US Department
of Transportation

Federal Highway
Administration

An Overview of Traffic Monitoring Programs in Large Urban Areas

July 1997

Joseph Mergel

Prepared by:

Center for Transportation Information
Volpe National Transportation Systems Center
US Department of Transportation
Cambridge, MA 02142

Prepared for:

Federal Highway Administration, Office of Highway Information Management
Washington, DC 20590

PREFACE

This is one of two documents prepared by the Center for Transportation Information of the Volpe National Transportation Systems Center in support of the Federal Highway Administration's Office of Highway Information Management. This report documents the status of traffic monitoring data collection and program activities found in urbanized areas. The companion report presents the results of a number of case studies of traffic monitoring data operations within several individual localities.

The Center for Transportation Information researched the status of traffic monitoring operations in urbanized areas of over 200,000 population by conducting telephone interviews with a number of staff from States, counties, cities, and metropolitan organizations responsible for traffic monitoring operations. The inquiries were used to document the status of traffic monitoring in urban areas and to identify a number of areas to be studied in more detail.

Joseph Mergel (Volpe Center) served as principal investigator. Denise Spadafora-Rodriguez (EG&G/UNISYS) had primary responsibility for development of the database of interview results. Johnathan Belcher (EG&G/UNISYS), Candace Brown (EG&G/DYNATREND), and James Green (EG&G/UNISYS) assisted in the telephone interviews.

Many metropolitan areas have begun or are planning to implement traffic monitoring programs to meet the many demands for traffic data. Several have requested information regarding FHWA guidance or program development in other jurisdictions. The latest FHWA guidance for urban areas was produced in the early 1980's and is out of date. A need exists to identify current program models or examples and to use these as the one basis for updating FHWA guidelines.

The purpose of this project is to document a series of examples of urban traffic monitoring data collection programs in order to support the development of urban traffic monitoring databases and promote the upgrading of urban traffic monitoring programs.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

Table Page

EXECUTIVE SUMMARY

The need for traffic monitoring data to support transportation programs in urbanized areas continues to increase. At the same time, the collection of traffic monitoring data in these areas is subject to numerous constraints, limitations, and restrictions. The collection of traffic monitoring data (traffic volume, vehicle classification, travel time, speed, vehicle occupancy, and truck weight) in urban areas has been carried out under a variety of organizational systems.

Traffic volume data collection is usually a combination of programs under one or more of the jurisdictions.

Vehicle classification data collection in urban areas tends to be very limited due to the cost and difficulties associated with automated equipment.

Truck weight data is collected for planning, highway design, research, and enforcement. Since enforcement is targeted at the overweight vehicles, it is basically useless for planning operations as it is not representative of truck weight loads on the system and is hampered by the evasive action of truck drivers.

Travel time and vehicle occupancy studies, have traditionally been carried out by MPOs on an irregular basis, usually in response to the need to update inputs to the regional transportation planning model.

Recent legislation will heavily influence both real-time and off-line data collection. Most significant are the Clean Air Act Amendments (CAAA) of 1990, and the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Both laws will require more and new types of traffic related data. The CAAA will require more accurate and frequent measurements of vehicle miles traveled (VMT). The ISTEA had mandated six new management systems by 1995. Each of these would depend on data from a Traffic Monitoring System being defined by each state.

ISTEA required states and metropolitan areas to create and utilize congestion management systems (CMSs).[1] As mandated by ISTEA, CMSs are to be developed and implemented in Transportation Management Areas (TMAs), which are metropolitan areas with over 200,000 population. In cooperation with MPOs, local governments, transit operators, and other cooperating agencies, state DOTs are encouraged to identify, develop, and implement the necessary data collection programs to address specific levels of congestion for transportation facilities.

The most visible growth in the use of traffic data will be in the area of real-time operations. Most of the systems that define ITS (Intelligent Transportation Systems) will drive the requirements for real-time, highway-based traffic data. The development of these systems will be strongly influenced by the CAAA, ISTEA and other social and political changes that will take place in the coming decade (e.g., government downsizing and retrenchment at all levels).

In summary, the current situation is one in which air quality and congestion considerations are driving a need for more and better data in the TMAs, at a time when staffing and budget cuts at all levels of government imply the need to do more with less. New technologies like ITS may hold the promise of a solution to this dilemma.

Many metropolitan areas have begun or are planning to implement traffic monitoring programs to meet the many demands for traffic data. Several have requested information regarding FHWA guidance or program development in other jurisdictions. The latest FHWA guidance for urban areas was produced in the early 1980's and is out of date. A need exists to identify current program models or examples and disseminate the information.

VNTSC's Center for Transportation Information (CTI) researched the status of traffic monitoring operations in urbanized areas of over 200,000 population by conducting telephone interviews with a number of staff from States, counties, cities, and

---

[1] The National Highway System Designation Act of 1995 designated the National Highway System (NHS) developed by the Department of Transportation (DOT) in cooperation with the States, local officials and metropolitan planning organizations (MPOs). The DOT proposed the system to Congress on December 9, 1993, as required by the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. The NHS legislation removed and added other mandates to the program. The States may choose not to implement in whole or in part any of the management systems required under ISTEA. The Secretary may not impose the 10% penalty on funds if the State elects this option.

However, the NHS legislation doe not affect the requirement in Section 134 of Title 23 that the planning process in all Transportation Management Areas include consideration of congestion, nor the requirement in Section 134(l) of Title 23 that Federal funds may not be programmed in a carbon monoxide and/or ozone nonattainment TMA for any highway project that will result in a significant increase in single-occupant-vehicle capacity unless the project is based on an approved congestion management plan.

metropolitan organizations responsible for traffic monitoring operations. In addition, the literature and information available from professional organizations, AASHTO, NCHRP, TRB, FHWA, and other governmental organizations was examined.

This report documents the status of traffic monitoring data collection and program activities found in urbanized areas. Based on the work reported here, several localities will be selected for an in-depth review, documentation, and assessment of their traffic monitoring data operations.

APPROACH

The general approach taken in this work was one of trying to get a sense of what was being done in large urban areas in terms of traffic data collection. We did not attempt a complete census of all agencies/jurisdictions potentially involved in traffic data monitoring. Nor did we attempt to formulate a statistically valid random sample of those same agencies. Our approach was simply to try to contact at least one agency at a city, county, MPO and state DOT level within each urbanized area with population greater than 200,000.

The purpose of this was two fold: first to get a sense, even if only on an anecdotal level, as to who was doing what, and how, and why in terms of data collection; and second, to identify programs that might potentially serve as models for urban areas throughout the country.

It should be noted that the greatest problem we had was in identifying individuals at the local level responsible for traffic data collection. We attempted to do this by first contacting the Division Administrator in the FHWA division offices in states containing the urbanized areas of interest, who in turn directed us to the appropriate FHWA staff person. In many cases, these staff were not familiar with any data collection efforts below the level of state DOT. Individuals involved in traffic data collection at the state DOTs could in most cases only refer us to someone at an MPO. We found that ironically the MPOs, while the agency level least involved in direct data collection of most types, were the most knowledgeable about who was involved in data collection within their area, and provided us with most of our contacts at the city and county level.

Responses for the 128 urbanized areas considered are summarized below.

	Type of Agency within the Urban Area			
	State DOT	**MPO**	**County[2]**	**City**
Collect Data	71	47	53	72
Not Collecting	7	71	46	19
Combined with Another Agency	0	6	9	13
No Response	55	6	15	29

The question of whether traffic monitoring data was more likely to be collected in areas with larger populations as opposed to areas with smaller population was also considered. There was no significant difference between the "large" (population > 500,000) areas and "small" (population between 200,000 and 500,000) areas in the observed results. Thus population size differences were ignored in the remainder of the analysis.

In addition, the question of whether traffic monitoring data was more likely to be collected in air quality attainment areas or nonattainment areas was considered. The observed differences were inconclusive and so this factor was also ignored in the remainder of the analysis.

Our largest non response was from State DOTs. In many cases, they were unable to provide us with information on their data collection programs within a specified TMA, although they could readily provide information on their total statewide program. In many cases, where the state DOT did provide data on their program at the TMA level, it was with what seemed to be a great deal of effort on their part.

RESULTS

Little in the way of information describing traffic data collection programs or practices was obtained by way of a conventional literature review, outside of the standards of recommended practice for traffic data collection, *AASHTO Guidelines for Traffic Data Programs,* and *Traffic Monitoring Guide.* Most of the documentation listed in the bibliography was obtained as a result of our phone conversations with individuals in the agencies involved with traffic data in some way. Most of this information did not prove useful for providing details on traffic data collection programs in specific urban areas. In addition to a standard library search, transportation related topics available on the

[2] Counties did not exist in 7 areas.

INTERNET were also examined in an attempt to find documentation describing the traffic data collection practices and programs of individual agencies or in general.

In the process of conducting our interviews we discovered a number of other studies similar to this one, that had been completed or were planned. MPOs in Denver, Kansas City, Nashville and Dallas had carried out surveys of local governments in order to find out what was or could be available in terms of traffic data, primarily in response to CMS needs. The Florida DOT conducted a survey of potential data collection resources at the local and regional level throughout the State of Florida, in order to establish a baseline of data available for use in ISTEA mandated management and monitoring systems. The ITE has had a survey dealing with Traffic Counting Practices in the works for the last five years. The latest version of their questionnaire is under review, and the timing of the survey itself has yet to be determined.

From the MPO surveys it was found that about half of the local agencies do not have a regular data collection program, i.e., either don't collect data or collect data only as needed (The portion not collecting data varied widely. In one area all jurisdictions surveyed did collect traffic data, while in another area about 80% of the jurisdictions surveyed did not collect traffic data). It was not possible to judge the quality of the regular programs from the MPO's survey data. Traffic volume counts were most prevalent with speed studies a distant second. Other types of data such as weight were hardly collected at all.

The corresponding results obtained as a result of this study are summarized below by type of program and type of data.

Traffic Volume Programs				
Type of Program	**Type of Agency within the Urban Area**			
	State DOT	**MPO**	**County**	**City**
Permanent Program	71	28	42	48
Special Studies Only	0	14	13	30

Vehicle Classification Programs				
Type of Program	**Type of Agency within the Urban Area**			
	State DOT	**MPO**	**County**	**City**
Permanent Program	65	16	4	5
Special Studies Only	1	18	25	32

Truck Weight Programs

Type of Program	Type of Agency within the Urban Area			
	State DOT	MPO	County	City
Permanent Program36	1	0	0	
Special Studies Only2	1	1	0	

Speed Programs				
Type of Program	Type of Agency within the Urban Area			
	State DOT	MPO	County	City
Permanent Program	24	10	2	8
Special Studies Only	8	16	34	37

Vehicle Occupancy Programs				
Type of Program	Type of Agency within the Urban Area			
	State DOT	MPO	County	City
Permanent Program	1	8	0	2
Special Studies Only	8	7	1	3

The highlights from the interviews conducted under this study are indicated below:

- It seems that programs collecting traffic volume data predominate, followed by those involved in collecting classification and speed/travel time data. Relatively little activity related to truck weight (other than by state DOTs) or vehicle occupancy data collection was found. State agencies predominate in the truck weight programs and in the vehicle occupancy area along with MPOs.

- An examination of the results for traffic volume programs would seem to indicate that at least on the average, permanent programs are meeting AASHTO if not TMG recommendations for count duration (between 24 and 48 hours) and frequency (every 3 years or less). While the number of count locations is substantial, little can be said definitively about the adequacy of the coverage without going into a detailed examination of the highway system within an urban area. Most permanent vehicle classification programs within urban areas are those of the state DOTs. As in the case of the traffic volume programs, the permanent classification programs would appear, on the average, to be meeting minimal recommended standards for duration and frequency.

- While activity in the traffic volume and classification programs is more evenly distributed within the urban areas among different agency types, much of the activity on the part of local agencies is carried out by means of special studies

only, rather than as part of a permanent data collection program.

- Intersection related counts, either “turning movement” or “traffic signal studies” predominate the special studies in the case of traffic volume programs, while “travel time” and “evaluate/set speed limits” were mentioned most often in the case of speed data programs, although most studies were not specified for this type of program.

- Much of the classification data collected by local agencies is done manually, as part of intersection turning movement counts and involves classifying vehicles as cars or trucks.

- In the area of speed/ travel time studies, local agencies are dominant within urban areas, but here again, much of the activity on the part of local agencies is carried out by means of special studies only, rather than as part of a permanent data collection program.

- Permanent traffic volume and classification data collection programs rely primarily on road tubes as opposed to permanently installed loops. Speed data however is collected by a variety of means, that is mechanical counters with road tubes, radar units, and increasingly, laser units. In many agencies the same counters can collect volume, classification, and/or speed data.

- State agencies use various types of traffic data for many different reasons. MPOs on the other hand tend to use all types of data, except truck weight, in their regional planning models, and for major investment studies or corridor studies. County and city agencies tend to use count, classification and speed data for local traffic planning primarily, and to a lesser extent, for major investment studies and corridor studies

- An attempt was made to find out the extent to which agencies shared or pooled data within an area. Two things stand out in the results. The first is that informal data exchange among agencies within an urban area is more common than formal. The second is that the formal exchange seems to be dominated by the flow of information to or from MPOs within urban areas. Informal exchange here means that it was done on a case by case basis, as needed. Formal exchange involves the transfer of a comprehensive data set on a regular or routine basis, e.g. each year.

- Most agencies responding did not have a problem with the current data sharing relationships. The problems most often indicated had to do with timeliness of data delivery, doubts about the quality of the data, and incompatible data formats. State agencies seemed to have the most complaints about data they received from local agencies.

- State agencies tended to rely on permanent in house staff for data collection, while other agency types utilized permanent in house staff supplemented by temporary help during the data collection “season”.

- Most comments regarding anticipated program changes dealt with traffic volume programs. Other than no change, expanded GIS capability, the capture and use of ATMS data for planning purposes, new and better data collection equipment, and program expansion were mentioned most often. Increased GIS use was mentioned most often under the “other” changes.

CANDIDATE CASE STUDY AREAS

Based on the interview results reported here, several localities will be selected for an in-depth review, documentation, and assessment of their traffic monitoring data operations. The review will examine the needs for the data, the uses of traffic data, institutional issues, organization, day-to-day program operation, staffing, funding, and equipment. Due to the importance and need for traffic data to support urban planning requirements, vehicle miles of travel, and the Highway Performance Monitoring System, the link between the traffic data collected and its use in these programs will be emphasized. The review will also explore the technology and day-to-day procedures, explaining how the data is collected, identifying difficulties, and showcasing the solutions devised.

The emphasis will be on the larger cities which we foresee as having more of a problem with traffic monitoring and its related issues. A geographical distribution is also necessary to provide a wider point of view. The emphasis will be on obtaining sufficient, detailed program information on these “case studies” to spur program improvement by learning from the mechanisms and successes of the programs studied.

The major points for consideration in the case studies that surfaced as a result of our work to date are as follows:

- Institutional Arrangements
  - inter agency contracting
  - coordination/cooperation
  - single agency data collection
- Funding Sources/Mechanisms
- Use of ATMS Data for Planning

Case Studies will be selected to highlight "interesting" or noteworthy examples of each of the major points, not necessarily "best" programs. The case study report will not present the programs as "best" cases, or examples, or carry any connotation of a judgment call on the quality of the programs.

All case studies will also include a confirmation of our original interview data plus additional questions related to:

method of sample selection for coverage counts,
use and source of adjustment factors,
day to day operations,
organization structure,
any problem areas such as, equipment, technical, political, budgetary, etc.

CONCLUSIONS

The conclusions of this report are based both on our review of the literature and our interviews with individuals involved in traffic data collection at various levels of government throughout the country. They are as follows:

- **There is a general lack of knowledge regarding which agencies collect what types of data and the manner in which it is collected within the states and within individual urban areas.**

- **There is no central source of information on the extent of use of new technology for either traffic management or traffic data collection within urban areas.**

- **The quality of urban area traffic data collection efforts, and presumably of the resulting data, varies widely. While many programs would appear to meet currently accepted standards, many others would not, and in many cases there is no program.**

- **Data within many urban areas would not appear to be collected in any kind of coordinated fashion. Most data exchange is informal. The CMS requirement of ISTEA appears to have forced agencies within urban areas to take stock of their local jurisdictions' programs.**

- **Funding and staffing cutbacks have hurt data collection efforts in the recent past, and continue to pose a threat in the future.**

- **New technology would seem to hold promise as a solution to budget/staff reductions, but does not seem to have lived up to its full potential.**

These results and conclusions imply a need for action in three areas, which should be explored in the in-depth case studies to be performed under the next task of this project. First there is the need for assured funding for traffic monitoring data collection. In addition, there is a need for the efficient use of data collection resources. This has two aspects: one is the increased use of automation for traffic monitoring data collection, as in ITS/ATMS: the other is in the consolidation/coordination of traffic monitoring data collection among jurisdictions within a given urbanized area.

RECOMMENDATIONS

The recommendations of this report are as follows:

- **FHWA should explore options for assured funding of data collection efforts, by various levels of government.**

- **FHWA should work to improve coordination among programs within FHWA funding ATMS, and those responsible for data collection, or having an interest in urban area traffic data.**

- **FHWA should require that all new federally funded ATMS systems have the capability of collecting traffic monitoring type data, and making that data available in a useful format**.

- **FHWA should explore the concept of a single regional data collection agency for each TMA.**

1. INTRODUCTION

1.1 BACKGROUND

The need for traffic monitoring data to support transportation programs in urbanized areas continues to increase. At the same time, the collection of traffic monitoring data in these areas is subject to numerous constraints, limitations, and restrictions. The collection of traffic monitoring data (traffic volume, vehicle classification, travel time, speed, vehicle occupancy, and truck weight) in urban areas has been carried out under a variety of organizational systems.

Traffic volume data collection is usually the responsibility of the State, MPO, city, or county jurisdiction, and often is a combination of programs under one or more of the jurisdictions. In general, urban traffic volume counting is designed to meet specific objectives, such as signal warrants and project development. Many of these activities may lack overall coordination. Usually, the State traffic group has responsibility for permanent counters within the urbanized area boundaries. Traffic management centers, operated by traffic engineering groups under city or State control, may collect additional traffic data. Portable counters may be employed by State crews on the higher functional systems and by local employees or contractors for the lower systems. In other cases, extensive portable counting is done completely under the jurisdiction of the city without State involvement.

