

**CONGESTION AND CONGESTION MANAGEMENT:  
IDENTIFICATION OF ISSUES**

by

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## SUMMARY

The causes and impacts of congestion continue to be a major concern in many urban areas. Almost every level of government has enacted or proposed legislation mandating the reduction of congestion. This paper focuses on the issues surrounding congestion and congestion management planning.

Most transportation engineers define congestion in terms of excess demand or insufficient capacity. However, congestion is more than simply too many vehicles in an inadequate transportation system. Because the impacts and perceptions of congestion vary from location to location, any measure or criteria used to define congestion must be sensitive to the perceptions of the local community.

Congestion management combines three historically separate planning processes into one comprehensive system for improving regional mobility. Congestion management employs various strategies to: 1) manage transportation system supply, 2) manage transportation system demand, and 3) manage land uses. Through congestion management, transportation officials attempt to maximize the use of the existing system while providing incentives to motorists to travel by alternate modes of transportation or during less congested periods.

Because of the impacts of congestion on the economic vitality, air quality conditions, and the quality of life in a community, many levels of government are enacting legislation mandating the reduction of congestion. At the federal level, both the proposed Surface Transportation Efficiency Act of 1991 and the Clean Air Act Amendment of 1990 provide significant funding for congestion management. California has enacted strict legislation requiring each county with a population center greater than 50,000 to design, adopt, and update congestion management programs. The Illinois DOT has developed an eight-point planning for dealing with congestion in northeast Illinois. In Phoenix, a congestion management program is being developed that will use voluntary compliance by surrounding communities.

The issues pertaining to congestion and congestion management planning are the subject of discussions throughout the transportation community. There is a need to develop a system for comparing congestion levels between communities that accounts for the varying nature of congestion. Since the burden of responsibility falls primarily on the local jurisdictions, a method for proportioning the costs of regionwide improvements amongst multiple agencies is required. Research is also required to determine the level of effectiveness of demand management and land use management strategies at reducing areawide congestion. The issue of what traffic should be excluded from the analysis when determining the level of conformance needs to be addressed. Finally, since the application of advanced technology will be essential to reducing congestion in the future, there is a need to explore the issue of using federal funding to help defer operation and maintenance costs of these advance systems.

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## INTRODUCTION

The increased concentration of population and economic activity in metropolitan areas has placed a strain on the nation's highway and surface street transportation system. Between 1983 and 1987, travel on major urban freeways increased by almost 30%. This increase has resulted in severe congestion and air quality problems. By 1987, almost 65.5% of the interstate peak-hour travel occurred in congested conditions (1). In 1988, the annual cost of congestion, nationwide, exceeded \$34 billion (2). By the year 2005, overall freeway congestion is expected to increase over 400 percent while congestion on nonfreeway facilities is expected to increase over 200 percent above 1987 levels (3).

Congestion is not just a problem for the major metropolitan areas. The Federal Highway Administration (FHWA) has projected the rate of increase in congestion will actually be greater in medium sized cities. In metropolitan areas with a population base of less than one million, congestion is expected to increase 1000% over 1987 levels by the year 2005. This is three times the rate expected for populations centers greater than one million people (4).

The causes and impacts of congestion continue to be major concerns in many urban areas. Almost every level of government has enacted or proposed legislation mandating the reduction of congestion. In the proposed Surface Transportation Efficiency Act of 1991, the United States Congress, on the recommendation of the Department of Transportation, has provided significant funding for the next five years to finance congestion mitigation and air quality improvements (5). States, such as California, are beginning to enact strict legislation requiring the development, adoption, and annual revision of programs to deal with their congestion problems (6). Many local city and county governments, their constituents tired of congestion, are adopting strict "no growth" policies, mandatory trip reduction ordinances, and other measures in an attempt to deal with congestion in their jurisdictions (7).

### Purpose of Paper

This paper focuses on the issues surrounding congestion and congestion management planning. Specifically, this paper attempts to answer the following questions:

1. What is congestion and how is it measured?
2. What are the elements of a congestion management plan?
3. How does congestion management differ from other long-range planning processes?
4. What are some of the social, policy, and institutional issues dealing with congestion management planning?

## Scope

This paper is intended to provide a brief overview of some of the congestion management activities occurring in select areas of the nation. The content of this paper is based on a review of the available literature as well as telephone interviews with representatives from select transportation agencies. The paper is intended to provide insight into the issues pertaining to congestion and congestion management and is not intended to be a detailed analysis of the congestion management efforts nationwide.

## CONGESTION AND CONGESTION MANAGEMENT

Transportation officials are beginning to pay increased attention to the issues of congestion and congestion management. However, different individuals and communities have different ideas as to the scope, magnitude, and impacts of congestion. Questions concerning threshold values for defining the onset of congestion and the measurement of congestion continue to be the topic of national debate amongst the transportation community. In this section, a definition of congestion and a brief discussion of some of the possible measures of congestion will be presented. The elements of congestion management planning and the differences between congestion management and long-range transportation planning are also discussed.

### Definition of Congestion

Most transportation engineers define congestion in terms of excess demand or insufficient capacity. To most transportation engineers, the term "congestion" relates to the condition that results when "the number of vehicles attempting to use a roadway at any given time exceeds the ability of the roadway to carry the load at generally acceptable service levels" (4). However, congestion and the impacts of congestion are relative depending upon the normal, everyday driving environment. Congestion that occurs in larger urban areas such as Los Angeles, New York, and Houston is not the same, in terms of sheer magnitude, as that experienced in smaller urban areas, such as Tampa, New Orleans, or Austin. The amount of delay that occurs, the number of individuals affected, and the costs associated with congestion are much greater in larger metropolitan areas. However, while the absolute measures of congestion are definitely greater in larger urban areas, the perceptions of and aggravations caused by congestion transcend city size. The residents of many smaller urban areas perceive the impacts of congestion on their quality of life as being just as bad or worse as those experienced by individuals who reside in larger urban areas (8). Therefore, any measure or criteria used to define congestion must be sensitive to the perceptions of the community.

In an attempt to be sensitive to this issue, participants in a recent two and one-half day workshop (9) conducted by the FHWA on a national system for monitoring urban congestion developed a slightly different definition of congestion. The group defined congestion as the following:

*An imbalance between traffic flow and capacity that causes increased travel time, cost, and modification of behavior.*

This definition represents a change from the traditional way of thinking about congestion. It focuses on the relationship between supply and demand, rather than on whether capacity is inadequate or demand excessive. The definition also places greater emphasis on the effects, consequences and cost of congestion.

