better, that's not our priority.

John Suhrbier: I wanted to pick up on the question on the linkage between transportation/air quality models/data and relate it back to VMT forecasting guidance. I spent a lot of time with transportation and air quality people. The air quality people tend to say: "Transportation data/models are really the weak link in all of this." One of the major reasons EPA is relying on HPMS data in the VMT forecast guidance section 187 work is because EPA lacks confidence in transportation model systems.

But we, as transportation people, have a tendency to say emissions models are off by a factor of 2 or 3, and then you've got the dispersion modeling. That's even worse.

My own conclusion in terms of getting on with life is to assume equality, equity, and weaknesses on both sides. There are some things that can be done quantitatively. There are some things that can be done qualitatively, as well.

In Massachusetts, I've had a chance to look at some regional modeling transport issues. The regional modeling work pretty convincingly demonstrates that Boston has a problem by itself. It's accentuated by some pollution transport, but the models certainly do not provide any evidence that there isn't an air quality problem.

So, I think, rather than debate -- it's not very constructive in my mind to debate whose models are worse, or whose models are better, but to somehow structure communication where progress can be made.

PANEL ON MANAGEMENT SYSTEMS: IMPLICATIONS FOR DATA AND COLLECTION PROCEDURES

David McElhaney, Federal Highway Administration, moderator

DATA NEEDS FOR MANAGEMENT SYSTEMS

Christopher R. Fleet, Federal Highway Administration

INTRODUCTION

The transportation planning process is being impacted in ways that have new implications for data needed to support that process. Recent legislation (i.e., the Clean Air Act Amendments of 1990 - CAAA '90; and the Intermodal Surface Transportation Efficiency Act of 1991 - ISTEA) are forcing improvements and modifications to the supporting analytical base for multimodal transportation decision-making. At the same time changing demands and needs are occurring at the State, regional, and local levels of government for improved responses to such concerns as urban congestion, assessing the complex interaction between land use development and travel, and environmental impacts of transportation decisions.

Because the substantial investment that has been made in the nation's infrastructure is susceptible to erosion if it is not managed effectively, a key element of the ISTEA is the requirement for each state to develop and maintain management systems in six specific areas. These areas are: (1) highway pavements of Federal-aid highways, (2) bridges on and off Federal-aid highways, (3) highway safety, (4) traffic congestion, (5) public transportation facilities and equipment, and (6) intermodal transportation facilities and systems. In addition the states must establish a traffic monitoring system for highways and public transportation facilities and equipment. The fundamental objective underlying these management systems is improving the efficiency of the nation's existing and future transportation systems.

ISTEA requires that regulations concerning the management systems be implemented by December 18, 1992. Much has to be done in the meantime in order to meet that date: an Advance Notice of Proposed Rule Making was published in the Federal Register June 3, 1992, and Notices of Proposed Rule Making for each system will be published in the Federal Register for review and comment; and a final regulation, taking into consideration all the comments, must be prepared and published by the December 18 date.*

ISTEA requires the states to be in the process of implementing each management system in fiscal year 1995, and they must certify before January 1, 1995 (and each subsequent year) that the management systems are, in fact, being implemented. A schedule for compliance may be established to meet the requirements for implementation through the rule-making process.

IMPLICATIONS FOR STATE AND MPO WORK PROGRAMS

ISTEA requires that any needs identified under the

* This activity and the outreach and training activities discussed later in this paper were anticipated at the time this paper was presented.

management systems must be considered in the planning and programming of transportation improvements at the state and metropolitan levels. In Transportation Management Areas (TMAs), the congestion management system (CMS) must be part of the metropolitan planning process. At least three of the systems (congestion, public transportation, and intermodal) will need to be closely coordinated with the updating of the State Implementation Plans (SIPs) in non-attainment areas. Because each state or metropolitan area is unique and has unique transportation problems, each of the management systems may be tailored to individual state or metropolitan area needs.

Since the clock is ticking toward the January 1, 1995 certification requirement, states and MPOs need to build in sufficient lead time in their work programs to scope out what is needed to develop and implement the systems. Coordination with other key planning requirements and their due dates must be considered as well. For example, states with CO nonattainment areas must update their SIPs by November this year, and states with ozone nonattainment areas must update them by November 1993. Transportation control measures (TCMs) proposed under the SIP update process will have to be closely coordinated and evaluated with transportation demand management (TDM) strategies proposed under the congestion management system.