Vehicle classification data collection in urban areas tends to be very primitive due to the cost and difficulties associated with automated equipment. It is usually done by manual or visual counting. Currently, few permanent classifiers are located in urban areas. Portable vehicle classification counts in urban areas are also few and far between. The most promising new developments focus on retrieving and storing data from video cameras used by traffic management control centers, automated toll installations, or other permanent traffic control devices.

Truck weight data is collected for planning, highway design, research, and enforcement. The FHWA has emphasized the use of permanent or portable WIM equipment for planning operations, however the collection of WIM data in urban areas is extremely limited. Enforcement is guided towards detecting and ticketing overweight trucks and is usually performed by police or motor carrier authorities using portable static scales. Since enforcement is targeted at the overweight vehicles, it is basically useless for planning operations as it is not representative of truck weight loads on the system and is hampered by the evasive action of truck drivers.
Travel time and vehicle occupancy studies, have traditionally been carried out by MPOs on an irregular basis, usually in response to the need to update inputs to their regional transportation planning models. These generally have been conducted as

"special studies" due to the time and expense associated with labor intensive data collection techniques. However, new technologies such as video techniques, AVI (Automatic Vehicle Identification) and GPS (Global Positioning Systems) will allow these types of data to be collected on a regular, if not continuous basis.

There are two primary reasons for monitoring vehicles: real-time operations and off-line analyses. The programs described above provide examples of data collection for off-line processing, or planning purposes.

Current real-time operations include automatic operation of traffic controls, traffic advisory and enforcement, as well as incident detection and response. Traffic controls might be traffic signals, ramp meters, toll booths, etc. Real time sensor data is also being used at more and more urban freeways to detect the congestion due to incidents. The use of real-time operational data is expanding into more applications as the cost of the communications and processing to use that data has gone down. [3]

Recent legislation will heavily influence both real-time and off-line data collection. Most significant are the Clean Air Act Amendments (CAAA) of 1990, and the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Both laws will require the collection of more traffic related data such as vehicle occupancy and speed.

The CAAA will require more accurate and frequent measurements of vehicle miles traveled (VMT). Those VMT may need to be presented as a function of speed, time of day, direction, route and vehicle type.

The Clean Air Act Amendments of 1990 (CAAA), for example set forth detailed requirements which apply to numerous metropolitan areas, including provisions for estimating transportation emissions and evaluating the conformity of transportation plans, programs and projects to the State Implementation Plans (SIPs) for attaining air quality standards. In order to meet CAAA requirements, many metropolitan planning organizations (MPO) will need to monitor growth rates, track vehicle miles of travel, and forecast the impacts of transportation options in more precise and quantitative terms than have been necessary in the past.

In future years the VMT estimates on which plans are based will be compared to "actual" VMT estimates derived from field studies or other sources. The CAAA provide much incentive for an MPO to develop the most reliable VMT (and other) data and forecasts it possibly can. Over-predictions of VMT and other travel indicators will lead to overestimation of the need for emissions controls. Under-predictions could result in difficulties in making conformity findings and achieving air quality progress goals, which

---

[3] Chachich, Alan C., "Highway-based Vehicle Sensors", *Technologies for Intelligent Vehicle Highways, Technology Tutorial Series Volume 2,* The International Society of Optical Engineering, Boston, November 1994.

in turn could trigger a need to apply drastic mitigation measures when problems become apparent (possibly more extensive and expensive than additional controls would have been at the outset).[4]

Current guidance from EPA calls for data from the HPMS to be used in estimating current VMT, although at the present time in some areas there are too few sample counts for this data base to be wholly reliable and alternative methods, such as regional travel simulation models, will be applied instead of or in addition to using HPMS data.

The conformity provisions of CAAA will pose one of the biggest challenges most metropolitan transportation organizations will face in transportation-air quality planning and analysis. Both federal actions and certain activities of the MPOs themselves are subject to the conformity provisions, which basically require that plans, programs, and projects must conform to the applicable State Implementation Plan (SIP) for achieving clean air, and must be found not to lead to new violations of the National Ambient Air Quality Standards, or interfere with attainment of the standards or compliance with interim emissions reduction requirements.

While CAAA requirements may pose the most immediate challenges, the ISTEA also increases the importance of good data and models. The ISTEA had mandated six new management systems by 1995.[5] Each of these would depend on data from a Traffic Monitoring System being defined by each state. ISTEA assigns more responsibility for

---

[4] Harvey, Greg and Elizabeth Deakin, *A Manual of Regional Transportation Modeling Practice for Air Quality Analysis,* Prepared for the National Association of Regional Councils, Deakin Harvey Skabardonis, July 1993.

[5] The National Highway System Designation Act of 1995 designated the National Highway System (NHS) developed by the Department of Transportation (DOT) in cooperation with the States, local officials and metropolitan planning organizations (MPOs). The DOT proposed the system to Congress on December 9, 1993, as required by the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. The NHS legislation removed some mandates and added others to the program.

The States may choose not to implement in whole or in part any of the management systems required under ISTEA. The Secretary may not impose the 10% penalty on funds if the State elects this option.
The Comptroller General, in cooperation with the States, is required to report to Congress by October 1, 1996 recommending to what extent the management systems should be implemented.

However, the NHS legislation does not affect the requirement in Section 134 of Title 23 that the planning process in all Transportation Management Areas include consideration of congestion, nor the requirement in Section 134(l) of Title 23 that Federal funds may not be programmed in a carbon monoxide and/or ozone nonattainment TMA for any highway project that will result in a significant increase in single-occupant-vehicle capacity unless the project is based on an approved congestion management plan.

transportation planning and decision-making to regional agencies and grants them greater flexibility in the use of funds. At the same time, ISTEA mandates efficient, effective transportation systems management decisions and, in particular, calls for metropolitan regions to address concerns about traffic congestion and air quality. In many cases state and local considerations further underscore the importance of good data and analysis tools.

ISTEA required states and metropolitan areas to create and utilize congestion management systems (CMSs). As mandated by ISTEA, CMSs are to be developed and implemented in Transportation Management Areas (TMAs), which are metropolitan areas with over 200,000 population.

The main purposes of the CMS are to gauge the existence and extent of congestion on the region's transportation facilities, and to examine strategies to manage that congestion. Federal CMS regulations emphasize the need for monitoring the usage of the transportation system (including the effects of any implemented congestion management strategies). Another component of the process is the development of technical abilities to forecast future congestion, and to forecast the potential impact of congestion management strategies. Even if the legal requirement for a CMS were to go away, in many urbanized areas the need for a CMS will not.

The choice of performance measure/indicators used up to the present has been dictated by two major factors. The first factor is that the types of data have been collected and are available for analysis have been perpetuated over time, and are oriented to gauging the performance of a particular mode of transportation. Thus the MPO tends to use performance measures/indicators based on traffic volumes and facility capacity. The second is that of the computer models available for travel forecasting; these models have concentrated on traditional performance measures/indicators. Thus, historically, travel monitoring reporting

procedures have relied on traffic volumes, vehicle classifications, vehicle occupancy, transit ridership reports, and speed.[6]

The most visible growth in the use of traffic data will be in the area of real-time operations. Most of the systems that define ITS (Intelligent Transportation Systems) will drive the requirements for real-time, highway-based traffic data. The development of these systems will be strongly influenced by the CAAA, ISTEA and other social and political changes that will take place in the coming decade. (e.g., government downsizing and retrenchment at all levels) One of these ITS systems is ATMS.

ATMS (Advanced Travel Management Systems) are systems that will manage the supply of transportation capacity. This includes detecting and responding to incidents; developing real-time responsive control strategies and implementing enforceable controls. Control strategies would include those to prevent or mitigate congestion, reduce emissions, reduce fuel consumption, and minimize travel time. All of these functions will place a demand on the traffic sensor system.

In summary, the current situation is one in which air quality and congestion considerations are driving a need for more and better data in the TMAs, at a time when staffing and budget cuts at all levels of government imply the need to do more with less. New technologies like ITS, while imposing additional data requirements, may hold the promise of a solution to this dilemma.

1.2 STUDY OBJECTIVES

Many metropolitan areas have begun or are planning to implement traffic monitoring programs to meet the many demands for traffic data. Several have requested information regarding FHWA guidance or program development in other jurisdictions. The latest FHWA guidance for urban areas was produced in the early 1980's and is out of date. A need exists to identify current program models or examples and to use these as the one basis for updating FHWA guidelines.

The purpose of this project is to research, study and document a series of examples, case studies, or model approaches on urban traffic monitoring data collection programs to support the development of urban traffic monitoring databases and promote the upgrading of urban traffic monitoring programs.
The study is intended to describe the traffic counting, vehicle classification, truck weight (WIM), vehicle occupancy, travel time and speed data collection operations in metropolitan or large urbanized areas, not those of complete States.

---

[6] *F.Y. 1995 Congestion Management System Annual Report for the Washington Region,* Metropolitan Washington Council of Governments and National Capital Region Transportation Planning Board, Washington, DC, September 20, 1995.

This report documents the status of traffic monitoring data collection and program activities found in urbanized areas, including cost, staffing, organization, institutional arrangements, equipment used, sharing of data, uses of the data, problems encountered, etc.

Based on the work reported here, several localities will be selected for an in-depth review, documentation, and assessment of their traffic monitoring data operations. The review will examine the needs for the data, the uses of traffic data, institutional issues, organization, day-to-day program operation, staffing, funding, and equipment. Due to the importance and need for traffic data to support urban planning requirements, vehicle miles of travel, and the Highway Performance Monitoring System, the link between the traffic data collected and its use in these programs will be emphasized. The review will also explore the technology and day-to-day procedures, explaining how the data is collected, identifying difficulties, and showcasing the solutions devised.

2. APPROACH

The general approach taken in this work was one of trying to get a sense of what was being done in large urban areas in terms of traffic data collection. We did not attempt a complete census of all agencies/jurisdictions potentially involved in traffic data monitoring. Nor did we attempt to formulate a statistically valid random sample of those same agencies. Our approach was simply to try to contact at least one agency at a city, county, regional planning agency and State DOT level within each urbanized area with population greater than 200,000 in the then latest available version of *Highway Statistics*.[7]

Our purpose in doing this was two fold: first to get a sense, even if only on an anecdotal level, as to who was doing what, and how, and why in terms of data collection; and second, to identify programs that might potentially serve as models for urban areas throughout the country.

We asked questions to determine whether the agency had a permanent data collection program, only collected data as required or on request, or did both

For agencies having permanent programs we asked questions in order to learn the number of data collection stations, type of data collected , frequency of collection, and typical duration of a data collection session.

For agencies collecting data as part of special studies we asked questions in order to learn the average number conducted per year, the type of data collected, and type of study, e.g., intersection turning movements.

We also asked questions related to the equipment used in various data collection activities, data use, data flows between agencies and any related problems, the extent of use of GIS, their data collection budget, their data collection staff level, staffing model (in house, contractor, etc.), and any anticipated changes in their program. The response rate varied with the nature of the question, as did the quality of the response. Answers to certain questions tend toward ball park estimates, while others are probably

[7] The urbanized areas were those indicated in the table titled "Selected Characteristics -1993, by Urbanized Area" (dated November 1994) in *Highway Statistics, 1993.* This table lists 132 urban areas with a population greater than 200,000. As a result of our conversations with individuals at various MPOs and State DOTs, it became apparent that four of the indicated urban areas were generally considered as a part of a another larger urbanized area. Thus for our purposes they were combined, resulting in our final group of 128 urbanized areas. The combinations were as follows: Trenton was combined with Philadelphia; Lorain was combined with Cleveland; Tacoma was combined with Seattle; and Newport News was combined with Norfolk.

more precise.

Interviews were conducted during the period January to March 1996. The interview responses were entered into an ACCESS database of 235 fields and 531 records. (This can be converted to an EXCEL or LOTUS spreadsheet or a PARADOX, FOXPRO or DBASE database.) The number of fields resulted from responses to questions in 9 topical areas roughly corresponding to the summary results tables of Chapter 3. The large number of fields results from the need to account for all possible responses in a simple format amenable to analysis within the context of a computerized database. The number of records resulted from the number of agencies potentially having traffic data collection programs in urbanized areas with population greater than 200,000 (at least one at each of four levels - State DOT, MPO, county, city). Much of the database is blank because of agencies that did not respond or did not collect traffic data, and because all responding agencies did not have a response for all questions. The data base is more fully described in a separate Technical Memorandum *Urban Traffic Monitoring Program - Definition Of The Interview Database.*

It should be noted that the greatest problem we had was in identifying individuals at the local level responsible for traffic data collection. We attempted to do this by first contacting the FHWA division offices in states containing the urbanized areas of interest. In many cases, these individuals were not familiar with any data collection efforts below the level of State DOT. Individuals involved in traffic data collection at the State DOTs could in most cases only refer us to someone at an MPO. We found that ironically the MPOs, while the agency level least involved in direct data collection of most types, were the most knowledgeable about who was involved in data collection within their area, and provided us with most of our contacts at the city and county level. Contacts obtained as a result of these referrals were supplemented as required by those obtained from the *ITE Directory, Directory of Metropolitan Planning Organizations,* and *the AASHTO Reference Book.*

Responses for the 128 urbanized areas considered are summarized below.

	Type of Agency within the Urban Area			
	State DOT	**MPO**	**County[8]**	**City**
Collect Data	71	47	53	72
Not Collecting	7	71	46	19
Combined with Another Agency	0	6	9	13
No Response	55	6	15	29

Three agencies that did not fit any of the above categories also had a data collection program of some sort.

[8] Counties did not exist in 7 areas.

The question of whether traffic monitoring data was more likely to be collected in areas with larger populations as opposed to areas with smaller population was also considered. Responses for urban areas with population greater than 500,000 are indicated below.

	Type of Agency within the Urban Area			
	State DOT	**MPO**	**County**	**City**
Collect Data	33	23	27	35
Not Collecting	2	37	19	8
Combined with Another Agency	0	1	5	7
No Response	30	2	10	14

Responses for urban areas with population less than or equal to 500,000 are shown below.

	Type of Agency within the Urban Area			
	State DOT	**MPO**	**County**	**City**
Collect Data	38	28	26	37
Not Collecting	5	34	27	11
Combined with Another Agency	0	5	4	6
No Response	25	4	5	15

There was no significant difference between the “large” areas and “small” areas in the observed results. Thus population size differences were ignored in the remainder of the analysis.

In addition, the question of whether traffic monitoring data was more likely to be collected in air quality nonattainment areas as opposed to attainment areas was also considered. Responses for urban areas in attainment for CO and ozone are indicated below.

	Type of Agency within the Urban Area			
	State DOT	**MPO**	**County**	**City**
Collect Data	30	12	22	31
Not Collecting	1	32	19	7
Combined with Another Agency	0	3	3	4
No Response	21	4	3	10

Responses for urban areas in nonattainment for either CO, ozone or both are shown below.

	Type of Agency within the Urban Area			
	State DOT	**MPO**	**County**	**City**
Collect Data	41	35	31	41
Not Collecting	6	39	27	12
Combined with Another Agency	0	3	6	9
No Response	34	2	12	19

The only difference of any significance is that MPOs are more likely to collect data in the nonattainment areas (47% of MPOs collect data) than in the attainment areas (27% of MPOs collect data). As with population size, this difference was ignored in the remainder of our analysis.

Appendix A contains a summary of agency level response/ non response for traffic volume monitoring programs for individual urbanized areas.

Our largest non response was from State DOTs. In many cases, they were unable to provide us with information on their data collection programs within a specified TMA, although they could readily provide information on their total statewide program. Typical responses were that they just did not have the numbers available on that basis, that FHWA should have that information already, or that they would have to contact their individual district or regional offices. In many cases, where the state DOT did provide data on their program at the TMA level, it was with what seemed to be a great deal of effort on their part.

3. RESULTS

3.1 LITERATURE REVIEW

Little in the way of useful information was obtained by way of a conventional literature review, outside of the standards of recommended practice for traffic data collection, *AASHTO Guidelines for Traffic Data Programs*[9], and *Traffic Monitoring Guide*[10]. *Most of the documentation listed in the bibliography was obtained as a result of our phone conversations with individuals in the agencies involved with traffic data in some way. Most of this information did not prove useful for providing details on traffic data collection programs in specific urban areas.*

*TRB*s NCHRP Summary of Progress* was reviewed In order to identify any related ongoing research. No projects were identified that dealt with traffic data collection or which appeared to be conducting surveys of traffic officials in a large number of urbanized areas. A review of the *AASHTO Reference Book* failed to identify any current programs related to data collection. We contacted the ITE for suggested local contacts and programs. The ITE provided a list of 23 operating TMCs.[11] This included only those operated by state agencies. They also provided a list of contact persons who could provide additional information on TMCs. We contacted the Principal Investigator on their traffic counting practices project, and obtained a copy of their draft questionnaire. Their survey has been in the works for five years, and their questionnaire is now undergoing its final review. They did not have a list of local agency contacts readily available and couldn't indicate when they would be conducting their survey.

As part of the literature review, sample TMS/H (Traffic Monitoring System for Highways) reports were reviewed as a possible souse of information on local level traffic data collection activities and potential points of contact. The reports examined did not prove to be a useful source of information in either regard. While some of these documents

---

[9] *AASHTO Guidelines for Traffic Data Programs,* American Association of State Highway and Transportation Officials, Washington, DC, 1992.

[10] *Traffic Monitoring Guide,* Federal Highway Administration, Office of Highway Information Management, Washington, DC, February 1995.

[11] These are operational as opposed to planned ATMSs, operated by State agencies: Sacramento, San Francisco, Fresno, Los Angeles, San Bernadino, San Diego, Orange County, CA, Denver, Hartford, Bridgeport, Chicago, Detroit, Minneapolis, New Brunswick, NJ, Long Island, NY, St. Davids, PA, Houston, Fort Worth, San Antonio, El Paso, Arlington, VA, Seattle, and Milwaukee. It was not indicated whether or not these facilities could and/or did collect and save real time traffic volume data for planning purposes.

provided a good description of the traffic data collection program for the state, they did not provide information on the state's data collection program in individual urban areas.