## Measures of Congestion

Most transportation engineers use Level of Service (LOS) to measure the relative performance of a facility. LOS, as defined by the 1985 Highway Capacity Manual (10), is a qualitative measure for describing the operations of the traffic stream on a facility. It is generally related to such operational factors as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience. However, as mentioned above, congestion is a relative phenomenon. Individuals from different sized communities in different parts of the country have different thresholds and tolerances to congestion (8). Engineers and transportation officials need to be cognizant of these differences when comparing congestion levels from different locales.

In a recent workshop conducted by FHWA on the development of a national urban congestion reporting system (9), participants identified four categories of measures that could be used to quantify congestion levels. Table 1 provides specific measures for each of the four categories. These measures attempt to quantify not only the level of congestion but also the duration, breadth, intensity, and extent of congestion.

## Congestion Management

Congestion is more than simply too many cars on inadequate or inefficient roadways. It is a result of complex demographic, social, and economic changes that have occurred since the end of World War II (4). Eliminating congestion requires careful evaluation of the impacts of individual transportation and land use decisions on one another and on the system as a whole.

Congestion management is an integrated approach to dealing with congestion in an area. It combines what have been historically three separate planning elements into one comprehensive system. It uses a combination of supply side, demand side, and land use management strategies to achieve balance in the transportation system. Many of the strategies and techniques employed to reduce congestion require individuals to change their travel behavior, governments to exercise strict control over land use decisions, and institutions and agencies to work together in a cooperative effort. It also requires that realistic expectations of the effectiveness of the techniques and strategies to eliminate congestion be developed and promoted.

Congestion management combines three distinct approaches to managing congestion into one comprehensive system. Congestion management programs typically consist of elements designed to: 1) manage transportation system supply, 2) manage transportation system demand, and 3) manage land uses. Each of these components are briefly discussed below. Figure 1 shows how the three elements are combined into a comprehensive congestion management system.

Table 1. Potential Measures of Congestion.

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*Person and Vehicle Measures*

- Cars/Lane/Hour
- Minutes of Delay/Capita
- Minutes of Delay/Vehicle
- Minutes of Delay/Person Delayed
- Minutes of Delay/Commuter

*PMT and VMT Measures*

- Minutes of Delay/VMT
- Minutes of Delay/Trip
- Thruput (persons/hour)
- VMT/LOS Category
- VHT/LOS Category

*System Measures*

- Number of 15 minute periods > LOS "X"
- Minutes of Delay/Lane Mile
- Percent Lane Miles > LOS "X"
- Peak Period Speeds
- Peak/Off Peak Speed Ratio
- Peak Period Nominal Speeds
- Number of Speed Change Cycles

*Time and Cost Measures*

- Average Travel Time/Trip
  - Average Travel Time/Peak Period Trip
  - Total Delay
  - Total Delay/Trip
  - Total Delay/Million VMT
  - Percent of Total Travel under Conditions of Delay
- 

Source: Reference 5.



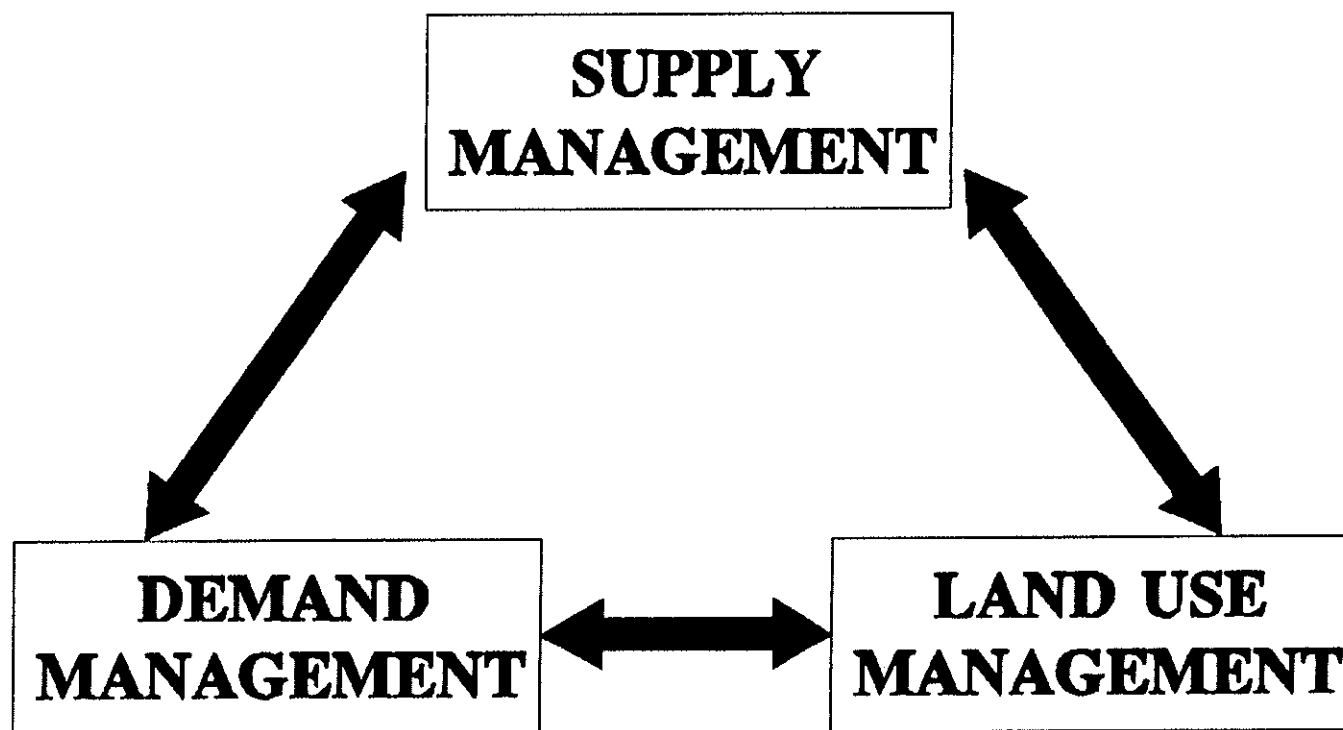


Figure 1. Elements of a typical congestion management program.

### *Supply Management*

Historically, the most common approach to alleviating traffic congestion has been to increase the supply (or capacity) of the transportation system. Two approaches can be used to increase the supply of a transportation system: add new facilities to the system and/or improve the efficiency of the system (4). Table 2 lists some of the techniques available for increasing the supply of a transportation system.