States and MPOs will be incorporating these important work activities into their planning work programs over the next few years. Many of these activities will require data, either collected directly or obtained from secondary sources, to support them and provisions must be made to put in place data collection and monitoring procedures.

The time line in Figure 1 is a picture of the potential activities leading up to the January 1, 1995 certification. The example includes supporting activities for the congestion management system, but other systems will need similar preparation and support (except possibly those that are already under the development process such as pavement management). Also shown are some of the milestone dates for other related activities, including those supporting air quality and metropolitan planning. FHWA and FTA are sensitive to the need to coordinate as many of the various planning activities required under ISTEA as possible. Not only does it make sense for efficiency, but the effects of strategies implemented under a management system will impact proposals developed to respond to air quality problems.

Officials responsible for developing their agency's work programs will recognize that there is much to do and little time in which to do it, especially in non-attainment areas. In the example in Figure 1, for a July-to-June fiscal year, draft programs ideally need to be available for review and approval in February-March. This means the program development effort should begin in November-December, an overall time frame of seven or eight months from the initial scoping to the start of the fiscal year. In practice this time element is often much shorter.

Work activities to ensure that management systems are being implemented in fiscal year 1995, need to be in place in fiscal year 1994. If the start of the fiscal year is July 1993, then the work program development period should begin roughly November or December of this year. Preparation time for meeting the November 1993 SIP update is considerably more condensed. That work would have to be started in fiscal year `1993 work programs beginning July of this year.

OUTREACH AND OTHER RELATED ACTIVITIES

As shown in Figure 1, a substantial effort is planned at the federal level to provide information, training and technical assistance over the next two to three years. Specifically for the congestion, intermodal and public transit systems, four multi-regional meetings are being planned for June and July. Similar meetings are being planned for the safety management systems.

A series of congestion management training sessions and workshops is being planned for states, MPOs and FHWA field staffs. Two are being developed through the National Highway Institute and will be available in late summer of 1993. One will be a one-day overview for managers and the other will be a three-day workshop for technical staffs. These will coincide with the early fiscal year 1994 state and MPO work program activities and provide the technical details of assessing congestion relief strategies. To provide early discussions on congestion management, a one-day overview is planned to be available starting February 1993. This will dovetail with the development stages of fiscal year 1994 work programs. It is quite likely that these one-day sessions will be available as part of, or as add-on to, other planned meetings.

Several research efforts are shown in Figure 1. One, starting this summer, is a review and synthesis of existing congestion management activities and applications of congestion relief strategies. The results of this effort will be available by December 1992 and will provide input to the one-day overview sessions. This project is being conducted jointly by FHWA's Office of Environment and Planning and Office of Technology Applications and is the first phase of a longer term marketing program of congestion management applications.

Several recent national conferences and workshops have focused on needed analytical improvements to respond to the new demands being placed on the planning process. Integral to an improved process are the data and information needed to support it. Notable among these conferences are the Conference on Transportation, Urban Form, and the Environment (held in Irvine, California, December 1990) and the Conference on The Effects of Added Transportation Capacity (held in Bethesda, Maryland, December 1991). Major recommendations for data needs to support new initiatives were made and published in the proceedings to the Irvine Conference and proceedings are expected soon for the Bethesda Conference. It would be useful to refer to these recommendations, as they have implications for the technical direction of the process, including data needs.

This is just a sample of the activity focused on the implementation of management systems required by ISTEA. More information will be available as outreach, training, technical assistance, and research activities are developed. We view open communications as critical in implementing the management systems.

COMMON ELEMENTS AND THEMES IN THE SIX MANAGEMENT SYSTEMS

As noted earlier, ISTEA requires six management systems. While these are envisioned as separate systems or sub-systems of an overall transportation management system, there are several important elements that run throughout all six management systems:

- Cooperation—the state is the responsible agency for developing and implementing the systems. In metropolitan areas, this must be accomplished in cooperation with the MPO. Transit agencies and local governments will also need to be involved.

- Objectives—the two fundamental purposes of the management systems are to improve the efficiency of transportation systems and to protect the public and private investment made in those systems.

- Implementation—transportation needs and improvements identified as a result of a management system must be considered by the states and MPOs in their plans and programs and must be considered in making project selection decisions. Thus, the management systems themselves will not be the end products. They will provide added information for decision makers for planning and programming.