Many of the documents obtained through our contacts with State and local agencies, were CMS documentation. There appears to be a wide variation in the "quality" of the CMS reports. Some of these provide no useful information for our purposes, while others provide a great deal of detailed information on current and planned traffic data collection activities by all involved agencies within an urbanized area. Examples of CMS reports providing useful information related to traffic data collection in an urban area are the Denver and Nashville documents cited below.

The other body of documents obtained as a result of our interviews were examples of the type of reports produced by local agencies. Many of these were "flow maps", while others were traffic volume reports, and examples of traffic studies. Most of the former did not provide a good description of how the data was collected, but rather summarized the results of the data collection effort. Many of the latter, while providing a good description of the data collection process, were one-time special studies, and the process described was not part of a permanent on-going data collection program. However, two examples of good descriptions of local programs were provided by Fayetteville, NC[12] and Toledo, OH.[13]

In addition to a standard library search, transportation related topics available on the INTERNET were examined in an attempt to find documentation describing the traffic data collection practices and programs of individual agencies or in general. The scan of the INTERNET was not very fruitful since many of the listed sources, primarily State DOT home pages, provided only general agency information, "real time" traffic reports, or lists of ongoing construction projects.

The Bureau of Transportation Statistics under the DOT home page proved to be a useful source of information, yielding a number of relevant documents, which were downloaded and printed for review.

---

[12] Neppalli, Kumar A., and Louis A. Chalmers, Jr., *Traffic Operations Report,* City of Fayetteville, Traffic Services Division, Fayetteville, April 1995.

[13] *Traffic Counting Program,* Toledo Metropolitan Area Council of Governments, Toledo, August 1990.

The ITE Reference Library contained back issues of *Congestion Management News* which contained some useful leads on innovative data collection approaches in urbanized areas.

Another report obtained as a result of our interviews was a recent ITE study of urban traffic engineering agencies.[14] It was hoped that it could provide a point of comparison for some of the budget and staffing data obtained from our interviews. However, its orientation was that of the total agency, and since traffic data collection is only one part of the typical traffic engineering agency's mission, no meaningful comparisons were possible. However, the report did provide a number of insights relevant to this study.

The survey was mailed to the chief traffic engineer in 600 urban agencies. Completed surveys were returned by 125. Cities accounted for 96 responses, county agencies 23 responses, and 1 response was from a town. A majority of the surveys mailed involved agencies which employed ITE members. Resources were not available to greatly expand the mailing list to include non-ITE members. The major finding were as follows:

- Funding for operations/maintenance and capital improvements and staff shortages are expected to remain significant issues in the next five years. The lack of adequate funding, both for operations/maintenance and capital improvements, is a significant issue to most agencies, regardless of jurisdiction size.

- Funding levels for agencies increased by 14 % in absolute dollars and 2% in constant dollars between 1988 and 1993. However, agencies feel that current funding levels are still only about 83 % of what is needed to perform all of their functions effectively.

- Total agency staff levels have increased by approximately 12 percent between 1988 and 1993, but still fall 20 percent short of what is necessary to perform all agency functions effectively.

- The lack of qualified professional personnel is expected to be a significant problem in five years.

[14] *Status and Effectiveness of Urban Traffic Engineering Agencies*, Institute of Transportation Engineers, Washington, DC, 1995.

- More than half of the respondents feel that congestion management systems will move functions to the agency and/or significantly increase the agency's workload. Despite the anticipated increased workload, only a small percentage of agencies expect increases in funding to deal with the potential impacts. Only for ITS is the anticipated increase in workload expected to be supplemented by increased funding. This will tend to further increase previously reported budget and staffing shortfalls, and will continue the trend of agencies having to do more with less.

Another issue that arose during the course of the study was the use of ITS, TMC or ATMS data for planning purposes. This question was both explored in the interviews, the literature review, and in discussions with researchers involved in other on-going ITS work at the Volpe Center. Other than asking each individual agency, we had difficulty in finding someone who knew which areas had TMCs let alone TMCs that could/did save system data for planning.

Unfortunately, most ITS systems are in their early stages of development and deployment. Most literature deals with what is planned for the future, rather than what is now operational. However, at least three systems in Los Angeles[15], Long Island[16], and Richardson, TX[17] were identified that can collect/save real time traffic data for planning purposes.

A Volpe Center report[18] on institutional issues in implementing regional TMCs indicated that the ATMS in Austin may be collecting/saving loop detector data for planning purposes. (Case study areas included Atlanta, Austin, Baltimore, Detroit, Los Angeles, and Rochester.) The report noted major staff reductions in the traffic engineering departments of Atlanta and Detroit. Other findings of potential relevance to this study were:

- Responsibility for traffic management operations is dispersed among numerous

---

[15] *ATSAC Evaluation Study,* Department of Transportation, City of Los Angeles, Los Angeles, June 1994.

[16] Smith, Steven A., *INFORM EVALUATION, Volume I: Technical Report,* Report FHWA-RD-91-075, Office of Safety and Traffic Operations R&D, Federal Highway Administration, McLean, January 1992.

[17] Black, John R., "The Richardson Count System", *ITS Online*.
Black, John R., "The Richardson Traffic Signal System", *ITS Online,* January 1995.
Purvis, Paul, "Freeway Incident Response from a City Perspective", *ITS Online.*

[18] Booz-Allen & Hamilton Inc., *Institutional Impediments to Metro Traffic Management Coordination,* prepared for Volpe National Transportation Systems Center, Cambridge, September 13,1993.

jurisdictions in metropolitan areas. As a result, changes to the operational organizations involved in metropolitan traffic management will be difficult to achieve and hindered by resource constraints and “turf battles”.

- Limited ATMS skills are available to organizations even in those areas where some of the technologies have already been implemented. The skills are limited in both breadth of knowledge and the depth of experience (the number of “experts” available).

- There is a need for consistent and sustainable funding for designing, building, operating, and maintaining ATMS. So far, sources for such funding have not been fully identified. State and local governments are unwilling or unable to take on greater indebtedness and are particularly concerned about their ability to support the operations and maintenance phase of an ATMS program.

The Volpe Center recently completed a series of case studies of ITS deployment in Boston, Denver, Miami, Milwaukee, Phoenix, Pittsburgh, and St. Louis. Milwaukee is saving the data collected by their freeway management system. None of the systems in the other cities studied currently does.

The Volpe Center is currently working on a series of case studies of communications options for ITS. The systems considered are in Boston, Cincinnati, Maryland, and San Antonio. None of these systems currently collect operational data for planning purposes.

In the process of conducting our interviews we discovered a number of other studies similar to this one, that had been completed or were planned. MPOs in Denver, Kansas City, Nashville and Dallas had carried out surveys of local governments in order to find out what was or could be available in terms of traffic data, primarily in response to CMS needs. The Florida DOT conducted a survey of potential data collection resources at the local and regional level throughout the State of Florida, in order to establish a baseline of data available for use in ISTEA mandated management and monitoring systems. The ITE has had a survey dealing with Traffic Counting Practices in the works for the last five years. The latest version of their questionnaire is under review, however the timing of the survey itself has yet to be determined.

The results of these efforts are presented here to provide a back drop and point of reference for the results of this effort presented in the following section.

As part of its CMS development effort the Denver MPO conducted a survey of the thirty-two cities and six counties included in their area. Twenty-one cities and four counties responded. Eighty four percent of those jurisdictions responding have traffic counting equipment, and about 30 percent have permanent daily traffic count locations. Nearly all of the jurisdictions perform traffic volume counts, with over 60 percent maintaining a regular traffic count program. For the regular traffic count programs the collection of daily traffic volumes is the most prevalent. All of the responding jurisdictions perform daily traffic counts and intersection turning movement counts on an as-needed and project specific basis. Vehicle occupancy counts appear to be rare. Vehicle classification information is not usually collected. Travel time/delay studies and spot speed studies are performed for signal timing analysis. The majority do not have full-time staff devoted to traffic data collection. Most employ extra temporary staff in the summer months or for specific traffic studies and projects. [19]

In Nashville, the MPO surveyed 16 agencies (itself included) regarding their data collection efforts, as part of its attempt to develop its CMS. The survey sought information on who was collecting land use data, roadway mapping data, and traffic data. Three counties and seven cities out of the thirteen local agencies surveyed responded. Only two local jurisdiction collected any traffic data, and this was on an "as needed" basis. [20]

As part of their CMS development efforts the Mid America Regional Planning Council (MARC) in Kansas City conducted a telephone survey (in the fall/winter of 1993/1994) of 7 counties and 25 local jurisdictions in their area in order to determine the current status of their data collection efforts related to traffic, pavement condition and bridges. All but two agencies responded to the traffic data portion. Of those responding 19% collected data on an annual basis, 10% biannually, 26% every three or more years and 45% "as needed". Only 32% indicated that the data was collected in accordance with FHWA procedures, and 31% indicated that they utilized some sort of systematic rotation of locations. Finally, 44% indicated that the data was collected on an area-wide basis, while the other 56% collected data only at specific "hot" spots.

In the Dallas-Fort Worth area the MPO conducted an inventory of data available at 9 cities, 3 counties, 3 Texas DOT District offices, and 5 other agencies in their area in September 1994. They sought information on the availability of data related to transportation infrastructure, public transportation systems, intermodal systems, non-recurring congestion, and miscellaneous planning data as well as data related to traffic

---

[19] *Design of Congestion Management Systems, Phase II-A, Final Report, CMS Design and Implementation Decisions*, prepared for the Colorado Department of Transportation, Denver Regional Council of Governments, and Pikes Peak Area Council of Governments, JHK & Associates and URS Consultants, November 1994.

[20] RPM & Associates, *Congestion Management System for the Nashville Area MPO,* prepared for the Nashville Area Metropolitan Planning Organization, Brentwood, TN, April 1995.

characteristics.

Of the city agencies:

- 6 had traffic volume data updated on an annual basis, 1 every 5 to 7 years, 1 when funds allowed, and 1 did not have the data because of budget constraints;
- 6 had intersection turning movement data updated "as needed", 1 every 3 years, 1 when funds allowed, and 1 did not have the data because of budget constraints;
- 1 had vehicle classification data updated on an annual basis, 2 updated "as needed", and 6 did not have the data;
- 1 had vehicle weight data updated on an annual basis, 1 updated "as needed", and 7 did not have the data;
- 1 had vehicle occupancy data updated "as needed", and 8 did not have the data;
- 1 had vehicle miles of travel data updated "as needed", and 8 did not have the data;
- 2 had 85 percentile speed data updated on an annual basis, and 7 updated "as needed";
- 7 had delay/travel time data updated "as needed", and 2 did not have the data.

Of the county agencies:

- 2 had traffic volume data updated as "needed", and 1 every 3 years;
- 1 had intersection turning movement data updated "as needed", and 2 did not have the data;
- 1 had vehicle classification data updated on an annual basis, and 2 updated "as needed";

- 1 had vehicle weight data updated “as needed”, and 2 did not have the data;
- none had vehicle occupancy data;
- none had vehicle miles of travel data;
- 2 had 85 percentile speed data updated “as needed”, and 1 did not have the data;
- 1 had delay/travel time data updated “as needed”, and 2 did not have the data.

Of the State DOT offices:

- 2 had traffic volume data updated on an annual basis, and 1 did not have the data;
- 1 had intersection turning movement data updated “as needed”, and 2 did not have the data;
- 1 had vehicle classification data updated on an annual basis, and 2 did not have the data;
- none had vehicle weight data;
- 1 had vehicle occupancy data updated every 2 years, and 2 did not have the data;
- 1 had vehicle miles of travel data updated “as needed”, and 2 did not have the data;
- 1 had 85 percentile speed data updated “as needed”, and 2 did not have the data;
- none had delay/travel time data.

The Florida survey requested information concerning the extent of the local agency’s ownership and maintenance responsibilities of Federal Aid Eligible public roads not on the State Highway System. It included questions relative to pavement management, and whether the agency collected data on the number of congested lane miles and duration of congestion. Questions concerned with the collection of traffic data included those dealing with the type of data collected, frequency of collection, method and duration of data retention, and whether the data was statistically or seasonally adjusted. Of the 350 agencies contacted statewide, 176 responses were received.

Statewide 47 out of 67 counties responded. Of these, 13 did not collect data, 31 collected count data, 15 speed data, 15 classification data and none collected weight or occupancy data. The number of sites ranged from "as needed" to 700. A full range of frequencies was reported. Of the 21 agencies using factors in order to adjust data to reflect annual average conditions, 5 used axle correction factors, 19 used seasonal factors, and 4 used growth factors. Seven agencies maintain the data on computer, 7 keep hard copy, and 18 use both. In-house staff were used by 33 agencies, 5 of these also used consultants or other agencies while 3 used consultants exclusively. Finally, 19 agencies indicated that they had plans to begin or increase data collection efforts.

Statewide 105 out of 247 cities responded. Of these, 71 did not collect data, 34 collected count data, 19 speed data, 7 classification data, 3 occupancy data and none collected weight data. The number of sites ranged from 9 to 500. A full range of frequencies was reported, while some indicated as needed. Of the 18 agencies using factors in order to adjust data to reflect annual average conditions, 2 used axle correction factors, 17 used seasonal factors, 5 used growth factors, and 1 used case specific factors. Eight agencies maintain the data on computer, 26 keep hard copy, and 9 use both. In-house staff were used by 35 agencies, 4 of these also used consultants or other agencies while 36 used consultants exclusively. Finally, 17 agencies indicated that they had plans to begin or increase data collection efforts.

Statewide 16 out of 25 MPOs responded. Of these, 9 did not collect data, 4 collected count data, 1 speed data, 2 classification data, 1 weight data and none collected occupancy data. The number of sites ranged from 10 to 630. Annual collection was reported by 4 agencies. Of the 5 agencies using factors in order to adjust data to reflect annual average conditions, 1 used axle correction factors, 3 used seasonal factors, 3 used growth factors, and 2 used case specific factors. One agency maintains the data on computer, and 7 use both computer and hard copy. In-house staff were used by 1 agency, while 7 used consultants or other agencies exclusively. Finally, 6 agencies indicated that they had plans to begin or increase data collection efforts.[21]

From the MPO surveys it was found that about half of the local agencies do not have a regular data collection program, i.e., either don't collect data or collect as needed (the portion not collecting data varied widely from zero in the Kansas City area to about 15% in Denver and Dallas to 80% in the Nashville area). It was not possible to judge the quality of the regular programs with the data available. Traffic volume counts were most prevalent with speed studies a distant second. Other types of data such as truck weight were hardly collected at all.

---

[21] *Evaluation of Traffic and Highway Data Collection Survey, Off-System Public Roads Eligible for Federal-Aid Funding, Volume 1*, prepared for Florida Department of Transportation, Transportation Statistics Office, Parsons Brinckerhoff, February 1995.

3.2 SUMMARY OF INTERVIEW RESULTS

3.2.1 Type of Program By Agency Type And Data Type

The first question in our interviews attempted to determine what types of traffic data collection programs each agency conducted within its jurisdiction or the TMA. This later point is important for state DOTs, since to the greatest extent possible we attempted to have them provide us information on their program within the TMA as opposed to their statewide data collection program. Here type of data included volume counts, vehicle classification, truck weight, travel time or speed, and vehicle occupancy. We attempted to determine if the data for each program was collected as part of a permanent ongoing program, special studies program (as needed/on request, etc.), or both. We also attempted to characterize each permanent program in terms of coverage (number of permanent program stations), count duration (in hours), and frequency (in years). For special studies we attempted to determine the number of counts/studies per year, their purpose or type, and whether they were done manually or involved mechanical counters.

The results from this question are summarized in Table 3.1 through 3.8. Table 3.1 indicates the number of urbanized areas having an agency of the type indicated collecting traffic data of a particular type as either part of a permanent program, as a result of special studies only, or by both means. Appendix A lists information on Traffic Volume Monitoring programs by agency level within individual urbanized areas.

The differences due to population size on type of program utilized by an agency (either permanent or special studies only), were inconclusive at best. (See Tables A.3 and A.4.) Counties were found to be more likely to have permanent Traffic Volume Monitoring programs in larger areas, while cities were more likely to have permanent Traffic Volume Monitoring programs in smaller areas. In areas with population greater than 500,000, 83% of counties and 55% of cities collecting data did so as part of a permanent data collection program. In areas with population less than or equal to 500,000, 68% of counties and 68% of cities collecting data did so as part of a permanent data collection program.

The differences due to air quality status on type of program utilized by an agency (either permanent or special studies only), were also inconclusive. (See Tables A.5 and A.6.) Counties and MPOs were found to be more likely to have permanent Traffic Volume Monitoring programs in nonattainment areas. In nonattainment areas, 85% of counties and 70% of MPOs collecting data did so as part of a permanent data collection program. In attainment areas, 64% of counties and 58% of MPOs collecting data did so as part of a permanent data collection program.

From Table 3.1 it seems that programs collecting traffic volume data predominate, followed by those involved in collecting classification and speed/travel time data. Relatively little activity related to truck weight or vehicle occupancy data collection was

found. State agencies predominate in the truck weight programs. In the vehicle occupancy area most programs are conducted by State DOTs and MPOs.

While activity in the traffic volume and classification programs is more evenly distributed within the urban areas among different agency types, much of the activity on the part of local agencies is carried out by means of special studies only rather than as part of a permanent data collection program. This is in line with the MPO's survey results discussed in the previous section. Further, much of the classification data collected by local agencies is done manually, as part of intersection turning movement counts, and involves classifying vehicles as cars or trucks.

In the area of speed/ travel time studies, local agencies are dominant within urban areas, but here again, much of the activity on the part of local agencies is carried out by means of special studies only, rather than as part of a permanent data collection program.

Tables 3.2 to 3.6 give some general characteristics of traffic data collection programs by type of data collected. "No. of responses" within each table indicate the number of urban areas having an agency of the type indicated having a permanent program or doing special studies of the type indicated. Note that multiple responses were allowed so that, as an example, a city agency might have indicated that it had an permanent program collecting data on an annual basis and also did counts as required both manually and using mechanical counters. "Average Value" was in all cases based on the number of responses for that particular characteristic.