If the capacity of the system could be continually expanded to accommodate increasing demand, congestion would not be a problem. Therefore, adding more capacity has been the most effective means, at least historically, of reducing congestion. However, transportation agencies can no longer rely on increasing system capacity to eliminate their congestion problems. Adding new capacity is oftentimes too costly, politically and environmentally sensitive, and time consuming to be a practical and feasible solution to the problem. Furthermore, the amount of improvement that can be achieved through operational changes is limited by the physical capacity (i.e., the number of traffic carrying lanes) of the system. Therefore, transportation planners and officials must employ other approaches such as demand management, and land use controls, to help eliminate congestion.

### *Demand Management*

Another method of reducing or eliminating congestion on the transportation system is to better manage the demand. Demand management, in its broadest sense, is "any action or set of actions intended to influence the intensity, timing, and spatial distribution of transportation demand for the purpose of reducing the impact of traffic" (4). Table 3 lists some of the more traditional demand management techniques.

Through demand management techniques, commuters are provided incentives to use one or more alternative transportation modes and/or services, or to travel at times when congestion levels are not as great. Mass transit, such as bus and rail service, is an effective way of moving large numbers of people in a fast, efficient, and reliable manner. Paratransit services, such as carpooling, vanpooling, subscription bus, and shared-ride services, can be an effective way of reducing travel in highly dispersed, low density areas. The construction of improvements and amenities to improve the quality and predictability of transit service is also a demand management technique.

Although specific measurements of the effectiveness of demand management techniques at reducing congestion are limited, available evidence suggests that a well-conceived and aggressively promoted demand reduction program can decrease short-term peak period travel demand by as much as 10 to 15% at particularly congested locations, such as entrances and exits to major activity centers (4). However, the effectiveness of demand management strategies at achieving appreciable reductions in travel demand on freeways and major arterials is not known.

Table 2. Strategies for Managing Transportation Supply.

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<i>Existing Facilities</i>	
<u>Freeways</u>	
•	Reconstruction
•	Incident Detection and Management System
•	Integrated Freeway and Arterial Network Surveillance and Control
•	Motorist Information Systems
•	Ramp Metering
•	Lane Width Reductions
•	Shoulder Utilization
•	High Occupancy Vehicle (HOV) Facilities
•	Intelligent Vehicle/Highway Systems
<u>Arterials</u>	
•	Reconstruction
•	Limited Access Arterials (Super Streets)
•	Traffic Signal Improvements
•	Computerized Traffic Signal Systems
•	Arterial Surveillance and Management
•	Intersection Improvements
•	Turn Prohibitions
•	One Way Streets
•	Reversible Traffic Lanes
•	Improved Traffic Control Devices
•	Parking Management
•	Good Movement Management
•	Arterial Access Management
•	HOV Facilities
•	Enforcement
	<i>New Facilities</i>
•	Construction of New Streets and Highways
•	Construction of Rail/Fixed Guideway Transit Facilities
•	Access Control and Management
•	Improved Geometric Design
•	Modernization through Reconstruction
•	Street Widening
•	Railroad Grade Separations
•	Grade Separation

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Source: Reference 4.

Table 3. Strategies for Managing Transportation Demand.

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<i>Transit Improvements</i>	
•	Rail/Fixed Guideway Transit Facilities
•	Fixed Route and Express Bus Service
•	Demand-responsive Service
•	Ridesharing
-	Carpools
-	Vanpools
-	Subscription Bus Service
•	Transit-Oriented Parking Management Strategies
-	Park and Ride
-	Kiss and Ride
•	Employer Incentives
-	Parking Subsidies
-	Reserved Parking
<i>Demand Reduction</i>	
•	Road Pricing (Congestion Pricing)
•	Auto Restricted Zones
•	Parking Management
•	Alternative Work Hours
-	Staggered Hours
-	Flex-Time
-	Compressed Work Week

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Source: Reference 4.

## *Land Use Management*

One of the most important elements of any congestion management program is the integration of land use management and controls into the planning process. Transportation engineers and planners have long known that there is a direct and fundamental relationship between land use and transportation demand. The type, density, and location of land uses have a direct impact of the generation and distribution of traffic. By the same token, the implementation of transportation improvements, such as the construction of new capacity, improves access to an area. Improved access, in turn, leads to development and increased traffic demands (11). The relationship between land use and the transportation system is depicted in Figure 2. Because of this relationship, congestion is likely to occur or worsen when local governments approve development without ensuring that an adequate transportation system is in place to meet anticipated demands in the corridor.

Land use management techniques use public policies to regulate the location, geographic pattern, density, quality, and rate of growth of development in an area (4). With land use management, local land use decisions are analyzed to determine if the resultant traffic demand is consistent and compatible with local and regional transportation goals and desires. Since the spatial distribution of land use greatly influences regional travel patterns, congestion management requires strict adherence to zoning and land development regulations as well as provisions to ensure that transportation improvements are in place when development occurs. Table 4 lists traditional techniques for managing land uses.

### **Differences Between Congestion Management and Long-Range Transportation Planning**

In the opinion of this author, there appear to be three ways in which congestion management and traditional long-range transportation planning differ. The primary difference between congestion management planning and traditional long-range transportation planning is in the way that demand management and land uses are integrated into the planning process. As shown in Figure 3, population and land use are inputs in the traditional long-range planning process. By utilizing existing and projected land uses as well as other socio-economic characteristics of an area, future traffic volumes, adjusted for improved transit operations, are estimated and assigned to the transportation network. Once assigned to the network, the level of operation for each facility in the network (usually measured in terms of level of service) is computed and compared with the desired levels of service. The objective of the typical long-range transportation planning process is to determine the type, number, and size (i.e., number of lanes) of transportation facilities required to achieve a desired level of operation given the anticipated travel demand on the system.

In congestion management, however, the objective is to achieve the maximum use of the existing transportation system. Since expansion of the system may be too politically sensitive and costly, land use and demand management techniques are used to keep demand below acceptable thresholds and to improve the people-moving efficiency of the system. Through congestion management, transportation and political agencies may be able to control the rate at which travel demand increases in the system.