- Funding Sources—the following program or system funds may be used for developing, establishing and implementing the management systems:

  - National Highway System, Surface Transportation Program, and FHWA state Planning and Research,

  - FTA Sections 8 (planning) and 9 (capital, planning and operating); and 26 (state and national planning and research),

  - Congestion Mitigation and Air Quality Improvement Program funds may be used in non-attainment areas for congestion, transit, and intermodal management systems since these systems are likely to directly benefit air quality, and

  - Apportioned bridge funds for the bridge management system.

- Data—all management systems have common activities that require data. More discussion on these elements will follow later in this paper, but briefly they include:

  - Define and monitor the magnitude of the problems,

  - Identify transportation improvement needs,

  - Analyze alternative solutions to the problems and assess their effectiveness in solving them, and

  - Measure the effectiveness of the implemented actions.

Data requirements will vary across management systems. Some data may be useful to all systems (e.g., traffic volumes or VMT), while other data will be unique to a single system (e.g., bridge structural data). Some data will be needed for federal reporting purposes; some will be collected only for use at the state and local levels. The data and its collection and analysis should be tailored to the individual needs and objectives of the system.

There are four sources of data that, at this point, are anticipated to be used for national monitoring needs. These four could supply some state and metropolitan needs also. These sources are: (1)the

traffic monitoring system required by ISTEA, (2)the Highway Performance Monitoring System (HPMS), with possibly some modifications, (3)FTA's Section 15 reporting requirements, and (4)the National Bridge Inventory. FHWA and FTA recognize that coordination among these data sources would help improve the efficiency of data collection and use among the various management systems and we will be working toward that end.

Clearly there are many issues beyond the data considerations that need to be resolved before full implementation of the management systems. These will be addressed through the normal rule-making process and opportunities for public review and comment and our outreach activities.

DATA NEEDS FOR PAVEMENT, BRIDGE, AND SAFETY MANAGEMENT SYSTEMS

The impetus for systems or programs in these areas has developed over several years, and ISTEA reinforces the need, continuance, and (in some cases) expansion of these programs. Many of the data requirements have been, or are well on the way to being, established and are well documented through AASHTO, NCHRP, or FHWA studies or reports. While data-related issues for these systems will be addressed in the regulation development process, the focus for this paper will be on the other three management systems. This paper will only briefly touch on the highlights of the pavement, bridge, and safety management systems.

Pavement Management Systems

FHWA issued guidance in December 1991 on Pavement Design Policy. It requires that each state have, among other things, a pavement management system (PMS) operational by January 13, 1993. This PMS should be based on the concepts described in AASHTO publications including its 1985 "Guidelines on Pavement Management." While this is a requirement for states, the policy guidance recommends that local PMSs are desirable.

Most states have been developing a PMS for some time and the current policy is expected to remain in effect, although the extent of network coverage has been expanded under ISTEA to include all highways other than local roads or rural minor collectors. The rulemaking process will address the issue of expanded coverage and the phase-in period needed to incorporate the additional mileage.

AASHTO guidelines identify five data categories for a PMS:[1]

- Inventory—facility location, functional classification, length, pavement type, etc.,
- Pavement condition—roughness, ride, distress, etc.,
- Construction and maintenance history,
- Traffic—AADT, particularly heavy truck traffic, for priority setting and to estimate loads for design purposes, and
- Cost—data for economic analysis and benefit/cost estimates.

The PMS requires many of the same data items required by HPMS for performance. The two need to be coordinated.

Bridge Management Systems

Bridge Management Systems (BMS) also have an established track record; based on a 1988 FHWA study most states had begun to organize, plan, or develop a system and progress was being made to implement them by the time the study was conducted. Another study, conducted under NCHRP, developed a model BMS[2] and AASHTO has developed draft BMS guidance. One data "hook" for coordination is the HPMS, since bridge location is identified in the HPMS data.

Safety Management Systems

State highway safety programs can be traced as far back as the 1966 Highway Safety Act and subsequent legislation. AASHTO has produced a guide for states; and FHWA, based on a review of state practices, developed a "good practice" document. Recently states supported the need for the "good practice" document as a base for developing their systems.