An examination of the results for traffic volume programs in Table 3.2 would seem to indicate that at least on the average permanent programs are meeting AASHTO if not TMG recommendations for count duration (between 24 and 48 hours) and frequency (every 3 years or less). While the number of count locations is substantial, little can be said definitively about the adequacy of the coverage without going into a detailed examination of the highway system within an urban area. Another point that stands out in the results is again the number of city agencies utilizing "special studies" for their data collection requirements. (Not to mention those not collecting data.)

Table 3.3 presents the corresponding results for vehicle classification programs. Here again "local" agencies rely primarily on "special studies" for their vehicle classification data. Most permanent programs within urban areas are those of the State DOTs. As in the case of the traffic volume programs, the permanent classification programs would appear on the average, to be meeting minimal recommended standards for duration and frequency.

Truck weight programs summarized in Table 3.4 are again dominated by permanent State DOT programs, as are the speed/travel time data collection programs of Table 3.5. However, of note in the case of speed studies are the relatively large number of city and county agencies collecting speed data as part of special studies.

Finally, the vehicle occupancy data collection that was part of a permanent program was reported primarily by MPOs with state and city agencies indicating that they collected this type of data as part of special studies in a small number of urban areas. (See Table 3.6.)

Comments received describing “special studies” in more detail are listed in Table 3.7 for traffic volume programs and 3.8 for speed data programs. It should be noted that multiple responses were allowed. Intersection related counts, either “turning movement” or “traffic signal studies” predominate in the case of traffic volume programs, while “travel time” and “evaluate/set speed limits” were mentioned most often in the case of speed data programs, although most studies were not specified for this type of program.

Seven responses from State agencies and four from county agencies listed “roadway planning and design” as the purpose of special classification studies. One MPO indicated “Pavement Management System inputs”, and two other MPOs listed “special studies”. Otherwise the classification special studies were not described or specified. Truck weight special studies and vehicle occupancy special studies in general did not specify any particular technique or purpose. “Other” special studies mentioned were seat belt usage studies.

TABLE 3.1 - NUMBER OF URBAN AREAS WITH AGENCIES COLLECTING TRAFFIC DATA BY TYPE OF DATA AND TYPE OF PROGRAM

Type of Program	Type of Agency within the Urban Area			
	State DOT	MPO	County	City
Traffic Volume				
Permanent	71	28	42	48
Special Studies Only	0	14	13	30
Both	60	17	40	45
Vehicle Classification				
Permanent	65	16	4	5
Special Studies Only	1	18	25	32
Both	35	4	3	0
Truck Weight				
Permanent	36	1	0	0
Special Studies Only	2	1	1	0
Both	9	0	0	0
Speed				
Permanent	24	10	2	8
Special Studies Only	8	16	34	37
Both	8	3	2	5
Vehicle Occupancy				
Permanent	1	8	0	2
Special Studies Only	8	7	1	3
Both	0	1	0	1
Other				
Permanent	0	0	0	0
Special Studies Only	2	2	0	2
Both	0	0	0	0

TABLE 3.2 - CHARACTERISTICS OF TRAFFIC VOLUME DATA COLLECTION PROGRAMS BY AGENCY TYPE

Program Characteristic	Agency Type							
	State DOT		MPO		County		City	
	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value
Permanent Programs								
Continuous Counters	67	15	6	60	8	52	19	28
Annual Count Cycle								
No.of stations	33	405	16	177	22	251	16	364
Count duration (hrs.)	31	51	15	35	21	51	15	47
3 year Count Cycle								
No.of stations	45	467	16	670	11	855	13	691
Count duration (hrs.)	42	54	16	33	11	46	13	39
Other Count Cycle								
No.of stations	23	1299	8	180	15	758	18	565
Count duration (hrs.)	24	37	8	28	15	40	18	42
Count frequency (yrs.)	23	3.1	5	3.2	11	2.9	17	2.5
Special Studies Programs								
No. manual counts/year	42	41	12	31	33	43	46	105
No. mechanical counts/year	23	72	21	59	36	89	39	208

TABLE 3.3 - CHARACTERISTICS OF VEHICLE CLASSIFICATION DATA COLLECTION PROGRAMS BY AGENCY TYPE

Program Characteristic	Agency Type							
	State DOT		MPO		County		City	
	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value
Permanent Programs								
Continuous Counters	34	17	1	10	0	0	1	30
Annual Count Cycle								
No.of stations	22	61	6	21	1	100	4	352
Count duration (hrs.)	19	57	5	30	1	24	4	33
3 year Count Cycle								
No.of stations	37	38	9	161	2	268	0	0
Count duration (hrs.)	33	43	8	26	2	108	0	0
Other Count Cycle								
No.of stations	11	35	4	40	1	50	0	0
Count duration (hrs.)	11	36	4	36	1	24	0	0
Count frequency (yrs.)	11	4	1	5	1	5	0	0
Special Studies Programs								
No. manual counts/year	13	31	9	24	14	11	14	20
No. mechanical counts/year	18	27	14	19	16	22	20	44

TABLE 3.4 - CHARACTERISTICS OF TRUCK WEIGHT DATA COLLECTION PROGRAMS BY AGENCY TYPE

Program Characteristic	Agency Type							
	State DOT		MPO		County		City	
	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value
Permanent Programs								
No.of stations	36	5	1	10	0	0	0	0
Count duration (hrs.)	19	91	0	0	0	0	0	0
Count frequency (yrs.)	22	2.5	0	0	0	0	0	0
Special Studies Programs								
Number/year	8	8	0	0	1	6	0	0

TABLE 3.5 - CHARACTERISTICS OF SPEED DATA COLLECTION PROGRAMS BY AGENCY TYPE

Program Characteristic	Agency Type							
	State DOT		MPO		County		City	
	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value
Permanent Programs								
No.of stations	24	25	8	137	2	188	8	138
Count frequency (yrs.)	11	1.2	9	2.3	2	4	4	2.2
Special Studies Programs								
Number/year	11	12	14	18	33	35	39	57

TABLE 3.6 - CHARACTERISTICS OF VEHICLE OCCUPANCY DATA COLLECTION PROGRAMS BY AGENCY TYPE

Program Characteristic	Agency Type							
	State DOT		MPO		County		City	
	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value
Permanent Programs								
No.of stations	1	7	6	37	0	0	2	17
Count frequency (yrs.)	1	1	5	1.4	0	0	1	.25
Special Studies Programs								
Number/year	7	3	4	5	1	1	4	6

TABLE 3.7 - TYPICAL TRAFFIC VOLUME SPECIAL STUDIES (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

Type of Special Study	Type of Agency in the Urban Area				
	State	MPO	County	City	Total
Turning movement	37	15	26	48	126
Volume counts	13	3	15	20	51
Traffic signal studies	1	1	8	17	27
Project design	13	9	2	2	26
Environmental studies	0	0	0	1	1
Not specified	8	7	13	9	37

TABLE 3.8 - TYPICAL SPEED SPECIAL STUDIES (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

Type of Special Study	Type of Agency in the Urban Area				
	State	MPO	County	City	Total
Delay studies	1	2	1	3	7
Congestion studies	1	3	0	0	4
Travel Time studies	1	8	6	6	21
Project evaluation	2	0	0	1	3
Evaluate/set speed limits	0	0	4	2	6
Not Specified	8	7	25	32	72

3.2.2 Data Collection Equipment By Agency Type And Data Type

We also attempted to learn something about the equipment used for collecting various types of traffic data under both on going data collection programs and special studies within each urban area. This data is summarized in Table 3.9. "No. of responses" is equivalent to number of urban areas with an agency of the type indicated responding. Average values are again based on the number of responses for that particular data item.

It should be noted that most respondents with permanent traffic volume and classification data collection programs rely primarily on road tubes for data collection as opposed to permanently installed loops. Speed data however is collected by a variety of means, that is mechanical counters with road tubes, radar units, and increasingly, laser units. In many agencies the same counters can collect volume, classification, and/or speed data.

TABLE 3.9- DATA COLLECTION EQUIPMENT BY AGENCY TYPE

Equipment	Agency Type							
	State DOT		MPO		County		City	
	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value
Traffic Volume								
No. of traffic volume counters[1.]	57	50	19	20	31	39	29	27
No. of stations with loops	42	64	8	11	10	49	22	63
No.of stations with road tubes	44	784	18	703	29	637	30	605
No. of counters for special study programs[2.]	16	42	8	10	22	17	40	17
Vehicle Classification								
No. of classification counters[1.]	36	25	10	18	6	9	3	21
No. of stations with loops	29	19	1	10	0	0	1	30
No.of stations with road tubes	22	43	6	131	3	62	2	675
No. of class. counters for special study programs[2.]	8	26	6	10	9	14	15	13
Truck Weight								
No. portable scales	15	4	1	1	1	1	0	0
No. permanent scales	8	2	1	10	0	0	0	0
No. WIM	20	3	0	0	0	0	0	0

TABLE 3.9 - DATA COLLECTION EQUIPMENT BY AGENCY TYPE (CONTINUED)

Equipment	Agency Type							
	State DOT		MPO		County		City	
	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value	No. of Responses	Average Value
Speed								
No. of speed counters[1.]	10	48	4	9	6	9	5	30
No. of stations with loops	6	74	1	10	0	0	4	39
No.of stations with road tubes	3	8	2	64	7	47	7	97
No. of speed counters for special study programs[2.]	3	19	2	6	6	13	9	25
No. video units for speed studies	1	2	2	4	5	1	6	6
No. radar units for speed studies	3	2	1	1	4	1	17	2
No. other units for speed studies[3.]	0	0	3	1	2	2	2	1
Vehicle Occupancy								
No. video units for occupancy studies	0	0	0	0	0	0	2	4
No. other units for occupancy studies	0	0	0	0	0	0	2	4

1. These figures are the number of counters reported by agencies having a permanent ongoing data collection program, and collecting data as required and/or as requested..
2. These figures are the number of counters reported by agencies not having a permanent ongoing data collection program.
3. “Other” units used in speed studies are primarily laser units.

3.2.3 Data Use By Agency Type

An attempt was made to learn why each type of agency within the urban areas collected the type(s) of data they did. Their responses are summarized by agency type in Tables 3.10 to 3.13. Here again, multiple responses were allowed.

The results present few surprises. As indicated in Table 3.10, State agencies use various type of traffic data for many different reasons. MPOs on the other hand tend to use all types of data, except truck weight, in their regional planning models, and for major investment studies or corridor studies. (Table 3.11) County and city agencies tend to use count, classification and speed data for local traffic planning primarily, and to a lesser extent for major investment studies and corridor studies. (Table 3.12 and Table 3.13)

TABLE 3.10 - STATE DOT DATA USE BY TYPE OF DATA (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

Data Use	Type of Traffic Data				
	Traffic Count	Vehicle Classification	Truck Weight	Travel Time/Speed	Vehicle Occupancy
HPMS/other FHWA input	71	58	32	18	0
VMT estimates	67	44	7	7	0
CMS programs	38	27	6	17	10
Local Traffic Planning	50	44	15	13	8
Regional Transportation Planning Models	48	39	11	17	11
Statewide Transportation Planning	63	44	17	16	10
Corridor Planning	58	40	14	17	11
Major Investment Studies	44	31	9	11	5
Environmental Planning	61	41	15	12	4
Other	6	14	11	2	1

TABLE 3.11 - MPO DATA USE BY TYPE OF DATA (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

Data Use	Type of Traffic Data				
	Traffic Count	Vehicle Classification	Truck Weight	Travel Time/Speed	Vehicle Occupancy
HPMS/other FHWA input	7	7	0	1	0
VMT estimates	22	7	0	5	0
CMS programs	28	9	1	17	10
Local Traffic Planning	35	20	1	11	6
Regional Transportation Planning Models	41	19	2	23	16
Statewide Transportation Planning	12	5	1	5	2
Corridor Planning	30	20	0	19	9
Major Investment Studies	24	13	3	9	6
Environmental Planning	15	9	1	8	5
Other	7	6	2	2	3

TABLE 3.12 - COUNTY AGENCY DATA USE BY TYPE OF DATA (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

Data Use	Type of Traffic Data				
	Traffic Count	Vehicle Classification	Truck Weight	Travel Time/Speed	Vehicle Occupancy
HPMS/other FHWA input	0	0	0	0	0
VMT estimates	10	4	0	2	0
CMS programs	10	4	0	4	1
Local Traffic Planning	52	17	0	22	1
Regional Transportation Planning Models	15	4	0	3	0
Statewide Transportation Planning	3	2	0	1	1
Corridor Planning	13	5	0	3	1
Major Investment Studies	14	3	0	3	1
Environmental Planning	11	3	0	3	1
Other	4	3	0	9	1

TABLE 3.13 - CITY AGENCY DATA USE BY TYPE OF DATA (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

Data Use	Type of Traffic Data				
	Traffic Count	Vehicle Classification	Truck Weight	Travel Time/Speed	Vehicle Occupancy
HPMS/other FHWA input	0	0	0	2	0
VMT estimates	13	5	0	5	0
CMS programs	15	7	0	9	0
Local Traffic Planning	76	34	0	34	2
Regional Transportation Planning Models	24	10	0	7	0
Statewide Transportation Planning	9	3	0	4	0
Corridor Planning	31	15	0	17	2
Major Investment Studies	18	7	0	7	0
Environmental Planning	18	6	0	8	1
Other	7	2	0	8	0

3.2.4 Data Flows Within Urban Areas

An attempt was made to find out the extent to which agencies shared or pooled data within an area. Each individual interviewed was asked if their agency provided other agencies with traffic data within the urban area or received data from other agencies, which agencies and what type of data. They were also asked if the data were provided informally or formally.

Informal exchange means that it was done as needed, on a case by case basis, e.g. an individual in one agency calling an individual in another to see if they had any recent data on a certain intersection or road segment. Formal exchange involves the transfer of a comprehensive data set on a regular or routine basis, e.g. each year, an agency provides other agencies within the area with a copy of all the traffic data it collected during the past year.

Tables 3.14 to 3.17 map the data flows between agency types within an urban area. It should be noted that multiple responses were common, that is one agency typically provided/received data from more than one type of agency within the area. Also all data flows were not balanced in that an agency may have received data from another type of agency, but did not provide data to that type of agency.

Two things stand out in the tables. The first is the preponderance of informal exchange

over formal. The second is that the formal exchange seems to be dominated by the flow of information to or from MPOs within urban areas. This should not be surprising. Since most "local" agencies do not have permanent data collection programs, they could not be expected to provide their data to others on anything other than an ad hoc basis. On the other hand, a major role of MPOs in most areas is to compile and distribute traffic data, either collected by themselves or others.

As indicated in Table 3.18, most agencies responding did not have a problem with the current data sharing relationships. The problems most often indicated had to do with timeliness of data delivery, doubts about the quality of the data, and incompatible data formats. State agencies seemed to have the most complaints about data they received from local agencies.

TABLE 3.14 - TRAFFIC DATA FLOW TO/FROM STATE DOTS WITHIN URBANIZED AREAS

	Number of Urban Areas		
	Formal Exchange	**Informal Exchange**	**Total**
To MPO	24	37	61
To County	8	37	45
To City	9	42	51
Total	41	116	157
From MPO	8	12	20
From County	6	16	22
From City	9	17	26
Total	23	45	68

TABLE 3.15 - TRAFFIC DATA FLOW TO/FROM MPOS WITHIN URBANIZED AREAS

	Number of Urban Areas		
	Formal Exchange	**Informal Exchange**	**Total**
To State Dot	22	16	38
To County	5	29	34
To City	7	32	39
Total	34	77	
From State DOT	29	18	47
From County	8	15	23
From City	7	15	22
Total	44	48	92

TABLE 3.16 - TRAFFIC DATA FLOW TO/FROM COUNTY AGENCIES WITHIN URBANIZED AREAS

	Number of Urban Areas		
	Formal Exchange	**Informal Exchange**	**Total**
To State DOT	8	18	26
To MPO	20	18	38
To City	4	19	23
Total	32	55	87
From State DOT	18	19	37
From MPO	9	9	18
From City	6	13	19
Total	33	41	74

TABLE 3.17 - TRAFFIC DATA FLOW TO/FROM CITY AGENCIES WITHIN URBANIZED AREAS

	Number of Urban Areas		
	Formal Exchange	**Informal Exchange**	**Total**
To State DOT	17	23	40
To MPO	19	37	56
To County	4	21	25
Total	40	81	121
From State DOT	28	30	58
From MPO	14	17	31
From County	1	12	13
Total	43	59	102

TABLE 3.18 - PROBLEMS EXPRESSED WITH CURRENT DATA EXCHANGE ARRANGEMENTS (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

Problem	Type of Agency				
	State	MPO	County	City	Total
Lack of funds	2	1	2	2	7
Lack of coordination	4	2	0	1	7
Duplication	3	0	0	0	3
Lack of cooperation	1	1	0	0	2
Not enough data/data not available	0	2	0	0	2
Excessive demands for data	3	0	0	0	3
Timeliness	10	1	3	1	15
Validity/inconsistent methods	6	4	2	2	14
Format/computer incompatibility	7	3	1	3	14
Need for automated exchange	2	2	0	1	5
None	42	40	54	76	212

3.2.5 Use Of GIS By Agency Type

Transportation agencies are currently faced with ever-increasing demands for data to support more effective decision making. Geographic information systems (GISs), which have been successfully applied in many fields outside of transportation, offer the potential to assemble and process these data. GIS software is designed to store, retrieve, and analyze data that are referenced to geographic location. Nearly all of the data managed by transportation agencies are or can be geographically referenced.

From our interviews we learned that current use of GIS varies widely by type of agency, with few city or county agencies having a system operational at the present time. However, a majority of the agencies not now having a GIS indicated that they had plans to implement one in the near future.