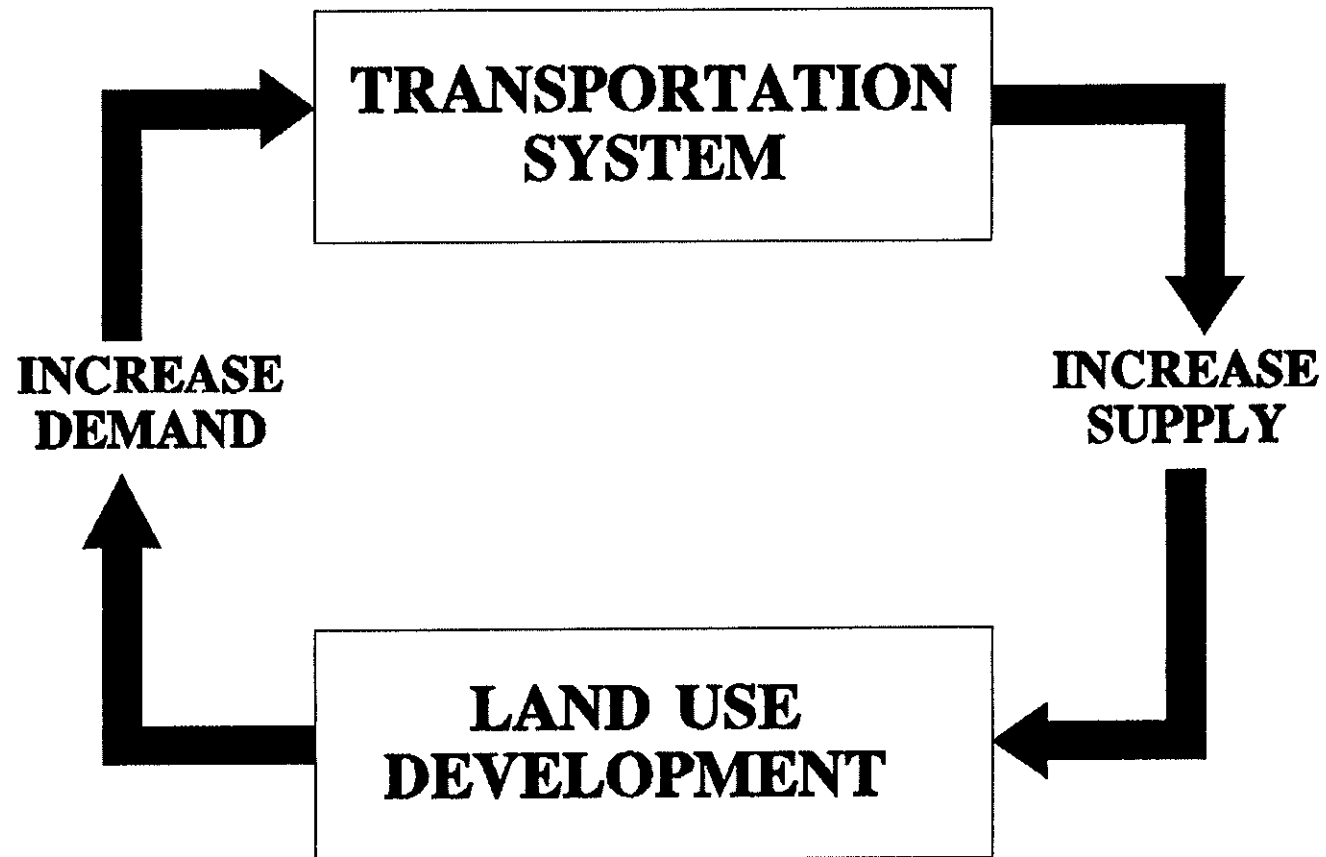


Figure 2. The relationship between the transportation system and land use.

Table 4. Strategies for Managing Land Uses.

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*Legislative*

- Land Use Policies for Improved Transit Access (High Density Nodes)
- Site Design Criteria for Increase Transit Usage
- Growth Management Ordinances
  - Trip Reduction Ordinances
  - Compatible Zoning
  - FAR Restrictions
- Conditional Development Approval
- Development Phasing Agreements

*Funding*

- Toll Roads
- Development Fees
- Impact Fees
- Tax Increment Financing
- Special Assessment Districts
  - Road Districts
  - Transportation Corporations

*Institutional*

- Traffic Management Association
  - Traffic Management Teams
  - Regional Traffic Management Associations
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Source: Reference 4.