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[1] AASHTO, "AASHTO Guidelines for Pavement Management Systems," Washington, DC, July 1990.
[2] Transportation Research Board, "NCHRP Report No. 300, Bridge Management Systems," Washington, DC, December 1987.

DATA NEEDS FOR CONGESTION, INTERMODAL, AND PUBLIC TRANSPORTATION FACILITIES

There are several unifying elements of ISTEA (and CAAA '90) that provide compelling reasons for discussing these three management systems together:

- ISTEA Policy—development of a national intermodal transportation system with emphasis on reducing air pollution and congestion,
- Planning and program development—statewide and metropolitan plans and programs must include:
  - Reduction of congestion and methods for preventing its development where it doesn't yet exist,
  - Methods to reduce vehicle travel (especially single occupant vehicles - SOVs), and
  - Efficient use of existing facilities and improving the flow of people and goods.

Transportation Management Areas (TMAs)

The transportation planning process in areas over 200,000 population and other TMAs must include a congestion management system. In non-attainment TMAs, a project that significantly increases SOV capacity may not be funded with FHWA or FTA funds unless it is part of an approved congestion management system.

Context for Management Systems

The context for management systems is the statewide and metropolitan processes for developing plans and programs.

Elements within a Common Framework

All three systems will have elements, some common, some unique, that will fit within the same framework of activities (see Table 1):

- Identification of systems or facilities:
  - Location, extent, area of concentration, network or facilities involved, modes, transfer points, etc.
- Identification of performance measures:
  - Is performance better, worse, remaining the same over time?
  - What is the change in condition, efficiency or effectiveness of the system, or quality of service provided over time?
- Data collection and system inventories:
  - Physical condition and operating characteristics (time, cost, capacity, usage, etc.);
  - Data to track location, duration, and severity of congestion (recurring and non-recurring) and evaluate effectiveness of strategies or actions.
- Monitoring and evaluation of facility or system performance:
  - Evaluation of performance is based on and supported by the performance measures established and the data collected;
  - Methods or approaches to evaluation will be needed so problems can be identified or located and solutions recommended;
  - Measures for monitoring may be different than those needed for strategy evaluation.
- Identification of strategies or actions and their evaluation:
  - Potential effectiveness or impact of proposed strategies need to be assessed;
  - Priorities of actions and costs would be identified.
- Implementation of strategies or actions:
  - Proposed actions, responsibilities for implementation, timing, funding sources, etc.;
  - Potential problems (institutional, financial, legal) to implementation;
  - Strategies or actions become part of state and metropolitan plans and improvement programs.

Data Issues Specific to the Congestion, Public Transit, and Intermodal Management Systems

Are There Any Changes?

Indeed, a lot has changed recently in terms of the dynamics of the transportation planning process and the transportation program. At the same time, the fundamentals of transportation planning that have evolved over many years will continue to play a major role. For example:

- Measuring change—the notion that measuring the change in performance and reliability of the transportation system (something we once called "surveillance") is necessary to manage a program of improvements for that system is not new.

- Long-term issues—improved mobility and congestion relief are issues that have been around for a long time.

- Positive impacts—on the environment and economic development continue to be major considerations in the formation of plans and programs.

- Technical base—the analytical process, with a long track record, provides a technical base for decisions about enhancing the transportation system's performance and assessing the relationships between modes of travel.

Changes in the Dynamics of the Process

What has changed is the framework and dynamics within which the process is carried out:

- Program changes—legislative and program funding changes have redirected emphasis and shifted responsibilities within the context of transportation planning and programming:

  - Available funding—FHWA funds available for metropolitan planning have more than doubled from $47M to $117M annually. One percent of the funds authorized for most of the major highway programs is now set aside for metropolitan planning, up from ½ percent. HP&R Program has increased from 1½ to 2 percent of the major highway programs. National Highway System and Surface Transportation Program funds may also be used for planning. FTA funds for metropolitan planning have increased 25 percent from $35M to $44M annually. Section 9 funds are also eligible for planning.

  - Responsibilities—the MPO's authority and responsibilities for project selection have increased.

  - Statewide planning—a statewide plan and program are now required and these must be integrated with metropolitan plans and programs.

  - Air quality—the CAAA '90 and subsequent attention by the environmental community have changed the way the transportation community does business in terms of the expected analytical quality and precision of planning products. The analytical transportation planning process is being impacted in a number of ways that have implications for changes needed in travel model structure, data needed for the models, and the way in which the models are applied.