TABLE 3.19 - GIS USE BY AGENCY TYPE (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

	Type of Agency in the Urban Area			
	State	MPO	County	City
Have a GIS	28	37	10	19
Do not have a GIS	43	16	52	66
Plan to use GIS in the future	34	10	28	36
Do not plan to use GIS in the future	9	6	24	30

3.2.6 Data Collection Budget By Agency Type

We also attempted to determine the annual budget for traffic data collection within the agency, or in the case of State DOTs, within the urban area. These results are indicated in Table 3.20. In addition, we also asked for the funding source, either budget line item or reimbursable agreement. These responses are shown in Table 3.21. While most agencies were funded through a budget line item, a significant portion of those able to respond to the question indicated that they were reimbursed by others for a least a portion of their data collection activity. Note that most agencies could not provide meaningful budget data.

"Number responses" is equivalent to number of urban areas with an agency of the type indicated responding to that particular question. Average values are again based on the number of responses for that particular data item.

TABLE 3.20 - AVERAGE DATA COLLECTION BUDGET

Agency Type	Number Responses	Average Annual Budget
State DOT	31	$62,410
MPO	27	$86,830
County	18	$34,840
City	35	$61,360

TABLE 3.21 - DATA COLLECTION FUNDING SOURCE

Agency Type	Number Responses		
	Line Item	Reimbursable Agreement	Both
State DOT	17	9	8
MPO	9	5	2
County	4	3	1
City	10	4	1

3.2.7 Data Collection Staff Levels By Agency Type

We also attempted to determine the number of staff involved in traffic data collection within the agency, or in the case of State DOTs, within the urban area. These results are indicated in Tables 3.22 to 3.25 with a table for each type of data collection agency. Most of the figures provided are rough estimates. Note that most agency staff involved in data collection activities only spend part of their time on this activity.

Under staffing, "Other" includes cases where a only a total data collection staff figure was provided. Contractor figures do not include those cases where substantial parts of

the program have been let out on contract completely.

"No. of responses" is equivalent to the number of urban areas with an agency of the type indicated responding to that particular question. Average values are again based on the number of responses for that particular data item.

As indicated in the tables, State agencies tended to rely on in house permanent staff for data collection, while other agency types utilized in house permanent staff supplemented by temporary help during the data collection "season", usually April/May to October/November.

TABLE 3.22 - AVERAGE DATA COLLECTION STAFF LEVEL FOR STATE AGENCIES

	In House				Contractor			
	Permanent		Temporary		Permanent		Temporary	
	No. of Responses	Avg. Staff Level	No. of Responses	Avg. Staff Level	No. of Responses	Avg., Staff Level	No. of Responses	Avg. Staff Level
Administrative	41	1.7	0	0	0	0	0	0
Field Crews	41	4.3	4	.6	0	0	2	6.2
Data Processing/Editing	31	1.6	0	0	2	3.2	0	0
Equipment Maintenance	22	1.2	1	.01	0	0	1	1
Other	19	1	7	1.2	3	.7	1	.5

TABLE 3.23 - AVERAGE DATA COLLECTION STAFF LEVEL FOR MPOS

	In House				Contractor			
	Permanent		Temporary		Permanent		Temporary	
	No. of Responses	Avg. Staff Level	No. of Responses	Avg. Staff Level	No. of Responses	Avg., Staff Level	No. of Responses	Avg. Staff Level
Administrative	22	1.2	0	0	1	1	0	0
Field Crews	22	2.3	13	2.1	1	.5	3	2.8
Data Processing/Editing	15	1.6	4	1.1	0	0	1	1
Equipment Maintenance	4	.7	0	0	0	0	1	1
Other	10	1.2	2	1.1	0	0	1	2

TABLE 3.24 - AVERAGE DATA COLLECTION STAFF LEVEL FOR COUNTY AGENCIES

	In House				Contractor			
	Permanent		Temporary		Permanent		Temporary	
	No. of Responses	Avg. Staff Level	No. of Responses	Avg. Staff Level	No. of Responses	Avg., Staff Level	No. of Responses	Avg. Staff Level
Administrative	21	.8	0	0	0	0	0	0
Field Crews	30	2.2	6	3.8	0	0	0	0
Data Processing/Editing	10	1.2	1	1	0	0	0	0
Equipment Maintenance	3	1	0	0	0	0	0	0
Other	18	1.5	3	1.7	0	0	1	3

TABLE 3.25 - AVERAGE DATA COLLECTION STAFF LEVEL FOR CITY AGENCIES

	In House				Contractor			
	Permanent		Temporary		Permanent		Temporary	
	No. of Responses	Avg. Staff Level	No. of Responses	Avg. Staff Level	No. of Responses	Avg., Staff Level	No. of Responses	Avg. Staff Level
Administrative	26	1.1	2	.75	1	1	0	0
Field Crews	44	1.9	5	1.4	0	0	1	5
Data Processing/Editing	22	.7	4	1.1	0	0	0	0
Equipment Maintenance	2	.2	2	.6	0	0	1	.6
Other	31	1.5	5	2.2	1	.2	2	2.1

3.2.8 Anticipated Program Changes By Agency Type

We generally closed each interview with a question on expected near term changes in the agency's traffic data collection program. These responses are listed in Table 3.26 to 3.31, with a table corresponding to each type of traffic data collection program, and one for "other". Multiple responses were allowed, and we did not use pre-defined categories. Responses were grouped into the categories indicated after the fact. As can be seen most respondents did not anticipate any changes in their programs.

Most comments dealt with traffic volume programs. Other than no change, expanded GIS capability, the capture and use of ATMS data for planning purposes, new and better data collection equipment, and program expansion were mentioned most often (Table 3.26). Increased GIS use was mentioned most often under the "other" changes (Table 3.31). Program expansion in the classification, weight, speed and occupancy data collection programs were mentioned most often, primarily by State DOTs and/or MPOs (Tables 3.27 - 3.30). However, the number of responses in these cases was not very large.

TABLE 3.26 - ANTICIPATED NEAR TERM CHANGES IN AGENCY'S TRAFFIC VOLUME DATA COLLECTION PROGRAM (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

Expected Change	Type of Agency				
	State	MPO	County	City	Total
Start program	1	2	0	0	3
Increase program	0	2	0	2	4
Increase staff	0	5	4	1	10
Decrease program/transfer to others	7	2	0	1	10
Decrease staff	0	1	2	1	4
Expand number of sites	1	2	2	2	7
Shift to consultants	8	1	0	1	10
New software/MIS	5	0	0	4	9
Expand GIS capability	0	7	8	9	24
Add equipment	0	1	5	4	10
Upgrade equipment	5	4	6	7	22
Use new technology/techniques	5	0	3	8	16
Upgrade signal system	0	0	0	4	4
Use signal system/ATMS data	3	2	4	9	18
Implement a TMC	0	1	1	3	5
Implement ITS	0	1	0	1	2
No change	38	30	35	42	145

TABLE 3.27 - ANTICIPATED NEAR TERM CHANGES IN AGENCY'S VEHICLE CLASSIFICATION DATA COLLECTION PROGRAM (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

Expected Change	Type of Agency				
	State	MPO	County	City	Total
Expand program	3	3	1	1	8
Review program	1	0	0	0	1
Decrease program	2	0	0	0	2
Add to number of sites	5	0	0	0	5
Use new technology/techniques	1	1	0	0	2
Upgrade equipment	2	3	0	1	6
No change	57	46	61	83	247

TABLE 3.28 - ANTICIPATED NEAR TERM CHANGES IN AGENCY'S TRUCK WEIGHT DATA COLLECTION PROGRAM (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

Expected Change	Type of Agency				
	State	MPO	County	City	Total
Expand program	6	0	0	0	6
Start program	5	0	0	0	5
Decrease program	1	0	0	0	1
Coordinate program with State	0	1	0	0	1
Upgrade equipment	5	0	0	0	5
No change	54	52	62	85	253

TABLE 3.29 - ANTICIPATED NEAR TERM CHANGES IN AGENCY'S TRAVEL TIME/SPEED DATA COLLECTION PROGRAM (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

Expected Change	Type of Agency				
	State	MPO	County	City	Total
Expand program	4	4	1	0	9
Stop program	4	0	0	0	4
Use new technology/techniques	2	4	1	0	7
Upgrade equipment	0	2	0	0	2
No change	61	43	60	85	249

TABLE 3.30 - ANTICIPATED NEAR TERM CHANGES IN AGENCY'S VEHICLE OCCUPANCY DATA COLLECTION PROGRAM (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

Expected Change	Type of Agency				
	State	MPO	County	City	Total
Expand program	0	1	0	0	1
Start program	7	1	1	0	9
Use new technology	1	1	0	0	2
Use accident data	1	1	0	0	2
No change	62	49	61	85	257

TABLE 3.31 - OTHER ANTICIPATED NEAR TERM CHANGES IN AGENCY'S OVERALL DATA COLLECTION PROGRAM (NUMBER OF RESPONSES BY AGENCIES IN THE URBAN AREAS)

Expected Change	Type of Agency				
	State	MPO	County	City	Total
Increase staff	2	0	1	1	4
Decrease staff	2	0	0	0	2
Increase budget	0	1	0	1	2
Privatization	3	0	1	0	4
Change in planning area	0	1	0	0	1
Improved data exchange	1	2	0	0	3
New models, studies	1	1	1	1	4
New software/MIS	7	0	0	0	7
Implement GIS	3	3	3	3	12
Upgrade equipment	2	0	0	0	2
Add equipment	3	0	0	0	3
Install loops	1	0	0	0	1
Use video technology	2	0	0	1	3
Implement a TMC	2	0	0	2	4
Implement ITS	0	0	0	1	1
No change	42	45	56	75	218

3.2.9 Some Example Traffic Monitoring Programs

This section contains descriptions of the traffic monitoring programs in five urban areas. These examples provide a different point of view of the data summarized in the previous sections. The point of view is that of the individual urban area and the agencies within that area. The examples are intended to be non-prejudicial in that they are not presented as examples of "good" programs or "bad" programs, but merely to give a better feel for the diverse range of traffic monitoring programs in existence today within the individual large urbanized areas.

They range from Minneapolis, where agencies collect traffic monitoring data as part of

a permanent program at all levels of government, to Syracuse where most agency levels collect traffic monitoring data only as part of special studies, or as needed. In the middle is Peoria where the State DOT and city have permanent data collection programs, while the MPO and county rely on special studies. Also included is Albuquerque, an example of an area where a single agency collects data for all other agencies in the urban area, and Lexington, KY, where a number of agency levels have been combined at least for the purposes of traffic data collection.

Minneapolis

The Minneapolis area has a population of 2,112,000, a land area of 1,192 square miles, and 10,103 mile roadway system. It is a Moderate nonattainment area for CO. The State DOT, and both city and county level agencies have permanent data collection programs. The MPO, Metropolitan Council, Twin Cities Area, does no data collection.

The state DOT, the cities and counties put together “The 7 County Flow Map”, which is based on an ongoing cooperative, coordinated data collection effort. They also obtain data from the MNDOT TMC. These data are treated like that from a continuous count station. The TMC monitors about 175 miles of freeway and provides data from their operations.

The TMC is working on a GIS for data storage and display and as a feed to simulation models. They collect data (speed and lane occupancy every five minutes) at half mile intervals, and at every exit/entrance ramp. They have 3000 detectors at 700 stations and 400 ramps over the freeway system. Data from only 20-30 stations are provided for planning purposes. The MNDOT TMC has 2-3 years of data stored.

Type of Program: All three agency levels maintain a permanent Traffic Count Data Collection Program. The MNDOT has 81 continuous counters in the area, and also collects data at another 8,400 sites on a two year cycle (48 hr. duration). The Ramsey County Public Works Department also collects data at 250 sites on a two year cycle (48 hr. duration) , and conducts about 50 turning movement and 28 approach volume mechanical counts/year on an “as needed” basis. The City of Minneapolis, Transportation Division collects data at 1200 sites on a two year cycle (48 hr. duration).

MNDOT also collects Vehicle Classification Data in the area using 6 continuous counters, and at another 23 stations where classification data is collected on a two year cycle (16 hr. duration). The city conducts about 25 mechanical classification counts /year on an as needed basis.

MNDOT collects Truck Weight Data in the area using 6 continuous counters. Finally, the county conducts about 25 Speed Data Collection Studies per year on an as needed

basis. These are a mix of mechanical counts and radar.

Data Collection Equipment: MNDOT uses 81 counters which do traffic volume counts, and 6 which do classification counts. All stations have permanently installed loops. Truck Weight data is collected at 6 WIM sites.

The county uses 12 counters which collect both volume and speed data. Road tubes are used at 250 traffic volume data collection sites and 25 speed data collection sites.

The city uses 35 counters to do volume counts. Road tubes are used at the 1200 traffic volume data collection sites.

Data Use:

The State DOT uses Traffic Count Data for the following purposes:

HPMS Input
VMT Estimates
Regional Transportation Planning Models
Statewide Transportation Planning
Corridor Planning

The State DOT uses Vehicle Classification Data for the following purposes:

HPMS Input
VMT Estimates
Statewide Transportation Planning
Corridor Planning

The State DOT uses Truck Weight Data for the following purposes:

Statewide Transportation Planning
Corridor Planning

The county uses Traffic Count Data for the following purposes:

Local Traffic Planning
Corridor Planning
Other

The county uses Travel Time/Speed Data for the following purposes:

Local Traffic Planning

The city uses Traffic Count Data and Vehicle Classification Data for the following purposes:

Local Traffic Planning
Other

Data Flows Within The Urban Area:

TRAFFIC DATA FLOW TO/FROM THE STATE DOT

	Formal Exchange	Informal Exchange
To MPO	count	
To County	count	
To City	count	
To Other		
From MPO		
From County	count	
From City	count	
From Other	count	

The agency has no problems with the current data sharing arrangements.

TRAFFIC DATA FLOW TO/FROM THE COUNTY

	Formal Exchange	Informal Exchange
To State DOT	count	
To MPO		count
To City		count
To Other		
From State DOT	count	
From MPO		
From City	count	
From Other		

The agency has no problems with the current data sharing arrangements.

TRAFFIC DATA FLOW TO/FROM THE CITY

	Formal Exchange	Informal Exchange
To State DOT	count	
To MPO		
To County	count	
To Other		
From State DOT	count	
From MPO		
From County	count	
From Other		

The agency has no problems with the current data sharing arrangements.

Data Collection Staff Levels: The county has a permanent in house staff of 1.5 full time equivalents working on data collection in total.[22] Staffing information was not available from the State DOT. The city also relies on permanent in house staff for data collection. The following are full time equivalents: 1 administrative; 0.5 field; and 0.1 data processing.

Anticipated Program Changes: None of the agencies anticipated any changes in their programs.

Peoria

The Peoria area has a population of 244,000, a land area of 151 square miles, and 1,258 mile roadway system. It is an attainment area. Illinois DOT, District 4, and the City of Peoria Engineering Department have permanent data collection programs. The MPO, Tri-County Regional Planning Commission, and Peoria County Highway Department utilize special studies only in their data collection efforts.

Type of Program: IDOT collects data at 400 sites on a two year cycle (24 hr. duration) , and conducts about 50 mechanical and 100 manual counts/year on an "as needed" basis. The city has 28 continuous counters installed, and collects data at another 128 sites annually. They also conduct about 100 mechanical and 25 manual counts/year on an "as needed" basis. The MPO conducts about 50 mechanical volume counts per year, and the county may conduct a few manual volume counts, both on an as needed

[22] Includes 1 full term person plus pieces of others equal to .5 person.

basis.

IDOT also collects Vehicle Classification Data in the area at 30 stations on a four year cycle (24 hr. duration). The MPO conducts about 50 mechanical classification counts per year on an as needed basis. Both the county and city conduct classification counts on an as needed basis.

The county collects Truck Weight Data as special studies about 6 times per year. Finally, the MPO conducts about 50 Speed Data Collection Studies per year on an as needed basis, and the city also does Speed Data Collection as needed.

Data Collection Equipment: IDOT uses 51 counters which do traffic volume counts, and classification counts. Road tubes are used at 600 traffic volume data collection sites and 20 sites have permanently installed loops. Truck Weight data is collected at 1 WIM site.

The MPO has two counters that can collect count, classification and speed data.

The county uses 2 counters to collect volume data and 1 radar unit to collect speed data.

The city uses 6 counters to do volume counts. Twenty eight sites have permanently installed loops. Two video units are used to collect speed data.

Data Use:

The State DOT uses Traffic Count Data and Vehicle Classification Data for the following purposes:

HPMS Input

The State DOT uses Vehicle Occupancy Data for the following purposes:

Other

The MPO uses Traffic Count Data, Vehicle Classification Data, and Truck Weight Data for the following purposes:

Local Traffic Planning
Regional Transportation Planning Models
Major Investment Studies

The MPO uses Travel Time/Speed Data and Vehicle Occupancy Data for the following purposes:

Local Traffic Planning
Regional Transportation Planning Models

The county uses Traffic Count Data and Travel Time/Speed Data for the following purposes:

Local Traffic Planning

The city uses Traffic Count Data, Vehicle Classification Data, and Travel Time/Speed Data for the following purposes:

Local Traffic Planning
Regional Transportation Planning Models
Corridor Planning
Major Investment Studies

Data Flows Within The Urban Area:

TRAFFIC DATA FLOW TO/FROM THE STATE DOT

	Formal Exchange	Informal Exchange
To MPO		count
To County		count
To City		count
To Other		
From MPO		
From County	count	
From City		count
From Other		

The agency has no problems with the current data sharing arrangements.

TRAFFIC DATA FLOW TO/FROM THE MPO

	Formal Exchange	Informal Exchange
To State DOT		count
To County		count, class.
To City		count, class.
To Other		
From State DOT	count, class.	
From County		
From City		
From Other		

The agency has no problems with the current data sharing arrangements.

TRAFFIC DATA FLOW TO/FROM THE COUNTY

	Formal Exchange	Informal Exchange
To State DOT		
To MPO		
To City		
To Other		count, speed
From State DOT	count, weight	
From MPO		
From City	count	
From Other		

The agency has no problems with the current data sharing arrangements.

TRAFFIC DATA FLOW TO/FROM THE CITY

	Formal Exchange	Informal Exchange
To State DOT		count
To MPO		count
To County		count
To Other		count
From State DOT		count
From MPO		
From County		
From Other		

The agency has no problems with the current data sharing arrangements.