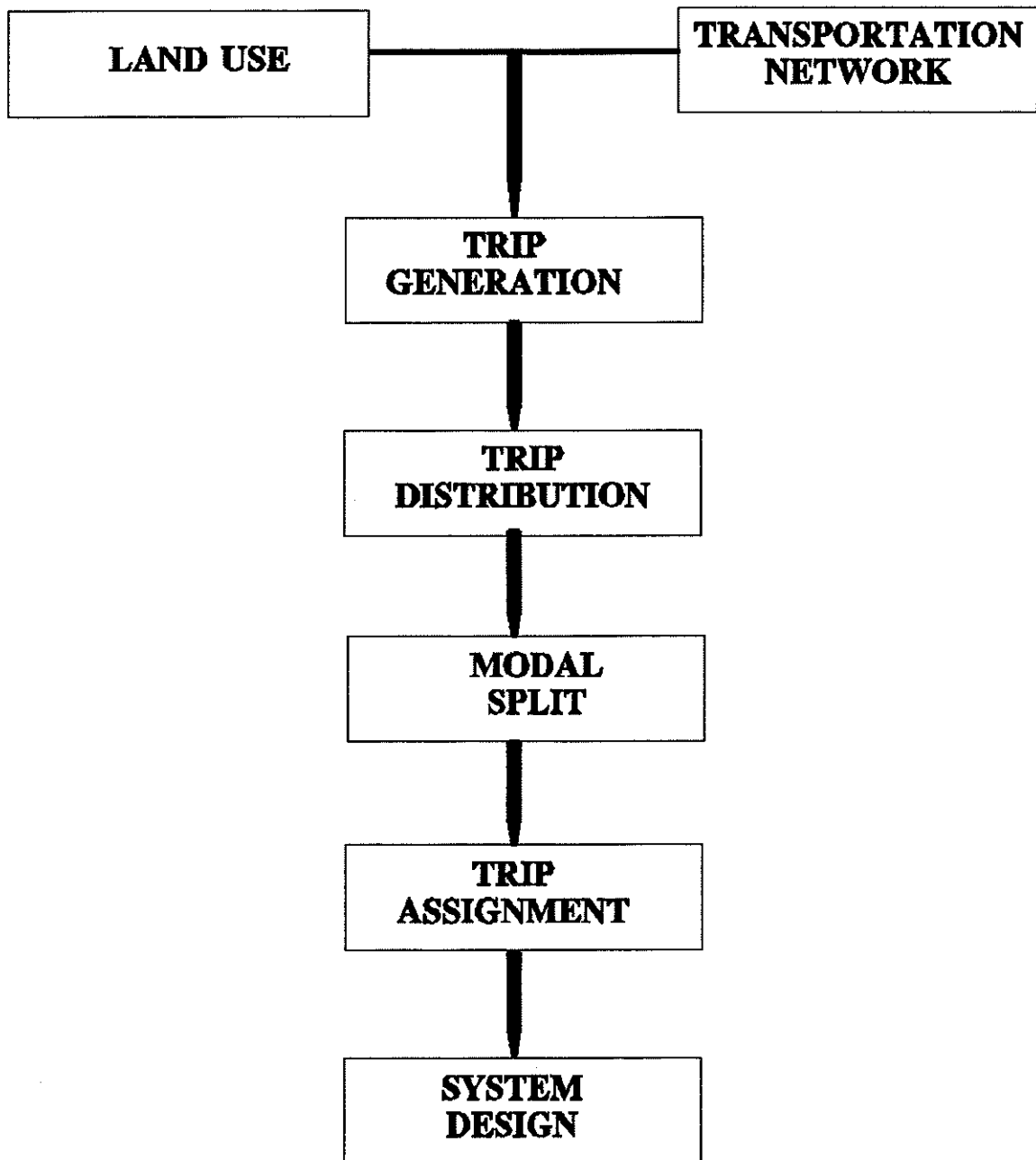


Figure 3. Traditional Long-Range Planning Process



Another important difference between congestion management and traditional long-range transportation planning is the level of cooperation between neighboring jurisdictions. With traditional long-range planning, individual planning organizations are responsible for determining the transportation needs within their specific jurisdiction. Because congestion is not restricted by jurisdictional boundaries, congestion management attempts to identify strategies that can be used to improve mobility on a regionwide basis. Congestion management is a cooperative effort among neighboring jurisdictions, particularly in locations where congestion occurs areawide. In situations such as these, multi-jurisdictional solutions may be required to mitigate or eliminate traffic congestion.

A final difference between congestion management and long-range transportation planning is the time period used in the analysis. Traditional long-range transportation planning attempts to determine the transportation needs at some point in the future, usually 20 years. Congestion management, on the other hand, not only attempts to address long-range transportation needs but also assists in evaluating day-to-day land use and transportation decisions. With congestion management, the impacts of local land use decisions on the entire regionwide transportation systems can be evaluated. If adverse impacts exist, congestion management techniques could be implemented to ensure that adequate transportation facilities are in place to meet the anticipated demand prior to permitting development to occur.

## CONGESTION MANAGEMENT LEGISLATION

Congestion and the management of congestion has become a major concern in many areas of the country. Because of the effects of congestion on economic growth, air quality, and the quality-of-life in general, congestion has become a major concern for all levels of government. Congestion levels have become so bad in some major metropolitan areas that it has become one of the top-ranking concerns of many suburban voters, even to the point of surpassing crime, housing, and unemployment as a major public concern (7).

With the completion of the Interstate system, the priority of the federal government has changed from constructing new facilities to better managing and improving the existing transportation system. Two important pieces of federal legislation that will have major impacts on congestion management planning and the transportation system as a whole are the Surface Transportation Efficiency Act of 1991 and the Clean Air Act Amendments of 1990.

### Surface Transportation Efficiency Act of 1991

In April of 1991, the United States Senate began debate on a new highway reauthorization bill (5). The bill, called the Surface Transportation Efficiency Act of 1991, authorizes \$105 billion from the Highway Trust Fund to be spent on the National Highway System over the next five years. The bill, as proposed and adopted by the Senate, represents a significant shift in the federal policy on transportation. As a policy statement, the bill officially declares the National System of Interstate and Defense Highway completed and that "the principal purpose of federal highway assistance shall henceforth be to improve the efficiency of the existing surface transportation system." (5) Therefore, the major emphasis of the bill is on improving the quality of operations of the existing highway system.<sup>1</sup>

To stress this emphasis, the legislation requires each state, in coordination with metropolitan planning organizations and other units of government, to develop management systems for dealing with pavements, bridges, safety, and congestion. As a minimum, these management systems will cover the National Highway System. These management systems are to be developed in accordance with regulations prescribed by the Secretary of Transportation and shall be based on a needs assessment of the existing transportation system. The bill allocates \$44.8 billion over the next five years to the Surface Transportation Program to fund these management systems. The Senate bill no longer

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<sup>1</sup>As typical of most major legislation, the Senate, and the House of Representatives each have slightly different versions of the bill. The Senate approved their version of the bill in late June of 1991. The legislation is not scheduled to be introduced to the floor of the House of Representative for debate until late July, 1991. Although significant differences between the two versions of the bill may exist, it is anticipated the major concepts and emphasis of the bills will be similar. Since the House version had not been introduced to the floor of the House at the time this report was prepared, the above discussion is based solely on the Senate version of the bill.

requires states to develop annual programs of projects (as required in past legislation) but uses the management systems as the basis for funding individual projects.

As mentioned above, each State will be required to have Congestion Management Systems as part of the urban transportation planning process. According to the bill, regional metropolitan planning organizations (MPOs) will have the primary responsibility for developing congestion management systems for the urbanized areas in a state. The bill mandates that metropolitan planning organizations be designated for each urbanized area of a state that has a population base of over 50,000. The regulation applies to any area that already exceeds or is expected to exceed this population threshold in the forecast period. In developing transportation plans and programs, each MPO is required, by regulation, to:

1. preserve existing transportation facilities and, wherever practical, meet existing and future transportation needs by using the existing transportation system more efficiently;
2. provide transportation planning that is consistent with applicable federal, state, and local energy conservation programs, goals, and objectives;
3. consider the need to relieve congestion;
4. conform with the applicable requirements of the Clean Air Act;
5. consider the effects of transportation policy decisions on land use and development;
6. recommend, where appropriate, the use of innovative financing mechanisms, including value capture, tolls, and congestion pricing to finance needed projects and programs;
7. provide for the programming of expenditures on transportation enhancement activities;
8. consider the effects of all transportation projects within a metropolitan area, including those undertaken with private funds;
9. consider the overall social, economic, and environmental effects of transportation decisions; and
10. develop a long range transportation plan.

The bill states that these requirements are to be fulfilled in cooperation and in coordination with state and local transportation agencies and relevant transit operators. The bill further stipulates that "travel demand reduction and operational management strategies" are to be used in developing congestion management plans for population areas that exceed 250,000.