  - Travel behavior—more fundamental is our realization that we need to better understand the complex interaction among the traveler, the transportation system, and land use and form; and that this relationship must be monitored over time.

Staying with the data needs in the analytical process for the moment, Dan Brand suggests that we haven't done so well in accurately modeling land use-travel interaction so far because we have been working with "...an incomplete model of travel and land use location behavior."[3/] He suggests that we need to change our approach to travel modeling and place the

[3/] Daniel Brand, "Research Needs for Analyzing the Impacts of Transportation Options on Urban Form and the Environment," in TRB Special Report 231, Transportation, Urban Form, and the Environment, Transportation Research Board, Washington, DC, 1991.

individual traveller (and his or her travel-related behavior) at the center of the model structure (see Figure 2, taken from Figure 1, of Brand's paper, p.103 of the Irvine Conference Proceedings).

Another issue, he says, is in dealing with what happens in practice. The problem is that the full range of costs of congestion (and making trips in that congested state) are not fully recognized or understood by the individual traveller. These costs include costs of delays, air pollution, energy consumption, etc. For the information about these costs to have any appreciable affect on travel, it must be incorporated into the travellers decision process--not an easy task, but one that is beginning to be considered through pricing strategies.

This suggests that, in addition to the more traditional transportation system and travel demand measures for monitoring the effects of strategies and actions, we need to be thinking about measuring the full range of travel costs and the relation of these costs to congestion, air pollution, and urban form.

Typical Data Items

In the meantime, what typical data should states and MPOs be considering for collection and monitoring to implement the management systems by fiscal year 1995? All three management systems will have among them one or more common components that should be considered for measuring and monitoring over time. These components are shown in Table 2, with examples of possible measurement items and the typical data that are needed to provide these measures. The components are:

- Measure—the first component is the measure itself, or "yard stick" that provides an indication of severity of congestion or condition of transit equipment, for example. The availability of the data from which these measures are derived (or the difficulty in obtaining the data) will influence the extent or quality of the measures.

The other components represent base data from which the measures are derived:

- System—the highway facilities, transit facilities, or intermodal connections in terms of such things as miles, lane miles, route miles, ton miles, etc.,

- Demand—the demand or usage of the system measured by VMT, PMT, AADT, passengers carried, or goods or people transferred,

- Time or cost—time or cost to use the system - for example - travel time, speed, transfer time of goods or people, delay or duration of congestion,

- Location or component—location, area, or class of interest of the element being measured, such as CBD, suburbs, designated area, specific network, transit route, or intermodal transfer facility, etc.

Data Sources

Both existing and new sources of data will have to be considered. A few examples of existing data sources are shown in Table 2. The transportation planning process has always relied on primary sources that are an integral component of transportation planning, as well as secondary sources that are collected under other programs or for other purposes, but are relevant to transportation planning.

New sources of data or methods of collection are likely to be necessary to support adequate management systems (and to ensure that information from the management systems is addressed in the planning process at both the metropolitan and state levels). A number of questions need to be answered first, however--among them:

- Incidents—how to monitor incidents? What are the measures to assess effects of incidents?

- Land use—what are the effects of land use alternatives and growth management strategies on travel and on reducing congestion?

- IVHS—how can the data produced by IVHS be integrated into the planning process and applied in the management systems?

The emphasis now must be on data coordination and sharing among agencies and jurisdictions and for multiple purposes:

- Efficiency and consistency—multiple uses of data, to the extent it is possible, must be considered to conserve resources and help ensure consistency between management system needs and other program needs (e.g., air quality analysis).

- Count-based travel—there is more emphasis now on developing count-based travel estimates. EPA is forcing the issue in its recent VMT Forecasting And Tracking Guidance; and VMT tracking is needed for congestion monitoring as well as for

air quality purposes. states cannot view traffic counting as one of the first activities to cut back when there is a shortage of funds.

- Link-level data—link speed information and temporal distributions of facility traffic volumes are needed for emissions modeling. This has implications for some of the same data collection procedures and analysis needed for congestion management, among them:

  - Speed inventories and estimation procedures,

  - Travel model post-processing for the MOBILE model inputs requires extensive facility-level information on regional speed/volume to develop profiles by functional class and area type.