Data Collection Budget: The county's annual data collection budget is $5,500.00. The city's annual budget is $12,000.00.

Data Collection Staff Levels: All agencies rely on permanent in house staff for data collection. The following are full time equivalents for the State: 3 field (plus 0.25 temporary in house). The following are full time equivalents for the MPO: 2 administrative; and 2 temporary in house other. The following are full time equivalents for the county: 0.02 administrative. The following are full time equivalents for the city: 2 administrative; and 1 other.

Anticipated Program Changes: Traffic Volume Program - More coordination is anticipated between IDOT and the local agencies with the local agencies doing more counting. The State is the lead agency in traffic counting. However, the MPO and city will take on more responsibility gradually. IDOT will count less and less on local roads. IDOT wants the MPO to take over more responsibility for the local counts. As requests come in the MPO will do the counts using IDOT equipment. This will be the first time the State will have the MPO, county, and city doing counts on all roads excluding state roads. The MPO and county will begin in 1998. The city will collect volume information from 400 site's in 1999 (because they are on a five year cycle). The city gives the MPO and county any data collected as special studies. The city also coordinates with the district DOT office on special study counts.

Syracuse

The Syracuse area has a population of 364,000, a land area of 233 square miles, and 1,677 mile roadway system. It is a Moderate nonattainment area for CO. While NYDOT, Region 3 has a permanent data collection program, the MPO, Metropolitan Transportation Council, Onendaga County, and the City of Syracuse, Department of Public Works all rely solely on special studies for their traffic data collection efforts.

Type of Program: The NYDOT has 4 continuous counters in the area, and also collects data at another 717 sites on a three year cycle (72 hr. duration). In addition they conduct about 150 manual turning movement counts/year on an "as needed" basis. The MPO conducts about 50 mechanical traffic volume counts/year on an "as needed" basis. The county conducts about 17 manual turning movement and 140 mechanical volume counts/year on an "as needed" basis. The city conducts about 40 mechanical volume counts /year on an as needed basis.

NYDOT collects Vehicle Classification Data and Speed Data in the area using its 4 continuous counters. The MPO conducts about 10 mechanical classification counts/year on an "as needed" basis.

Finally, NYDOT collects Truck Weight Data in the area at 1 permanent site.

Data Collection Equipment: NYDOT uses 47 counters which do traffic volume counts, and 4 which do classification counts and collect speed data. Truck Weight data is collected at 1 WIM site. The county has 6 counters. The city has 6 counters.

Data Use:

The State DOT uses Traffic Count Data and Vehicle Classification Data for the following purposes:

HPMS Input
VMT Estimates
CMS programs
Local Traffic Planning
Regional Transportation Planning Models
Statewide Transportation Planning
Corridor Planning
Major Investment Studies
Environmental Planning
Other

The State DOT uses Travel Time/Speed Data for the following purposes:

Other

The MPO uses Traffic Count Data and Vehicle Classification Data for the following

purposes:

Local Traffic Planning
Regional Transportation Planning Models

The county uses Traffic Count Data for the following purposes:

Local Traffic Planning
Other

The city uses Traffic Count Data for the following purposes:

Other

Data Flows Within The Urban Area:

TRAFFIC DATA FLOW TO/FROM THE STATE DOT

	Formal Exchange	Informal Exchange
To MPO	count	
To County		count
To City		count
To Other		
From MPO		
From County		count
From City		count
From Other		

There are problems with the reliability of counts received from other agencies related to equipment problems/data editing.

TRAFFIC DATA FLOW TO/FROM THE MPO

	Formal Exchange	Informal Exchange
To State DOT		count
To County		count
To City		count
To Other		
From State DOT	count	
From County		
From City		
From Other		

The agency has no problems with the current data sharing arrangements.

TRAFFIC DATA FLOW TO/FROM THE COUNTY

	Formal Exchange	Informal Exchange
To State DOT		
To MPO	count	
To City		
To Other		
From State DOT	count	
From MPO		
From City		
From Other		

The agency has no problems with the current data sharing arrangements.

TRAFFIC DATA FLOW TO/FROM THE CITY

	Formal Exchange	Informal Exchange
To State DOT		
To MPO		count
To County		count
To Other		count
From State DOT	count	
From MPO	count	
From County	count	
From Other		

The agency has no problems with the current data sharing arrangements.

Data Collection Staff Levels: All agencies rely on permanent in house staff for data collection. The State DOT employs parts of 3 full time equivalents (plus 0.5 temporary in house); the MPO employs parts of 3 full time equivalents; and the city employs parts of 1 full time equivalents. The following are full time equivalents for the county: 0.05 administrative; and 0.25 field.

Anticipated Program Changes: The agencies anticipated the following changes in their Traffic Volume Program:

The State DOT is considering the hiring of a contractor to help with their count backlog.

The MPO may start a permanent count program for non state roads subject to budget and workload considerations.

The county received 12 old counters from the State DOT, and may expand its program based on budget limitations.

The city is going to put their sign, signal, and count data into a GIS.

Lexington

The Lexington area has a population of 234,000, a land area of 286 square miles, and roadway system of 1,214 miles. It is Marginal nonattainment area for ozone. The MPO is combined with the city/county. The city, MPO, and county staff are all in the same location. There are no distinct lines between them. They all work as one under the Lexington Fayette Urban County Government. All references to the city program below

are for the combined agency. In addition, the State DOT has an independent data collection program in the urbanized area.

The city has an extensive vehicle detection component included as part of their computerized traffic signal system. Within this component are over 1,500 presence and system detection loops located throughout the county. The system loops provide real-time vehicular volumes and lane occupancies. Information from the signals is collected by the city.

They also have an innovative method of doing travel time studies. The city is involved in a public-private partnership with UPS. UPS does travel time studies for their own planning purposes. The public agencies use this as an additional data source.

Type of Program: The Kentucky Transportation Cabinet maintains an extensive data collection program in the area. The Traffic Count Data Collection Program utilizes 3 continuous counters. Data is also collected at 7 stations on an annual cycle, 205 stations on a 3 year cycle, and 239 stations on a six year cycle. All data is collected for a duration of 48 hours. The city also collects Traffic Count Data under a permanent program utilizing 85 continuous counters. Data is also collected at 300 stations on a 2 year cycle (8 hr. duration). In addition to this permanent program the city conducts about 30 manual counts (turning movements, volume through intersections) per year in the area on an as needed basis.

The State's Vehicle Classification Data Collection Program utilizes 1 continuous counter. Data is also collected at 8 stations on an annual cycle, 25 stations on a 3 year cycle, and 35 stations on a six year cycle. All data is collected for a duration of 48 hours. In addition to this permanent program they conduct about 5 manual counts per year in the area on an as needed basis. These are 16 to 24 hour counts for project design inputs.

Truck Weight data is collected by the State at one station on an annual basis and at 7 other stations on a three year cycle. All data is collected for a duration of 48 hours.

The city also conducts a travel time survey at the same locations that collect volume data one month out of the year.

Data Collection Equipment: The State DOT has 41 traffic volume counters for use in the area. Thirty seven of these can also collect classification data. Five portable scales and 1 permanent scale are used to collect Truck Weight Data.

The city uses 85 counters which collect both volume and speed data. All city stations have permanently installed loops.

Data Use:

The State DOT uses Traffic Count Data for the following purposes:

HPMS Input
VMT Estimates
CMS programs
Local Traffic Planning
Regional Transportation Planning Models
Statewide Transportation Planning
Corridor Planning
Major Investment Studies
Environmental Planning

The State DOT uses Vehicle Classification Data for the following purposes:

HPMS Input
VMT Estimates
CMS programs
Local Traffic Planning
Regional Transportation Planning Models
Statewide Transportation Planning
Corridor Planning
Major Investment Studies
Environmental Planning
Other - cost allocation, and public requests

The State DOT uses Truck Weight Data for the following purposes:

VMT Estimates
CMS programs
Statewide Transportation Planning
Corridor Planning
Major Investment Studies
Environmental Planning

The city uses Traffic Count Data for the following purposes:

VMT Estimates
CMS programs
Local Traffic Planning
Regional Transportation Planning Models
Corridor Planning
Major Investment Studies
Environmental Planning

Data Flows Within The Urban Area:

TRAFFIC DATA FLOW TO/FROM THE STATE DOT

	Formal Exchange	Informal Exchange
To MPO	count	
To County		
To City		
To Other		
From MPO		count
From County		
From City		
From Other		

The agency has no problems with the current data sharing arrangements.

TRAFFIC DATA FLOW TO/FROM THE CITY

	Formal Exchange	Informal Exchange
To State DOT		
To MPO		
To County		
To Other		
From State DOT		count
From MPO		
From County		
From Other		

The agency has no problems with the current data sharing arrangements.

Data Collection Budget: The State's annual budget for the area is $44,000.00, from State and federal planning funds. The city's annual budget is $45,000.00.

Data Collection Staff Levels: Both agencies rely on permanent in house staff for data collection. The following are full time equivalents for the State: 0.3 administrative; 1 field; 0.2 data processing; and 0.1 equipment. The following are full time equivalents for the city: 1 administrative(plus 0.5 temporary in house); and 1 data processing (plus 0.5 temporary in house).

Anticipated Program Changes: The State DOT anticipated the following program changes:

Traffic Volume Program - They are investigating an expert data system. They will use new counters at permanent count sites in 1996-97.

Vehicle Classification Program - They will use new counters, and new sensors at permanent count sites in 1996-97.

Truck Weight Program - They are investigating the use of more continuous stations, probably bending plate systems.

The city has an ITS system in the early development stage. In addition, they will use cameras and system loops with motion detectors for data collection.

Albuquerque

The Albuquerque area has a population of 427,000, a land area of 175 square miles, and roadway system of 1,866 miles. It is Moderate nonattainment area for CO. The State DOT no longer does data collection in the larger urbanized areas of New Mexico other than from their permanent continuous traffic count stations. The Middle Rio Grande Council of Governments (the MPO) is the sole data collection agency in the area. It collects data for the state DOT, and county and city governments in the area. All data is in a GIS and accessible to all local governments. The State provides monthly data from their permanent continuous traffic counter sites.

Type of Program: The Traffic Count Data Collection Program is a permanent program. Data is collected by means of 12 continuous counters, on an annual cycle at 13 stations (60 hr. duration), and on a three year cycle at 3480 stations (48 hr. duration). In addition Vehicle Classification Data is collected on a 3 year cycle at 300 stations (48 hr. duration).

Data Collection Equipment: The agency uses 50 counters which do both volume and classification counts. Thirteen stations have permanently installed loops. Road tubes are used at the other 3480 traffic volume data collection sites and 300 classification data collection sites.

Data Use:

The Traffic Count Data is used for the following purposes:

HPMS Input
VMT Estimates
CMS programs
Local Traffic Planning
Regional Transportation Planning Models
Statewide Transportation Planning
Corridor Planning
Major Investment Studies
Environmental Planning
Other

The Vehicle Classification Data is used for the following purposes:

HPMS Input
VMT Estimates
CMS programs
Local Traffic Planning
Regional Transportation Planning Models

Data Flows Within The Urban Area:

	Formal Exchange	Informal Exchange
To State Dot	count	
To County		count
To City	count	
To Other		
From State DOT	count	
From County		
From City		
From Other		

The agency has no problems with the current data sharing arrangements.

Data Collection Staff Levels: The agency relies on permanent in house staff for data collection. The following are full time equivalents: 0.2 administrative; 3.4 field; 0.5 data processing; and 0.3 other.

Anticipated Program Changes: Traffic Volume Program - Getting 34 permanent ATRs on arterials in the next year (contract held up in court). State plans to put in more permanent ATRs on the interstates as budget and reconstruction allow. Changing to a work station environment. A TMC is planned as part of the proposed CMS.

Travel Time/Speed Program - Will use GPS for constant travel time monitoring. Routes will be selected from trip tables from their EMME model (just in planning stage.)

4. CANDIDATE CASE STUDY AREAS

One of the primary purposes of the work reported in the previous chapters was the identification of urban traffic data collection programs that could be used as examples for local agencies throughout the country. This is a time of great change in the profession. Agencies are being pressed to collect more and better data with less, or at best, the same resources. Some agencies' programs have been or are in the process of being squeezed out of existence in terms of their data collection efforts[23]. Other agencies have ambitious plans for high tech systems, falling under the umbrella of ITS, that may or may not be capable of gathering and saving traffic data in a form useable for planning purposes.

The urban areas selected for a more in depth case study will have two points in common. Their data collection program will be operational today, as opposed to planned. Secondly, the program will be a permanent on-going one which appears to meet minimum AASHTO and TMG standards for data collection. While many of the agencies contacted had plans for expanded conventional programs, or rather elaborate ITS like systems, that could be used for traffic data collection, it is difficult to do a case study on a planned system/program, and more meaningful to do a case study on something that is now in place and works.

The emphasis will be placed on traffic volume programs, since this seems to be the type of data that most agencies collect in urban areas. Programs will also be considered on two bases, that is regional and purely local. We will attempt to provide examples of individual city or county agencies that have a "good" program, but we will also provide examples of regional programs that involve a number of local agencies working together in a cooperative, coordinated data collection effort. Finally, we hope

---

[23] Seventeen local agencies provided unsolicited comments to the effect that permanent data collection programs had ceased to exist or were about to, or could not keep up with their normal data collection schedule because of staff/ budget cuts.(Akron, Baltimore (city and county), Buffalo(city and county), Columbus OH, Corpus Christi, Dallas, Dayton, Hartford, Honolulu, Houston, Jersey City, Bergen County NJ, Pittsburgh (Allegheny County), Richmond, and Utica NY(Onieda County))

Ten agencies saw future budget problems as a threat to plans for needed equipment replacement and upgrades, or the data collection program itself. (Albany County NY, Anchorage, Austin, Chicago (Cook County), Cleveland (Cuyahoga County), Fort Lauderdale, Virginia Beach, Syracuse, and Alexandria, VA)

Staff/ budget cuts at the state level are forcing the transfer of data collection responsibilities from State DOTs to local level agencies in Illinois, and Washington, was a primary reason for Virginia's transferring its program to consultants, and has New York considering the use of consultants, at least to help catch up with their scheduled count backlog.

to provide examples of programs involving innovative use of technology, that are in place and operational today.

Based on the interview results reported in the previous section, several localities will be selected for an in-depth review, documentation, and assessment of their traffic monitoring data operations. The review will examine the needs for the data, the uses of traffic data, institutional issues, organization, day-to-day program operation, staffing, funding, and equipment. Due to the importance and need for traffic data to support urban planning requirements, vehicle miles of travel, and the Highway Performance Monitoring System, the link between the traffic data collected and its use in these programs will be emphasized. The review will also explore the technology and day-to-day procedures, explaining how the data is collected, identifying difficulties, and showcasing the solutions devised.

Each of the selected areas will be visited to interview responsible program managers or staff and detail the specifics of the traffic monitoring data program. The examination will emphasize the successes achieved and problems surmounted in the collection of reliable data. Since it is expected that traffic data within an urban area may be collected by a variety of organizations, the interaction, cooperation, organizational arrangements, agreements, and data sharing of all the involved entities will be explored.

The emphasis will be on the larger cities which we foresee as having more of a problem with traffic monitoring and its related issues. A geographical distribution is also necessary to provide a wider point of view. The emphasis will be on obtaining sufficient, detailed program information on these “case studies” to spur program improvement by learning from the mechanisms and successes of the programs studied.

The major points for consideration in the case studies that surfaced as a result of our work to date are as follows:

- Institutional Arrangements
  - inter agency contracting
  - coordination/cooperation
  - single agency data collection
- Funding Sources/Mechanisms
- Use of ATMS Data for Planning

Case Studies will be selected to highlight "interesting" or noteworthy examples of each of the major points. The case study report will not present the programs as "best" cases, or examples, or carry any connotation of a judgment call on the quality of the programs.

4.1 COORDINATED DATA COLLECTION PROGRAMS

Some of the case studies will highlight the collection of data for the urban area in a coordinated, cooperative fashion. This was considered a hallmark of a good program because it implies that data from all agencies involved is on one consistent basis in terms of vintage, validity, and reliability, and that one can get a reasonably good sense of regional traffic volumes, and their trends with some degree of confidence. This is of importance since congestion and air quality concerns are usually considered on a regional basis.

This coordination can be achieved in a number of ways, and to varying degrees. In a number of urban areas, de facto coordination has been achieved because a single agency has emerged as the only traffic data collection agency in the urban area. In other areas, a "lead agency" assigns data collection responsibilities to other agencies in the area, who then collect the data on an agreed upon schedule, and according to agreed upon standards such as count duration. A modification of this latter model seems to have appeared as a result of the CMS requirements, in that the assigned data collection responsibilities may only cover those facilities in the region that had been included as part of the CMS.

4.2 USE OF NONTRADITIONAL DATA COLLECTION TECHNIQUES

Other case studies will highlight programs that can collect traffic volume data from an ATMS, i.e., a computer controlled traffic signal system. This "technology" was considered significant because it was one of the most often cited program changes indicated in our agency interviews[24]; one that we received mixed messages on in terms

[24] Agencies in the following urban areas indicated that they had plans for a new TMC, and that it would be capable of collecting and saving signal system data for planning purposes: Austin, Baton Rouge, Canton, Cincinnati, Columbus GA, Dallas, Denver, Houston, Las Vegas, Louisville, Modesto, Phoenix, Portland, Raleigh, Seattle, South Bend, St. Louis, Tampa, and Winston-Salem.

Agencies in the following urban areas indicated that they had plans for a new TMC, but did not indicate that it would be capable of collecting and saving signal system data for planning purposes: Albuquerque, Boston, El Paso, Greenville SC, Pittsburgh, Reno, and Savannah.

of potential implementation problems[25]; and one which, if implemented properly, holds promise as a way out of the "do more with less" dilemma facing many local agencies in that in can effectively automate at least a portion of the traffic volume data collection process.