To date, specific regulations for developing and implementing congestion management systems have not been developed by the FHWA. However, it is envisioned that FHWA's requirements for implementing the congestion management provision of the legislation, once it is approved, will be flexible to allow jurisdictions to tailor solutions to conform with local conditions and desires (12). FHWA is planning on holding a workshop with various representatives of state and local transportation planning agencies in late August, 1991, to begin developing specific regulations and criteria for developing congestion management systems. Specific issues to be addressed in this workshop include the following:

1. the division of responsibility between the State and the MPO,
2. the approach to be used in establishing baseline congestion levels,
3. the amount of detail expected in the system plans,
4. the type of incentives necessary to encourage implementation of "tougher" demand reduction strategies, and
5. the appropriate federal oversight mechanisms for administering the requirement to develop congestion management plans.

The Senate bill also provides \$1 billion annually for the next five years to finance the Congestion Mitigation and Air Quality Improvement Program which is also an element of the Surface Transportation Efficiency Act of 1991. These funds are to be used for financing projects that will make a significant contribution towards achieving the ambient air quality standards established by the Clean Air Act. Only those projects that reduce vehicle miles traveled (VMT), fuel consumption, or other factors that effect air quality are eligible for funding under this program. Projects that result in the construction of new capacity for use by single occupant vehicles (except where the project consists of a high occupancy vehicle facility which can also be used by single occupant vehicles at other than peak travel times) are not eligible for funding under this program.

### **Clean Air Act Amendments of 1990**

Another piece of federal legislation that will have a significant impact on congestion management activities is the Clean Air Act Amendments (CAAA) of 1990. The law will have a major impact on transportation planning and project development, particular in those areas that currently do not conform to the National Ambient Air Quality Standards for ozone and carbon monoxide. Significant revisions in the areas of sanctions, conformity, and emission forecasting will affect transportation planning in all nonattainment areas (13).

Under the new provisions of the CAAA, the restriction of federal-aid highway funds will be one of the primary sanctions imposed on areas that fail to conform to air quality standards. Where, in the past, highway sanctions could be imposed only for failing to submit a State Implementation Plan (SIP), the sanctioning of highway funds under the new act can now be imposed for both failing to submit an SIP as well as failing to implement a SIP.

Furthermore, highway funds can be sanctioned when non-transportation related sources (e.g., failures related to stationary source controls) fail to meet air quality standards.

The CAAA also places stringent requirements for nonattainment areas to achieve conformance. The requirements, shown in Tables 5 and 6, vary depending upon the severity and type of pollutant causing the air pollution problems in an area. The law requires compliance in nonattainment areas be achieved using demand and land use management techniques (called Traffic Control Measures or TCMs in the legislation) to reduce vehicle miles traveled (VMT) and vehicle emission. Congestion Mitigation and Air Quality Improvement Program funds, as discussed above, are to be used to fund these improvements.

Table 5. Provisions for Nonattainment Areas: Ozone.

Severity of Ozone Pollution	Provisions	Current No. of Areas
Moderate	Emissions reductions: 15% in 6 years	32
Serious	TCMs to offset growth in emissions/VMT/Trips--after 6 years	16
Severe	TCMs to offset growth--after 2 years Employer trip reduction	8
Extreme	Possible heavy-duty vehicle restrictions	1

Source: Cited in Reference 9.

Table 6. Provisions for Nonattainment Areas: Carbon Monoxide.

Severity of CO Pollution	Provisions	Current No. of Areas
Moderate	VMT forecasts in SIPs Automatic contingency measures	38
Serious	TCMs to offset growth in emissions/VMT/trips Explain TCM rejection Provide comparable reductions Implement economic incentive/TCM program	3

Source: Cited in Reference 9.

## **CASE STUDIES OF CONGESTION MANAGEMENT PROGRAMS**

Congestion management activities are beginning to occur throughout the United States. The following section provides a case study review of some of the congestion activities occurring at a state, regional, and local level in different parts of the country.

### **California**

California is, perhaps, the leader in developing and implementing congestion management programs. In June of 1990, the voters of California approved a referendum to increase the level of funding for transportation improvements. Along with this approval, the state legislature enacted laws mandating that congestion management programs (CMPs) be "developed, adopted, and annually updated for every county that includes an urbanized area" of greater than 50,000 population (5). Based on this definition, over 31 counties in California are required to develop, and submit congestion management programs.

The purpose of congestion management programs in California is to integrate land use, transportation, and air quality decisions. CMPs are intended to be used by local and regional transportation and environmental officials to assess potential congestion and environmental concerns, and to develop balanced, multi-modal programs for addressing these concerns. The CMP provides local governments and congestion management agencies with a mechanism to improve system efficiency through coordinated roadway construction, traffic flow improvements, transit utilization goals, and demand management procedures.

By law, each CMP is to contain, as a minimum, the following:

1. an element defining the CMP transportation system and level of service standards for the highway and roadway portions of the system;
2. a transit standards element;
3. a transportation demand management and trip reduction element;
4. a program for analyzing the impacts of land use decisions; and,
5. a seven year capital improvements program.

To achieve the legislative objectives, appropriate land use, transportation, and air quality agencies are required to integrate their planning processes and develop a coordinated approach for responding to congestion.

By statute, all existing state highways and principal arterials within the county are to be included in the CMP planning network. All new highways and principal arterials are required to be included in the system. Once a facility has been defined as an element of the CMP system, it cannot be removed. All elements in the system are required to maintain at least a Level of Service (LOS) E. If the current level of service of an element is LOS F,

then the statute requires that actions be implemented in order to prevent congestion levels from becoming worse on the facility. The ultimate responsibility of conforming to the LOS standards rests with each of the cities and the county within the CMP. Since the local jurisdictions have approval authority over land use decisions which may ultimately affect conformance to the LOS standards, each local jurisdiction is responsible for ensuring that the adopted LOS standards are met for all roadways within their jurisdiction, including state highways. This places the burden of responsibility on each local government to carefully consider the impacts of future land use decisions on the CMP network. If conformity cannot be maintained, cities and counties have to develop remedies to increase funding for projects and programs which will improve the level of service on the system (including state highways).

The legislation also requires that transit and demand management be included as elements in the CMP. Frequency, routing, and scheduling standards are to be established for both bus and rail transit modes. By statute, local governments are required to adopt mandatory trip reduction and travel demand ordinances. The following lists the purposes of these ordinances:

1. improve system efficiency by developing measures to increase the person throughput of the system with minimal capital expense;
2. ensure that alternative modes of transportation are included as components of the transportation system;
3. reduce vehicle trips and vehicle miles of travel by encouraging the use of alternative modes;
4. improve the overall level of service of the transportation system by reducing vehicle demand or by maximizing the person throughput; and
5. integrate air quality planning requirements with the transportation planning and programming functions.