Accuracy

Accompanying the broader range of data needs and applications is a need for greater emphasis on reasonability checking on information being produced or used within the planning process and, consequently, the management systems.

Transportation studies will need to do a good job of balancing the experience level of their analysts and sophistication (or lack of sophistication) in the models with new (and often seemingly unrealistic) demands being placed on the analytical process. Analysts (and managers) need to ask questions such as:

- How much difference does it make? What are the effects of a change in level of service or in implementing a strategy on travel and can the management system measure it?

- What is important? What is the purpose of the data being collected or being produced by an analysis? How precise and accurate does the information need to be? Do the answers need to be: quick and dirty?; $\pm$ 10%?; or bullet proof and court safe?

Frequency

Data will need to be submitted on a regular basis to FHWA and FTA, probably annually if existing sources (e.g., HPMS, Section 15) are used. Beyond this, the frequency of data collection will vary depending on the state and local needs and the management systems they establish. All systems will need data often enough to provide basic information:

- To discern changes in the component being measured,

- To supplement secondary data sources,

- Although a measure may be needed every year, some data may not be available every year and may be collected every two or three years and a measure derived in the in-between years.

SUMMARY

Requirements for management systems will make it necessary for states and MPOs to carefully review their acquisition, use, and sharing of data. Data collection is expensive, and coordination will be a key element in data-related activities. This is necessary not only for efficiency, but the effects of strategies developed under management systems will have to be evaluated for their effects under related programs, such as air quality.

Clearly much must be accomplished by U.S. DOT, as well as the states and MPOs, to meet milestone dates in establishing management systems. Substantial outreach and effort is planned over the next few years to provide assistance and training. This report includes many of the supporting activities and requirements to respond to ISTEA as they were anticipated at the time it was prepared. More information will be available as outreach, training, technical assistance, and research activities are developed; and as the various Notices of Proposed Rule Making are prepared.