Other technologies such as AVI, GPS, video, aerial photography, and GIS that could have been considered are not yet widely used in practice and are still somewhat experimental, and are more appropriate to the collection of travel time/speed/delay/congestion type of traffic data rather than volume. While this type of traffic data will assume increased importance in the future, it is not currently a significant part of most agencies' data collection programs. GIS while holding significant promise as a data management, data display, and analysis tool, also appears to be in an early developmental stage, at least as far as traffic data collection agencies are concerned.

[25] Agencies in the following urban areas indicated that they now had the capability of collecting and saving signal system data for planning purposes:Canton OH, Chattanooga, Hartford, Long Island NY, Los Angeles, Lexington, New Haven, Norfolk, Milwaukee, Minneapolis, Pensacola , Peoria, Richardson, TX, Rochester, and W. Des Moines.

Agencies in other areas noted that there were problems associated with using the data from their signal system.

Bergen Co. NJ, Virginia Beach, and Washington, DC indicated that while their signal controllers could save the data, that they couldn't afford to install or replace the required loop detectors.

Columbus, OH noted that the data produced by their system was not in a usable format for electronic transfer; that it required downloading, manual editing and re entry; and that the data gets overwritten because of their systems limited storage capability.

5. CONCLUSIONS

The conclusions of this report are based both on our review of the literature and our interviews with individuals involved in traffic data collection at various levels of government throughout the country. They are as follows:

There is a general lack of knowledge regarding which agencies collect what types of data and the manner in which it is collected within the states and within individual urban areas.

The greatest problem encountered in the course of this study was that of identifying individuals at the local level responsible for traffic data collection. We attempted to do this by first contacting the FHWA division offices in states containing the urbanized areas of interest. In most cases, these individuals were not familiar with any data collection efforts below the level of state DOT. Individuals involved in traffic data collection at the state DOTs could in most cases only refer us to someone at an MPO. We found that ironically the MPOs, while the agency level least involved in direct data collection of most types, were the most knowledgeable about who was involved in data collection within their area, and provided us with most of our contacts at the city and county level.

Our largest non response was from State DOTs. In many cases, they were unable to provide us with information on their data collection programs within a specified TMA, although they could readily provide information on their total statewide program. Typical responses were that they just did not have the numbers available on that basis, that FHWA should already have that information, or that they would have to contact their individual district or regional offices. In many cases, where the state DOT did provide data on their program at the TMA level, it was with what seemed to be a great deal of effort on their part. Perhaps an argument in favor of the use of GIS to track traffic data and data collection sites.

There is no central source of information on the extent of use of new technology for either traffic management or traffic data collection within urban areas.

Another issue that arose during the course of the study was the use of ITS, TMC or ATMS data for planning purposes. This question was both explored in the interviews, the literature review, and in discussions with researchers involved in other on-going ITS work at the Volpe Center. Other than asking each individual agency, we had difficulty in finding someone who knew which areas had TMCs, let alone TMCs that could/did save system data for planning. Part of the problem seems to derive from the lack of a single FHWA funding source for ITS. Many ITS-like systems are being funded through CMAQ, and thus do not appear on project lists published by the ITS Joint Program Office.

The quality of urban area traffic data collection efforts, and presumably of the resulting data, varies widely. Many programs would appear to meet currently accepted standards, many others would not, and in many cases there is no program.

From the data reported in the MPO-conducted surveys, it was found that about half of the local agencies do not have a regular data collection program, i.e., either don't collect data or collect as needed. It was not possible to judge the quality of the regular programs with the data available. Traffic volume counts were most prevalent with speed studies a distant second. Other types of data such as truck weight were hardly collected at all.

Our interview results generally confirmed this picture. It seems that programs collecting traffic volume data predominate, followed by those involved in collecting classification and speed/travel time data. Relatively little activity related to truck weight or vehicle occupancy data collection was found.

An examination of the parameters for the permanent traffic volume programs would seem to indicate that on the average, programs are meeting at least AASHTO if not TMG recommendations for count duration (between 24 and 48 hours) and frequency (every 3 years or less). While the number of count locations is substantial, little can be said definitively about the adequacy of the coverage without going into a detailed examination of the highway system within an urban area.

Another point that stands out in the results is the number of city agencies utilizing "special studies" for their data collection requirements.(Not to mention those not collecting data.) Intersection related counts, either "turning movement" or "traffic signal studies" predominate in the "special studies" of traffic volume programs. Further, much of the classification data collected by local agencies is done manually, as part of intersection turning movement counts, and involves classifying vehicles as cars or trucks.

Data within many urban areas would not appear to be collected in any kind of coordinated fashion. Most data exchange is informal. The CMS requirement of ISTEA appears to have forced agencies within urban areas to take stock of their local jurisdictions' programs.

Two things stand out regarding data exchange in the urban areas. The first is the preponderance of informal exchange over formal. The second is that the formal exchange seems to be dominated by the flow of information to or from MPOs within urban areas. This should not be surprising. Since most "local" agencies do not have permanent data collection programs, they could not be expected to provide their data to others on anything other than an ad hoc basis. On the other hand, a major role of MPOs in most areas is to compile and distribute traffic data, either collected by themselves or others.

The MPO surveys mentioned above are perhaps the more elaborate examples of the data inventory process that was a prerequisite to the development of a viable CMS within any urban area.[26]

Funding and staffing cutbacks have hurt data collection efforts in the recent past, and continue to pose a threat in the future.

The ITE survey found that funding for operations/maintenance and capital improvements and staff shortages are expected to remain significant issues for local traffic engineering agencies over in the next few years. The lack of adequate funding, both for operations/maintenance and capital improvements, is a significant issue to most agencies, regardless of jurisdiction size. While funding and staff levels were found to have increased on average, agencies felt that current funding and staff levels represented about 80% of what was needed to perform all of their functions effectively. More than half of the respondents felt that new requirements such as congestion management systems would result in increased workload, without increases in funding to deal with the potential impacts. This will tend to continue the trend of agencies having to do more with less.

[26] It should be noted that agencies within one urban area, initiated a dialog on mutual data collection concerns, as a result of this study's inquires.

Our interviews tended to confirm this picture. Seventeen local agencies provided unsolicited comments to the effect that permanent data collection programs had ceased to exist or were about to, or that they could not keep up with their normal data collection schedule because of staff/ budget cuts. Ten agencies saw future budget problems as a threat to plans for needed equipment replacement and upgrades, or the data collection program itself.

Staff/ budget cuts at the state level are forcing the transfer of data collection responsibilities from State DOTs to local level agencies in at least two states; was a primary reason for another state transferring its program to consultants; and has another state considering the use of consultants, at least to help catch up with their scheduled count backlog.

New technology would seem to hold promise as a solution to budget/staff reductions, but does not seem to have lived up to its full potential

The new technology considered here involves that hardware and software connected with collecting traffic volume data from an ATMS/TMC/ computer controlled traffic signal system. This "technology" was considered significant because it was one of the most often cited program changes indicated in our agency interviews, one that we received mixed messages on in terms of potential implementation problems, and one which, if implemented properly, holds promise as a way out of the "do more with less" dilemma facing many local agencies in that in can effectively automate the traffic volume data collection process.

As a result of our interviews we were able to identify systems in 15 urban areas which could/did save their operational data for planning purposes. Agencies in 4 other areas indicated that they would, except for funding- related equipment installation or maintenance problems. There are future plans to implement systems that would have this capability in 19 other areas. (In 7 other areas it was not specifically indicated whether the planned TMC would have this capability.)

Responsibility for traffic management operations is dispersed among numerous jurisdictions in metropolitan areas. As a result, changes to the operational organizations involved in metropolitan traffic management will be difficult to achieve and hindered by resource constraints and "turf battles".

Limited ATMS skills are available to organizations even in those areas where some of the technologies have already been implemented. The lack of qualified professional personnel is expected to be a significant problem in five years.

There is a need for consistent and sustainable funding for designing, building, operating, and maintaining ATMS. So far, sources for such funding have not been fully identified. State and local governments are unwilling or unable to take on greater indebtedness and are particularly concerned about their ability to support the operations and maintenance phase of an ATMS program.

The recommendations of this report are as follows:

FHWA should explore options for assured funding of data collection efforts, by various levels of government.

If local agency traffic data is to form the bedrock of CMS and CAAA related analyses, it is clear that an assured funding mechanism is required to preserve the quality of currently acceptable data collection programs, to raise the quality of substandard data collection programs, and initiate data collection programs in local jurisdictions as required.

FHWA should work to improve coordination among programs within FHWA funding ATMS, and those responsible for data collection, or having an interest in urban area traffic data.

The need for high quality traffic data in urban areas, and the ability to fund systems which can potentially provide that data even as only one aspect of a system's overall capabilities, seems to be the common thread that ties together various offices within FHWA, whether their major concern is ITS, CMS, CMAQ, or the traditional data collection interests of OHIM.

FHWA should require all new federally funded ATMS systems to have the capability of collecting traffic monitoring type data.

Despite the fact that systems in a number of areas now collect ATMS data for planning purposes, there may be a problem in upgrading existing systems in order to provide them with this capability. This later problem is currently being addressed in a few urban areas.[27]

FHWA should explore the concept of a single regional data collection agency for each TMA.

An alternative response to not collecting data in response to budget/staff cut backs would appear to be the idea of local jurisdictions pooling remaining resources to fund a single viable data collection agency for the region. The barriers as well as the potential advantages to all involved agencies would have to be explored in more detail.

[27] A study has been proposed for the Houston area which is to look into the possibility of using ATMS/TMC data. In addition studies are underway in the Columbus, and San Antonio areas which address the problem of integrating the traffic data from an existing computer controlled signal system for city streets, with the data generated by a new freeway incident management system.

APPENDIX A - ADDITIONAL CHARACTERISTICS OF TRAFFIC VOLUME MONITORING PROGRAMS

TABLE A.1 - STATUS OF TRAFFIC VOLUME MONITORING PROGRAMS WITHIN LARGE URBAN AREAS

Urbanized Area	Agency Type							
	DOT	MPO	County	City	DOT'	MPO'	County'	City'
New York				P	P		SS	SS
Los Angeles								
Chicago	P	P	P					
Philadelphia		P			P	P		
Detroit								
San Francisco-Oakland				COMB				
Washington	P	P	P	P	P			
Dallas-Ft. Worth			P	P				
Houston				P				
Boston	P	SS		SS				
San Diego			COMB	P				
Atlanta			P					
Minneapolis-St. Paul	P		P	P				
Baltimore	P		SS	SS				
Phoenix	P	SS	P	P				
St. Louis	P			P				
Miami-Hialeah			P					
Seattle-Everett	P		P	P				
Pittsburgh		P		SS				
Tampa-St. Pete		P	P					
Cleveland			P					
Denver	P	P	P	COMB				
San Jose								
Riverside-San Bernadino								
Kansas City	P		P	P				
Fort Lauderdale		P						
Portland-Vancouver	P		P	P				
Milwaukee	P			P				
Cincinnati			P	P	P			
Sacramento								
San Antonio								
Buffalo-Niagara Falls		SS	P	SS				
New Orleans	P		NA	SS				
Norfolk-Portsmouth	P			SS				
Oklahoma City	P		SS	P				
Orlando			P					
Columbus			P	SS				
Indianapolis								
Providence-Pawtucket	P							
Memphis	P			P				

TABLE A.1 - STATUS OF TRAFFIC VOLUME MONITORING PROGRAMS WITHIN LARGE URBAN AREAS (continued)

Urbanized Area	Agency Type							
	DOT	MPO	County	City	DOT'	MPO'	County'	City'
Las Vegas	P		P	P				
West Palm Beach			P					
Salt Lake City	P		P	SS				
Louisville	P	P		SS				
Jacksonville			COMB	P				
Birmingham	P	SS	P	SS				
Tulsa	P		P	P				
Honolulu			SS	COMB				
Rochester	P	P	P					
Dayton		SS	P	P				
Hartford-Middletown	P	SS	NA	SS		SS		
Nashville-Davidson	P		SS	COMB				P
Springfield-Chicopee	P	P						
Richmond	P			SS				
El Paso		COMB		SS				
Austin				SS				
Omaha	P		P	SS				
Akron		SS		SS				
Fresno								
Charlotte	P			P				
Oxnard-Ventura								
Albany-Schenectady		P	P	SS				
Toledo			P					
Wilmington	P	SS						
Sarasota-Bradenton								
New Haven-Meriden	P	SS	NA					
Allentown-Bethlehem		P		P				
Tucson	P		P	P				
Albuquerque		P						
Bridgeport-Milford	P	P	NA	P				
Grand Rapids			P					
Charleston	P			SS				
Scranton-Wilkes-Barre		P						
Flint		P	P					
Colorado Springs	P							
Baton Rouge	P		NA	P				
Syracuse	P	SS	SS	SS				
Youngstown-Warren		P	SS					
Wichita	P		P	P				
Worcester	P	P						

TABLE A.1 - STATUS OF TRAFFIC VOLUME MONITORING PROGRAMS WITHIN LARGE URBAN AREAS (continued)

Urbanized Area	Agency Type							
	DOT	MPO	County	City	DOT'	MPO'	County'	City'
Raleigh	P			P				
Bakersfield			P	P				
Columbia	P			SS				
Augusta			COMB	P				
Melbourne-Palm Bay		P	COMB					
Chattanooga	P			P				
Mobile	P		P	P				
Knoxville	P	P	P	P				
Harrisburg		P						
Spokane	P		P	P				
Little Rock	P		SS	SS				
Jackson	P			P				
Lawrence-Haverhill	P	P						
Des Moines	P		SS	P				P
Stockton								
Lansing-East Lansing			P					
Corpus Christi		COMB		P				
Provo-Orem	P			P				
Davenport-Rock Island	P	SS		SS	P			
Pensacola			P					
Ogden	P							
McAllen-Edinburgh		SS		P				
Reno	P	SS		SS				
Greenville	P		SS	SS				
Shreveport	P		NA					
Modesto			P	P				
Columbus			COMB	SS				
Fort Wayne		P		SS				
Fayetville	P			P				
Canton			SS	P				
Peoria	P	SS	SS	P				
Madison	P			P				
South Bend		P	P	P				P
Anchorage	P		NA					
Lancaster-Palmdale								
Fort Meyers-Cape Coral			P					
Lexington-Fayette	P	COMB	COMB	P				
Montgomery	P	COMB		SS				
Daytona Beach								
Savannah				P				

TABLE A.1 - STATUS OF TRAFFIC VOLUME MONITORING PROGRAMS WITHIN LARGE URBAN AREAS (continued)

Urbanized Area	Agency Type							
	DOT	MPO	County	City	DOT'	MPO'	County'	City'
Winston-Salem	**P**			**P**				
Durham	**P**	**P**		**COMB**				
Lowell	**P**	**SS**						
Santa Rosa			**P**	**P**				
Rockford	**P**		**P**	**SS**				
Utica-Rome	**P**		**SS**					
Lancaster		**P**						
Ann Arbor			**P**	**P**				

KEY

	NO RESPONSE
	NO DATA COLLECTION PROGRAM
P	PERMANENT DATA COLLECTION PROGRAM
SS	DATA COLLECTION BY SPECIAL STUDY ONLY
COMB	AGENCY COMBINED WITH ANOTHER LEVEL
NA	NO COUNTY GOVERNMENT

Duplicate agency types are indicated in the table in those cases where an urban area covered more than one state, and responses were received from multiple state DOTs, MPOs, counties or cities within the given urban area.

TABLE A.2 - URBAN AREAS BY TYPE OF TRAFFIC MONITORING PROGRAM (PERMANENT/SPECIAL STUDIES)

URBAN AREAS WITH A PERMANENT TRAFFIC VOLUME DATA COLLECTION PROGRAM AT FOUR LEVELS OF GOVERNMENT (2)

Washington
Knoxville

URBAN AREAS WITH A PERMANENT TRAFFIC VOLUME DATA COLLECTION PROGRAM AT THREE LEVELS OF GOVERNMENT (16)

Chicago
Minneapolis-St. Paul
Phoenix
Seattle-Everett
Denver
Kansas City
Portland-Vancouver
Cincinnati
Las Vegas
Tulsa
Rochester
Tucson
Wichita
Mobile
Spokane
South Bend

URBAN AREAS WITH A PERMANENT TRAFFIC VOLUME DATA COLLECTION PROGRAM AT TWO LEVELS OF GOVERNMENT (40)

New York
Philadelphia
Dallas-Ft. Worth
St. Louis
Tampa-St. Pete
Milwaukee
Oklahoma City
Memphis
Salt Lake City
Louisville
Birmingham
Dayton
Nashville-Davidson
Springfield-Chicopee
Omaha
Charlotte
Albany-Schenectady
Allentown-Bethlehem
Bridgeport-Milford
Flint
Baton Rouge
Worcester
Raleigh
Bakersfield
Chattanooga
Jackson
Lawrence-Haverhill
Des Moines
Provo-Orem
Davenport-Rock Island
Modesto
Fayetville
Peoria
Madison
Lexington-Fayette
Winston-Salem
Durham
Santa Rosa
Rockford
Ann Arbor

TABLE A.2 - URBAN AREAS BY TYPE OF TRAFFIC MONITORING PROGRAM (PERMANENT/SPECIAL STUDIES) (continued)

URBAN AREAS WITH A PERMANENT TRAFFIC VOLUME DATA COLLECTION PROGRAM AT ONE LEVEL OF GOVERNMENT (51)

Houston
Boston
San Diego
Atlanta
Baltimore
Miami-Hialeah
Pittsburgh
Cleveland
Fort Lauderdale
Buffalo-Niagara Falls
New Orleans
Norfolk-Portsmouth
Orlando
Columbus
Providence-Pawtucket
West Palm Beach
Jacksonville
Hartford-Middletown
Richmond
Toledo
Wilmington
New Haven-Meriden
Albuquerque
Grand Rapids
Charleston
Scranton-Wilkes-Barre
Colorado Springs
Syracuse
Youngstown-Warren
Columbia
Augusta
Melbourne-Palm Bay
Harrisburg
Little Rock
Lansing-East Lansing
Corpus Christi
Pensacola
Ogden
McAllen-Edinburgh
Reno
Greenville
Shreveport
Fort Wayne
Canton
Anchorage
Fort Meyers-Cape Coral
Montgomery
Savanah
Lowell
Utica-Rome
Lancaster