The legislation also calls for a regionwide data base to be established. This data base is to be used to forecast regional traffic volumes; to model the impacts of major operational changes in transit routing, frequency, and coordination; to determine the impacts of increased mode choice and temporal shifts resulting from the implementation of demand management legislation; and to assess the impacts and costs of local land use decisions on the regional transportation system. Through modeling efforts, local governments will be able to determine the cumulative impacts of their land use decisions, and approve, disapprove, or modify their land use decisions to ensure conformance.

### **Northeastern Illinois**

As with many other regions in the United States, rapid economic development and population growth in Northeastern Illinois has outpaced transportation improvements. By the year 2010, future traffic demands are expected to increase by 23% over 1987 levels. To



address current and future transportation needs in the region, the Illinois Department of Transportation, in cooperation with many of the other transportation and planning agencies in the region, developed an eight-point plan for reducing congestion in the region (14). The plan, called "Operation Green Light", focuses on increases in capacity and reductions in transportation demand to address congestion problems in the region.

The plan primarily focuses on expanding the capacity of the existing transportation system. The five elements of the plan listed below illustrate how capacity is to be increased through the congestion management process. The plan requires that capacity be increased by implementing the following strategies:

1. expanding and developing the major new transit and freeway corridors;
2. creating a "Strategic Regional Arterial" network to reduce demand on the freeway network;
3. improving other important regional arterials to improve inter-community access and mobility;
4. improving freeway traffic management capabilities by expanding freeway traffic surveillance and control, and incident management systems; and
5. improving arterial street traffic management capabilities by installing a computerized traffic signal system, developing a region wide incident detection network, and creating a system to monitor overall congestion on arterial roadways.

The plan also provides recommendations for reducing vehicular demand on the transportation system. Northeastern Illinois has one of the most extensive transit networks in the United States. The plan identifies strategies for improving the convenience and reliability of the transit system. Transit services improvements include installing pullouts at major transit stop locations, providing priority treatments for transit vehicles, improving highway access to railway stations, and providing preferential facilities for high-occupancy vehicles. Operation Green Light also considers several demand management strategies, such as promoting alternative work schedules, increasing employer ridesharing programs, and promoting off-peak truck deliveries. The plan also advocates that policy makers and planning agencies pay increased attention to alternative modes of transportation, such as pedestrian and bicycles, in their traditional planning processes as a way to decrease vehicular demand on the transportation system.

One of the shortcomings of the plan is that it does not include a land use management element. Although the plan encourages local planning agencies to work with their respective governments to determine land uses compatible with the highway and transit systems, it does not provide a mechanism for ensuring that approved development and land uses do not overload this system.

## Phoenix, Arizona

In December of 1990, the Maricopa Association of Governments (MAG) in Phoenix, Arizona requested proposals from qualified consultants to develop an initial plan for managing congestion in the MAG planning area (15). Development of the plan is being jointly funded by the Urban Mass Transportation Administration (UMTA), FHWA, and the Maricopa County Highway Department, in cooperation with the 27 member agencies of the MAG, the Regional Public Transportation Authority, and the Arizona Department of Transportation. The plan is intended to address the mobility needs of the region and will be used as a mechanism for guiding and monitoring the implementation of multi-modal transportation improvements and travel reduction efforts. The plan will also serve as the basis for identifying and implementing improvements to ensure compliance with the air quality standard as set forth in the 1990 Clean Air Act. The plan will also assist local member agencies in their land use planning efforts, and will provide recommendations for implementing market incentives for improving transportation in the region.

The target year of the plan is 2005. The following strategies are to be considered in developing the plan:

1. demand management techniques such alternate work schedules, parking management controls, ridesharing, etc.;
2. land use controls such as restrictions on the number of building permits issued, FAR restrictions, etc.;
3. the use of market incentives such as user fees, tolls, and congestion pricing for funding transportation improvements, etc.;
4. techniques for improving roadway capacity such as expansion needs, HOV lanes, traffic management techniques, etc.;
5. improvements to the transit service; and,
6. the use of alternative transportation modes such as bicycles, pedestrians, telecommuting, etc.

Each of the strategies are to be assessed as to their costs, public acceptability, ability to relieve congestion, and air quality and energy implications. Model projections of total congestion will be used to compare the effectiveness of the strategies to level of service goals. Procedures for implementing and monitoring the plan are also to be provided.

One of the unique features about the congestion management program being developed in Maricopa County is that agencies are being requested to participate in implementing the recommended improvements in the program on a volunteer basis. Other than the need to conform to the requirement of the Clean Air Act of 1990 and a federally mandated implementation plan for the Maricopa County Non-attainment Area, there is no legislation requiring member organizations to implement the improvements. It is believed that since the program is being developed through the MAG, member organizations will follow the proposed implementation plan (16).

## ISSUES ASSOCIATED WITH CONGESTION MANAGEMENT

The following section discusses some of the social, policy, and institutional issues associated with congestion management. These issues were identified by the author during the research for this paper. Recommendations for addressing these issues are also presented in this section. A summary of the recommendations is presented in Table 7.

### **Measuring Congestion**

In order to assist them in apportioning funding, state and federal transportation officials need a method of comparing congestion between various regions. Existing means of comparison (LOS) implies that the effects and impact of congestion are uniform between regions. However, as discussed above, congestion is a relative phenomenon. The costs and impacts of congestion vary between regions. Commuters in larger, more populated areas have different expectations and delay thresholds than commuters in smaller communities.

In addition, most measures of system performance such as delay, speed, etc. are indicators of "average" travel conditions (9). However, average conditions do not adequately describe the total dimension of the congestion problem. For example, if only a few facilities in an area are heavily congested, averaging these facility with the rest on the uncongested facilities in the region would mask the effects of the congestion. Similarly, averaging travel on a facility over a day or week may not adequately report the peak period demand for that facility. Therefore, the use of averages as a reporting mechanism may tend to underestimate the true congestion level for an area.

### *Recommendation*

Measures of congestion need to be developed that adequately describe the depth, breadth, intensity, and extent of the congestion problem. Candidate measures need to be carefully examined to ensure that they do not distort or under report congestion problems. Therefore, the development of congestion indices that use multiple measures of congestion is recommended. The measures should emphasize the duration (e.g., percentage of peak period travel with respect to total travel), breadth (e.g., percentage of vehicles affected), and depth (e.g., percentage of travel occurring during congested periods) of the congestion problem. The indices should also reflect the costs to society (fuel consumption, emissions, etc.) and individual costs (delay costs, frustration level, etc.) to account for regional and population differences.

