning Council (WILMAPCO)	CMS Technical Advisory Committee identifies congested corridors considering congestion density. Results of the CMS include a matrix of congested corridors and possible strategies and mitigation methods. CMS helps to identify possible projects to be moved into further stages of planning/development including LRP and TIP.
Mid Ohio Regional Planning Commission	Developed a ranking procedure (Microsoft Access tool) that helps to choose which programs to include in the TIP based on weighting measures of effectiveness.

Appendix C: Contact List

Appendix C
Contact List

Agency	E-mail	Phone	References
Michigan DOT	Gary Endres CMS Specialist endresg@michigan.gov	517-335-4583	MDOT. Michigan's Congestion Management System. TRB Conference on the Application of Transportation Planning Methods. May 1997.
Florida DOT	Martin Guttenplan FDOT System Planning Office martin.guttenplan@dot.state.fl.us	850-414-4906	Florida's Mobility Performance measures Program. December 2000. The Florida Reliability Method in Florida Mobility Performance Measures Program pp1-2
New York Metropolitan Transportation Council	Aizaz Ahmed Manager, Regional Planning & Special Studies Unit aahmed@dot.state.ny.us	718-472-3172	Congestion Management System Description and Procedures. New York Metropolitan Transportation Council.
Maricopa Association of Governments – Phoenix, Arizona	Mark Schlappi System Analysis Program Manager: Transportation schlappi@mag.maricopa.gov	602- 254-6300	1998 MAG Regional Congestion Study. Final Report 2000. Maricopa Association of Governments.
Brevard MPO	Kama Dobbs Transportation Planner kdobbs@brevardmpo.com	321-690-6890	2003/04 State of the System Reports Draft Technical Report, Renaissance Planning Group, June 2004
Greater Buffalo-Niagara Regional Transportation Council	Kimberly T. Smith Elena Modicamore Assistant Planners ksmith@gbnrtc.org emodicamore@gbnrtc.org	716- 856-2026	Congestion Management System: Description and Procedures Greater Buffalo-Niagara Regional Transportation Council (February 2004)

Contact List

Agency	E-mail	Phone	References
Corpus Christi MPO	Mohammad Farhan Transportation Planner II Corpus Christi MPO mfarhan@swbell.net	361- 884-0687	Congestion Management System Plan. Corpus Christi Metropolitan Planning Organization. November 1997 http://www.corpuschristi-mpo.org/documents/CongestionMSPlan.pdf
Campo (Capital Area Metropolitan Planning Organization)	Rachel K. Everidge-Clampffer, Senior Planner CAMPO rachel.clampffer@campotexas.org	512-974-6051	Congestion Management Systems: Work Plan Status Report. CAMPO Congestion Management Systems: State of the System Report. CAMPO
Hillsborough County MPO Tampa, FL	Joe Zambito Transportation Modeling and Special Projects	813-272-5940	Congestion Management Systems Practices. Chapter 3. Federal Highway Administration – Good CMS Practices. By Joan G. Hudson (TTI) January 2002
WILMAPCO	Daniels Blevins Senior Planner WILPACO dblevins@wilmapco.org	302-737-6205 Ext.21	WILMAPCO Congestion 2004 Management System Summary. Wilmington Area Planning Council. May 2004.
Mid Ohio Regional Planning Commission	Nicholas T. Gill. P.E. Mid-Ohio Regional Planning Commision ngill@mail2.morpc.org	614-233-4151	Congestion Management System: Existing and Future Conditions Report. A Companion Report to the 2030 Transportation Plan. June 2004. Mid-Ohio Regional Planning Commission
South Jersey Transportation Planning Organization (SJTPO)	Timothy Chelius SJTPO tchelius@sjtpo.org	856-794-1941	CMS For Non-Urbanized Areas: New Jersey Experience. August 2002. By Peter Lai (Parson Brinckerhoff-FG); Timothy Chelius (South Jersey Transportation Planning Organization, and Pete Kremer (Parson Brinckerhoff-FG) Appendixes A, B, C of Congestion Management Systems Development and Operation. SJTPO