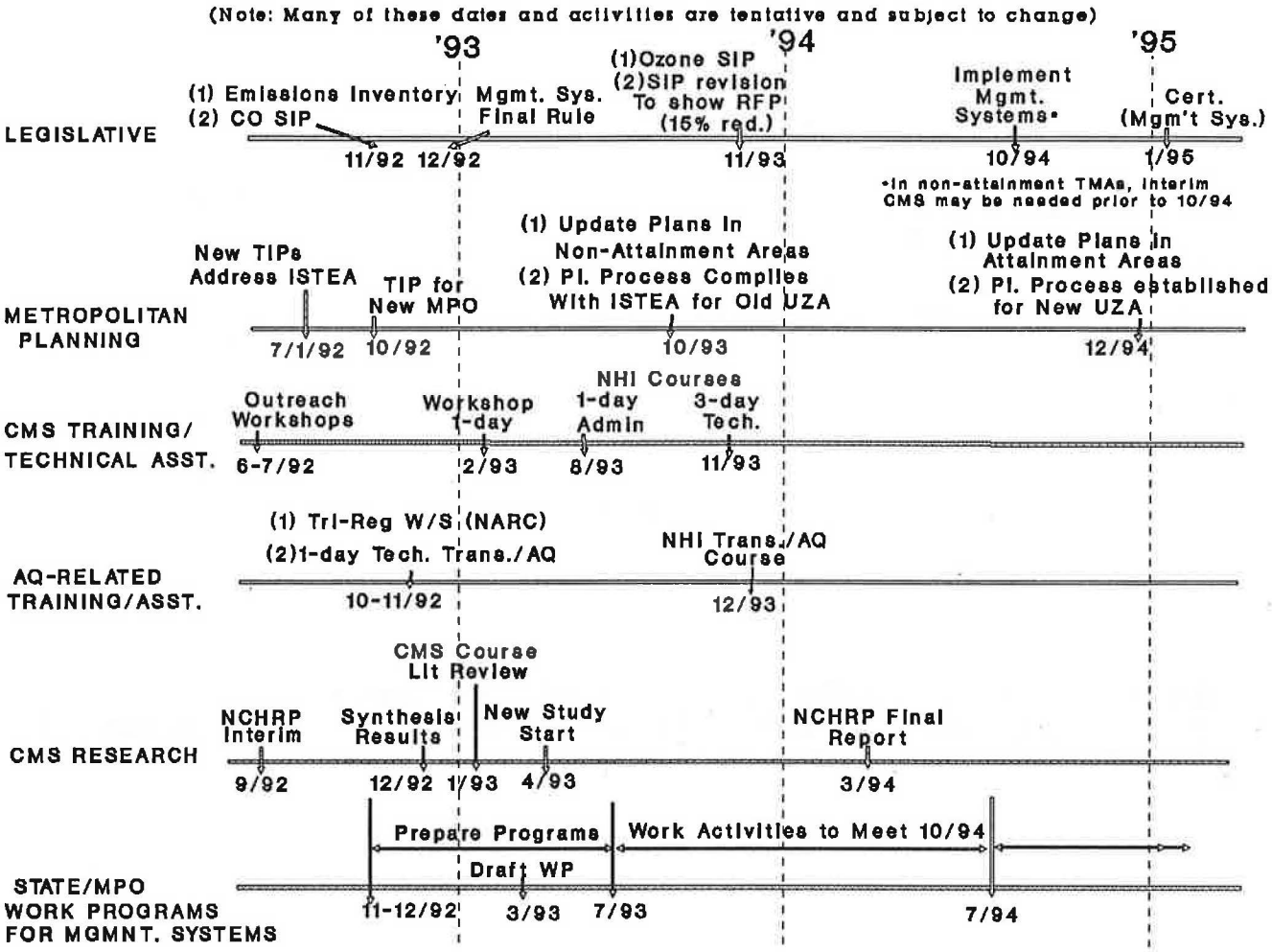

FIGURE 1 Milestone dates for selected activities supporting ISTEA.
(Note: Many of these dates and activities are tentative and subject to change.)

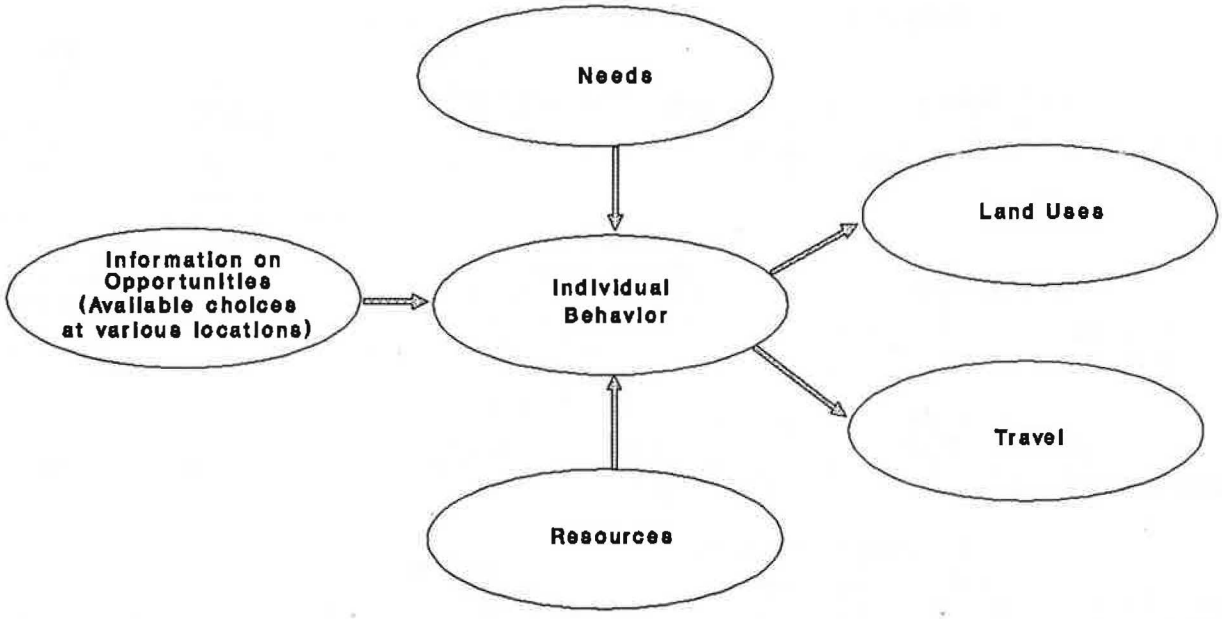

FIGURE 2 A new look at the effect of traveler behavior on land use travel interactions (from Brand, "Research Needs for Analyzing the Impacts of Transportation Options on Urban Form and the Environment," TRB Special Report 231, 1991 Figure 1).