### **Burden of Responsibility**

In much of the reviewed legislation, the burden of responsibility for conforming to the legislation is placed on the local agency. For example, in California, each local government agency is responsible for ensuring that the roadways (including state facilities) in its jurisdiction conform to the established level of service criteria (6). If they do not, the local agency is required to take corrective measures to reduce the demand or increase the capacity. However, mitigating the impacts of congestion may place a large financial burden on some local municipalities, particularly those with limited resources.

Table 7. Summary of Recommendations.

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*Measuring Congestion*

- Measures of congestion need to be developed that adequately describe the breadth, intensity, and extent of the congestion problem. The development of congestion indices that use multiple measures of congestion is recommended.

*Burden of Responsibility*

- The burden of mitigating congestion should be based on the proportion that each community contributes to the total regionwide congestion problem. Population or the number of motor vehicles registered in each municipality could be used to quantify a community's share of the burden.

*Assessment of Effectiveness*

- Additional research is needed to determine the level of effectiveness of demand and land use management techniques at reducing areawide congestion. Quantitative measures of the amount of traffic that can be reduced by implementing specific demand reduction strategies are needed.

*Permitted Exemptions*

- Exemptions permitting the reduction of background traffic or specific traffic flow improvements should not be permitted. The analysis of a system's efficiency should be based on the true traffic patterns and conditions that exist in a region.

*Federal Funding of Operations and Maintenance*

- The federal government should participate in the funding of the operations and maintenance of traffic improvements installed as congestion management techniques. Provisions for replacing hardware, typically a maintenance item, need to be included in the federal funding legislation.
-

Furthermore, many locations have a strong, central attractor (such as a CBD) surrounded by "bedroom" communities. Traffic demands on the facilities near the core attractor are often greater than those in the surrounding communities. The demand on the facilities in the "bedroom" communities is composed of traffic generated primarily by the bedroom community. On the other hand, the demand near the core attractor is composed of both the traffic generated by the core attractor and the bedroom community. Therefore, if applying California's laws for managing congestion, the core area would carry a greater responsibility for mitigating the congestion.

### *Recommendation*

Each municipality must share in the burden of mitigating the impacts of congestion. The burden of mitigating congestion should be based on the proportion that each community contributes to the total regionwide congestion problems. Each municipality would be responsible for providing financial support equivalent to their share of the congestion problem. Population or the number of motor vehicles registered in each municipality could be used to quantify a community's share of the burden. Detailed origin/destination studies may also be required to determine how much traffic each municipality contributes to the congestion problem. A regional congestion management agency could be responsible for collecting the funds and implementing the appropriate congestion mitigation projects in that municipality. This would allow funds to be allocated equitably throughout the region to ensure that congestion problems are addressed on a regionwide basis.

### **Assessment of Effectiveness**

While the effects of improving capacity are well known and relatively easy to calculate, there is limited quantitative data on the effectiveness of demand management and land use management techniques on reducing congestion. With the decreased ability to fund and construct capacity improvements, local agencies have to rely more on demand management and land use controls to eliminate or mitigate congestion problems. Unless undertaken on a massive scale, the effectiveness of demand reduction strategies is limited to only specific congestion locations. Demand reduction strategies are reportedly ineffective at causing appreciable reductions in traffic on freeways and major arterials (4). Therefore, congestion management agencies need to be able to quantify and predict the impacts of implementing these type of techniques on congestion levels.

### *Recommendation*

Care must be exercised by transportation agencies not to generate unrealistic public expectations as to the effectiveness of demand reduction techniques to reduce areawide congestion levels. Additional research is needed to determine the level of effectiveness of demand management and land use management techniques at reducing areawide congestion. Quantitative measures of the amount of traffic that can be reduced by implementing specific demand reduction strategies are needed. Both site specific and systemwide effectiveness measures are required.

## **Permitted Exemptions**

The California legislation permits the impacts of interregional travel; construction, rehabilitation, or maintenance of facilities; freeway ramp metering; traffic signal coordination by the state or multi-jurisdictional agencies; and traffic generated by low and very low income housing to be excluded when determining conformance with established level of service standards. However, the traffic generated and impacts from these items are part of the transportation system and have a direct impact on traffic flow in the region. By providing exemptions, congestion levels in the region may be underestimated. By including these factors in the analysis, a true representation of the level of congestion and the effectiveness of mitigation measures can be determined.

### *Recommendation*

Exemptions when determining conformance should not be permitted. The analysis of the system's efficiency should be based on the true traffic patterns and conditions that exist in a region. If exemptions are permitted, true improvements to the transportation system cannot be measured.

## **Federal Funding of Operations and Maintenance**

Traditionally, projects eligible for federal matching funds are limited to the construction of new roadways or capital intense operational improvements (such as freeway and arterial traffic surveillance and control system). The federal government will only provide funding for the first six months of operation after the improvements have been completed. At that time, the state or local agency is totally responsible for funding the operations and maintenance of these facilities. As more operational improvements are installed with federal funds, state and local governments may find it difficult to provide operational and maintenance funding.

### *Recommendation*

The federal government should participate in the funding of the operations and maintenance of traffic improvements installed as congestion management techniques. With the federal emphasis shifting from the construction of new facilities to the more effective management of the existing transportation system, the federal government should also provide support for the operations and maintenance of the system. Provisions for replacing hardware, typically a maintenance item, need to be included in the Federal funding legislation.

## **CLOSURE**

Congestion has become a major social and political concern in many metropolitan areas. Congestion can have a direct impact on the economic vitality and quality of life of an urban area. Federal, state and local governments have reacted to congestion problems by enacting strict environmental and land use controls in an attempt to mitigate the impacts of congestion. Congestion management is an integrated approach to dealing with the problem of congestion. It utilizes supply, demand, and land use management strategies to achieve balance between capacity and demand for the transportation system. It provides a foundation for local and regional transportation agencies to work together to reduce congestion and improve the quality of life on a regionwide basis.

Because of the impacts of congestion on the economy, environment, and quality of life, congestion management activities are beginning to occur throughout the nation. These activities will require dramatic changes in the ways in which many transportation agencies view congestion. Multi-jurisdictional solutions above and beyond traditional long-range planning processes will be required to mitigate the impacts of congestion within a region. Only through a comprehensive system which uses techniques to better manage supply, demand, and land uses can the impacts of congestion be mitigated and reduced.

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