TABLE 1 EXAMPLES OF ELEMENTS OF MANAGEMENT SYSTEM ACTIVITIES
CONGESTION, TRANSIT AND INTERMODAL

ACTIVITY	ELEMENTS
Identification of Systems or Facilities	Location, extent, area of concentration, network, modes, etc. Examples: statewide, metropolitan area, corridor; public or private operators; intra- or inter-state movement of persons or goods; coastal or inland ports, rail, truck, or bus terminals.
Identification of Performance Measures	What is the condition, efficiency, or effectiveness of the system? Is performance better, worse, remaining the same? Examples: quality of service, travel time or cost, condition of facilities or equipment, cost or passengers carried per unit of service, movement of people or goods, time for intermodal transfer.
Data Collection and Systems Inventories	Physical condition and operation characteristics. Examples: time of travel, cost, capacity, usage, duration and severity of problem.
Monitoring and Evaluation of Facility or System	Evaluate performance and establish methods to locate and identify problems, and develop solutions; determine causes for inefficient movement of people or goods; monitor and evaluate effectiveness of previously implemented strategies.
Strategy Identification and Evaluation	Address current and future deficiencies; assess effectiveness of proposed strategies; set priorities; identify costs and funding sources; identify potential problems to implementation.
Implementation of Strategies or Actions	Plan for implementation; proposed actions, responsibilities for implementation, timeframe, funding sources; incorporated into plans and programs.

TABLE 2 POSSIBLE DATA FOR THREE MANAGEMENT SYSTEMS

Component	Congestion	Public Transit	Intermodal
MEASURES	LOS lane-miles>LOS "X" VMT>LOS "X" %VMT by funt. class VMT/lane-mile delay/lane mile delay/VMT delay/trip delay/vehicle delay/person delayed delay/incident delay due to construction avg. travel time/trip persons/hour on facility/ corridor persons/vehicle	riders/vehicle mile riders/vehicle hour peak load factors on-time performance cost/vehicle mile cost/rider accidents/veh. mile roads calls/veh. mile veh. hours/employee veh. miles/employee riders/employee capital replacement fund	cost/ton mile by mode cost/passenger mile by mode average value/pound (freight) on-time performance average transfer time between modes (passenger and freight) average cost due to losses or theft per trip by mode average accident cost per trip by mode
DATA: System	lane miles lane miles of HOVs capacity functional class proportion of system congested nature and location of construction underway location and duration of incidents on the system	vehicle hours vehicle miles route miles riders employees accidents useful life of assets terminals/garages equipment service hours	ton miles passenger transfer freight losses from thefts (total value) accidents useful life of assets access facilities under construction (to airports, railroads, harbors, intermodal centers)
Usage of the System or Demand	Trips VMT,DVMT total PMT & Peak ADT Period no. of vehicles using HOV lanes no. of persons using HOV lanes proportion of travel congested/delayed proportion of persons congested/delayed proportion of vehicles congested/delayed duration of peak period	passengers (total and peak period) market share	passengers freight by category-frequency and duration proportion of freight delayed proportion of passengers delayed by transfer market share

TABLE 2 POSSIBLE DATA FOR THREE MANAGEMENT SYSTEMS (continued)

Component	Congestion	Public Transit	Intermodal
Time or Cost to Use the System	person hours of delay vehicle hours of delay average speed peak period speed average travel time: peak and off-peak proportion of travel time under congestion or delayed parking cost	headway average speed wait time transfer time operating cost walking distance parking cost	transfer time-peak and off peak headway average travel time of freight during peak and off peak transfer cost
Location or Area of Interest	central city suburbs suburban fringe specific functional class coordinates for GIS	routes lines transfer points	intercity intracity international transfer points routes and lines
SOURCES OF DATA: Primary Sources	traffic counting programs travel time surveys home interview surveys employer surveys vehicle occupancy counts screen line counts cordon surveys surveys at activity centers vehicle class. counts parking inventories site impact studies computerized signal systems	on board surveys employer surveys surveys at activity centers	on board surveys employer surveys surveys at intermodal centers travel time surveys shipping surveys
Secondary Sources	Census Data system inventories HPMS	Section 15 data	census data section 15 data system inventories (harbor, airport, railroad) truck inventory and use survey