URBAN AREAS WHERE TRAFFIC VOLUME DATA IS COLLECTED ONLY BY MEANS OF SPECIAL STUDIES AT TWO LEVELS OF GOVERNMENT (1)

Akron

TABLE A.2 - URBAN AREAS BY TYPE OF TRAFFIC MONITORING PROGRAM (PERMANENT/SPECIAL STUDIES) (continued)

URBAN AREAS WHERE TRAFFIC VOLUME DATA IS COLLECTED ONLY BY MEANS OF SPECIAL STUDIES AT ONE LEVEL OF GOVERNMENT (4)

Honolulu
El Paso
Austin
Columbus, GA

URBAN AREAS NOT RESPONDING (14)

Los Angeles
Detroit
San Francisco-Oakland
San Jose
Riverside-San Bernadino
Sacramento
San Antonio
Indianapolis
Fresno
Oxnard-Ventura
Sarasota-Bradenton
Stockton
Lancaster-Palmdale
Daytona Beach

TABLE A.3 - TYPE OF TRAFFIC VOLUME MONITORING PROGRAMS IN URBAN AREAS WITH POPULATION GREATER THAN 500,000

Traffic Volume Programs				
Type of Program	Type of Agency within the Urban Area			
	State DOT	MPO	County	City
Permanent Program	33	12	25	21
Special Studies Only	0	6	5	17

TABLE A.4 - TYPE OF TRAFFIC VOLUME MONITORING PROGRAMS IN URBAN AREAS WITH POPULATION BETWEEN 200,000 AND 500,000

Traffic Volume Programs				
Type of Program	Type of Agency within the Urban Area			
	State DOT	MPO	County	City
Permanent Program	38	16	17	27
Special Studies Only	0	8	8	13

TABLE A.5 - TYPE OF TRAFFIC VOLUME MONITORING PROGRAMS IN URBAN AREAS IN ATTAINMENT FOR CO AND OZONE

Traffic Volume Programs				
Type of Program	Type of Agency within the Urban Area			
	State DOT	MPO	County	City
Permanent Program	30	7	14	20
Special Studies Only	0	5	8	12

TABLE A.6 - TYPE OF TRAFFIC VOLUME MONITORING PROGRAMS IN URBAN AREAS IN NONATTAINMENT FOR EITHER CO, OZONE OR BOTH

Traffic Volume Programs				
Type of Program	**Type of Agency within the Urban Area**			
	State DOT	**MPO**	**County**	**City**
Permanent Program	41	21	28	28
Special Studies Only	0	9	5	18

APPENDIX B - GLOSSARY

AADT (Annual Average Daily Traffic)

The estimate of typical daily traffic on a road segment for all days of the week, Sunday through Saturday, over the period of one year.

ADT (Average Daily Traffic)

The total traffic volume during a given time period (more than a day and less than a year) divided by the number of days in that time period.

ATR (Automatic Traffic Recorder)

A device that records the continuous passage of vehicles across a given section of roadway by hours of the day, days of the week or months of the year.

ATR Counts

Base traffic counts recorded at an automatic traffic recorder.

AVC (Automatic Vehicle Classifier)

A device that works in conjunction with computerized electronic equipment that counts and classifies vehicles by type and axle configuration.

Axle Correction Factor

The factor developed to adjust vehicle axle sensor base data for the incidence of vehicles with more than two axles, or the estimate of total axles based on automatic vehicle classification data divided by the total number of vehicles counted.

Base Count

A traffic count that has not been adjusted for axle factors (effects of trucks) or seasonal (day-of-week/month-of-the-year) effects.

Base Data

The unedited and unadjusted measurements of traffic volume, vehicle classification, and vehicle or axle weight.

Clean Air Act Amendments of 1990 (CAAA)

Legislation authorizing the Environmental Protection Agency (EPA) to establish and implement rules, which among other topics concerns mobile pollutant emission sources which affect air quality.

Congestion Mitigation/Air Quality Improvement Program (CMAQ)

A funding program for projects that contribute to the attainment of a National Ambient Air Quality Standard or are included in a State Implementation Plan pursuant to the Clean Air Act of 1990.

Congestion Management System (CMS)

A systematic process that provides information for decision makers on transportation system performance and alternative strategies to alleviate congestion and enhance the mobility of persons and goods.

Count

The data collected as a result of measuring and recording traffic characteristics such as vehicle volume, classification, speed, weight, or a combination of these characteristics.

Count Period

The beginning and ending date and time of traffic characteristic measurement.

Count Type

The traffic characteristic being measured, the measurement device, and time period.

Coverage Count

A traffic count taken as part of the requirement for system-level estimates of traffic. The count is typically short-term, and may be volume, classification, or Weigh-in-Motion.

DVMT (Daily Vehicle Miles Traveled)

Annual Average Daily Traffic on a road segment, expressed as AADT, multiplied by the length of the road segment.

Functional Classification

The grouping of streets and highways into classes, or systems, according to the character of service they are intended to provide. The recognition that individual roads do not serve travel independently and most travel involves movement through a network of roads is basic to functional classification.

GIS (Geographic Information System)

A method of storing, analyzing, and displaying spatial data.

HPMS (Highway Performance Monitoring System)

A federally mandated data reporting system for all roads except local.

Incident Management

A systematic approach to reduce non-recurring congestion by increased incident detection, response, and clearance; driver information systems; construction management; and traffic management.

Intelligent Transportation System (ITS)

A system that employs electronics, communications, and/or information processing to improve the efficiency of surface transportation operations and provide real-time information about travel options.

Intersection Counts

Traffic counts taken at an intersection, either manually or with counters, to study the flow of vehicles through the intersection. Generally, straight movements are recorded with counters, and turning movements are either taken manually or in combination with counters.

Loop Detector

A detector that senses changes in inductance, of its inductive loop sensor, caused by the passage or presence of a vehicle near the sensor.

Manual Counts

Measurement of traffic characteristics based on human observation, which may or may not be electronically recorded.

Mechanical Counts

Measurement of traffic characteristics by sensors and electronic recording of the measurements, independent of human observations.

MPO (Metropolitan Planning Organization)

Regional agency responsible for urbanized area transportation planning.

NHS (National Highway System)

A designated system of highways of National Significance mandated under the Intermodal Surface Transportation Efficiency Act of 1991. The purpose of the NHS is to provide an interconnected system of principal arterial routes to serve major population centers, airports and public transportation facilities, to meet national defense requirements and to serve interstate and interregional travel.

Peak Period

The highest period of traffic flow during the a.m. and p.m. time period.

Permanent Count Stations

ATRs that are permanently placed at specific locations throughout the region to record the distribution and variation of traffic flow by hours of the day, days of the week, and months of the year from year to year.

Project-Related Count

A traffic count taken to support a roadway or bridge project.

Seasonal Factors

Parameters used to adjust base counts which consider travel behavior fluctuations by day of the week and month of the year.

Special Count

A traffic count taken to respond to a request for traffic information, not included as part of the coverage or project-related count plan.

Special Purpose Count

A traffic count taken for the specific purpose of better understanding traffic flow characteristics at predetermined sections of roadway. These may include studying the effects of traffic accidents, roadway closures or traffic re-routing.

SHRP (Strategic Highway Research Program)

A five year program for pavement and operations research funded by Congress and managed through the National Academy of Sciences. One of the four research areas, long-term Pavement Performance, is planned as a 20-year program.

TMA (Transportation Management Area)

An urbanized area with a population greater than 200,000. These were designated as

a result of ISTEA.

TMC (Traffic Management Center)

Also known as Traffic Operations Center, it serves as the nerve center for a traffic management system. Data on traffic conditions collected in real time by any of a variety of means is transmitted to the TMC where traffic engineers, assisted by computer, monitor traffic flow and respond to congestion in a variety of ways, such as adjustments to traffic signal timing, transmitting information on current conditions to motorists via changeable message signs, etc.

Traffic Monitoring Guide (TMG)

Document that provides FHWA's recommended approach to the monitoring of traffic characteristics. The guide provides direction for persons interested in conducting a statistically based monitoring of traffic counting, vehicle classification, and truck weighing.

Traffic Monitoring System for Highways (TMS/H)

A systematic process for the collection, analysis, summary, and retention of highway related person and vehicular traffic data, on public highways and streets.

Traffic Program

The collection, editing, summarization, reporting and analysis of traffic volume, classification and weight data.

Vehicle Classification

The measurement, summarization and reporting of traffic volume by vehicle type and axle configuration.

VMT (Vehicle Miles Traveled)

Average Sunday through Saturday vehicle movement on a specific road segment multiplied by the length of the road segment, reported in the form of daily and annual VMT.

WIM (Weigh-in-Motion)

The process of estimating a moving vehicle's static gross weight and the portion of that weight that is carried by each wheel, axle, or axle group or combination thereof, by measurement and analysis of dynamic forces applied by its tires to a measuring device.

APPENDIX C - BIBLIOGRAPHY

AASHTO Guidelines for Traffic Data Programs, American Association of State Highway and Transportation Officials, Washington, DC, 1992.

Abernethy, Bruce and James Gunn, “A Different Perspective on National Architecture”, *Traffic Technology International*, February/March 1996, pp. 34-40.

.

Analytical Procedures to Support a Congestion Management System, prepared for US Federal Highway Administration, Cambridge Systematics, Inc., Cambridge, April 1995.

Arnold, E.D., *Congestion on Virginia*s Urban Highways,* Report VTRC 88-R24, Virginia Transportation Research Council, University of Virginia, Charlottesville, April 1988.

ATSAC Evaluation Study, Department of Transportation, City of Los Angeles, Los Angeles, June 1994.

Black, John R., “The Richardson Count System”, *ITS Online*.

Black, John R., “The Richardson Traffic Signal System”, *ITS Online,* January 1995.

Booz-Allen & Hamilton Inc., *Institutional Impediments to Metro Traffic Management Coordination,* prepared for Volpe National Transportation Systems Center, Cambridge, September 13,1993.

Chachich, Alan C., “Highway-based Vehicle Sensors”, *Technologies for Intelligent Vehicle Highways, Technology Tutorial Series Volume 2,* The International Society of Optical Engineering, Boston, November 1994.

COG - Congestion Monitoring, South Central Regional Council of Governments, New Haven, February 1996.

Conceptual Design Study For the Las Vegas Area Computer Traffic System (LVACTS) Upgrade Alternatives, prepared for Las Vegas Area Computer Traffic System, Barton-Aschman Associates, Inc., January 1993.

Congestion Management Case Studies, Metropolitan Planning Technical Report No. 8, Federal Highway Administration, September 1995.

The Congestion Management Program, It Actually Works , August 1994.

Congestion Management Program Resource Handbook, November 1990.

Congestion Management Subsystem Work Plan for the CARTS Area, METROPLAN, A Council of Local Governments, October 1994.

Congestion Management System Analysis - Phase II Report, Southwestern Pennsylvania Regional Planning Commission, Pittsburgh, March 1996.

Congestion Management System for Hampton Roads, Virginia, Hampton Roads Planning District Commission, Chesapeake, October 1995.

Congestion Management System for the Twin Cities Metropolitan Area, Metropolitan Council of the Twin Cities, November 1995.

Congestion Management System Work Plan, prepared by Kentuckiana Regional Planning and Development Agency, Louisville, September 1994.

Congestion Management System Work Plan, prepared by Knoxville Urban Area Metropolitan Planning Organization, Knoxville, September 1994.

Congestion Management System Work Plan, Draft, prepared by Richmond Regional Planning District Commission, Richmond, March 2, 1995.

Congestion Management System Work Plan for the Central Puget Sound Region, Technical Paper MTP-13, Prepared by Regional Project Evaluation Committee, Puget Sound Regional Council, September 1994.

Congestion Management System Work Plan for the Kansas City Metropolitan Area, prepared by Mid-America Regional Council, Kansas City.

Congestion Management System Work Plan for the Washington Region, prepared by National Capital Region Transportation Planning Board, Washington, DC, September 1994.

Congestion Management System 1995 Progress Report, prepared by Central Massachusetts Regional Planning Commission, Worcester, October 1995.

Design of Congestion Management Systems, Phase I, Final Report, prepared for the Colorado Department of Transportation, Denver Regional Council of Governments, and Pikes Peak Area Council of Governments, JHK & Associates, November 1993.

Design of Congestion Management Systems, Phase II-A, Final Report, CMS Design and Implementation Decisions, prepared for the Colorado Department of Transportation, Denver Regional Council of Governments, and Pikes Peak Area Council of Governments, JHK & Associates and URS Consultants, November 1994.

Design of Congestion Management Systems, Phase II-A, Performance Monitoring Plan, prepared for the Colorado Department of Transportation, Denver Regional Council of Governments, and Pikes Peak Area Council of Governments, JHK & Associates and URS Consultants, November 30, 1994.

Evaluation of Traffic and Highway Data Collection Survey, Off-System Public Roads Eligible for Federal-Aid Funding, Volume 1, prepared for Florida Department of Transportation, Transportation Statistics Office, Parsons Brinckerhoff, February 1995.

Feasibility Study of an Interface Between Traffic Signal Control Systems and Freeway Management System for the Columbus Area, Mid-Ohio Regional Planning Commission, Columbus, April 28, 1995.

*Florida*s Mobility Management Process/Congestion Management System,* Florida Department of Transportation, December 1994.

F.Y. 1995 Congestion Management System Annual Report for the Washington Region, Metropolitan Washington Council of Governments and National Capital Region Transportation Planning Board, Washington, DC, September 20, 1995.

Harvey, Greg and Elizabeth Deakin, *A Manual of Regional Transportation Modeling Practice for Air Quality Analysis,* Prepared for the National Association of Regional Councils, Deakin Harvey Skabardonis, July 1993.

Highway Traffic Trends in the Delaware Valley Region, 1960-1985-1990, Delaware Valley Regional Planning Commission, Philadelphia, January 1992.

"Inside San Antonio TransGuide", *ITS Online.*

Intelligent Transportation Systems (ITS) Projects, US Department of Transportation, Washington, DC, January 1996.

Jackson, David W. and Allan J. DeBlasio, *ITS Institutional and Legal Issues Program - Review of the Houston Smart Corridor Operational Test,* Report No. DOT-VNTSC-FHWA-95-4, US Department of Transportation, Volpe National Transportation Systems Center, Cambridge, June 1995.

""Lessons-Learned" In Atlanta's New Advanced Transportation Management Center", *ITS Online*, February 1996.

Lexington - Fayette County Average Daily Traffic Count Directory, Lexington - Fayette Urban County Government, Department of Housing and Community Development, Division of Planning - Transportation Planning Section, Lexington, Spring 1994.

The Louisiana Congestion Management System (CMS) Workplan, December 1994.

Northern Middlesex Congestion Management System, The Northern Middlesex Council of Governments, Lowell, December 1995.

Maricopa Association of Governments Congestion Management System, Phoenix, April 4, 1995.

Mobility Management Program, Manual of Practice, Ohio-Kentucky-Indiana Regional Council of Governments, Cincinnati, October 1995.

Neppalli, Kumar A., and Louis A. Chalmers, Jr., *Traffic Operations Report,* City of Fayetteville, Traffic Services Division, Fayetteville, April 1995.

Nuworsoo, Cornelius, *Congestion Management System Work Plan for the Baltimore Region,* Baltimore Metropolitan Council, Baltimore, September 1994.

PAG 1992 Mobility Management Plan - Summary Report, prepared for Pima Association of Governments, JHK & Associates, December 1993.

Patel, Raman, "Moving Toward Corridor Coordination", *Traffic Technology International*, February/March 1996, pp. 18-26.

Poorman, John, *Capital District Transportation Committee (NY) Experience with Local Performance Measures,* prepared for the NTS Performance Conference, Washington, D. C., November 1-2, 1995.

Portland Interim CMS, undated draft.

Portland Regionwide Advanced Traffic Management System Study- Advanced Traffic Management Systems (ATMS) Plan, DKS Associates, October 1993.

Preliminary Feasibility Study For the Las Vegas Area Computer Traffic System (LVACTS) Upgrade Alternatives, prepared for Las Vegas Area Computer Traffic System, Barton-Aschman Associates, Inc.

Purvis, Paul, "Freeway Incident Response from a City Perspective", *ITS Online*.

Regional Congestion Management System Work Plan, New York Metropolitan

Transportation Council, New York, December 1994.

Regional Traffic Counts from 1969 to 1994, The Northern Middlesex Council of Governments, Lowell.

RPM & Associates, *Congestion Management System for the Nashville Area MPO,* prepared for the Nashville Area Metropolitan Planning Organization, Brentwood, TN, April 1995.

Schrank, David L., et.al., *Trends in Urban Roadway Congestion - 1982 to 1991 Volume 1: Annual Report,* Report FHWA/TX-94/1131-6, Texas Transportation Institute, The Texas A&M University System, College Station, September 1994.

Schrank, David L., et.al., *Trends in Urban Roadway Congestion - 1982 to 1991 Volume 2: Methodology and Urbanized Area Data,* Report FHWA/TX-94/1131-6, Texas Transportation Institute, The Texas A&M University System, College Station, September 1994.

Smith, Steven A., *INFORM EVALUATION, Volume I: Technical Report,* Report FHWA-RD-91-075, Office of Safety and Traffic Operations R&D, Federal Highway Administration, McLean, January 1992.

State of Hawaii Congestion Management System (CMS), Austin, Tsutsumi & Associates, Inc., Honolulu, October 1994.

State of Oregon, Traffic Congestion Management System, CMS Perspective, Oregon Department of Transportation, Traffic Section, Salem, Oregon, June 1995.

Status and Effectiveness of Urban Traffic Engineering Agencies, Institute of Transportation Engineers, Washington, DC, 1995.

St. Louis Region Congestion Management System Work Plan, Draft, East-West Gateway Coordinating Council, St. Louis, September 29,1994.

System Planning Requirements for a Congestion Management System, Task 4 Interim Report, JHK & Associates, Albuquerque, March 1995.

Traffic Characteristics of Kentucky Highways -1994, Kentucky Transportation Cabinet, Department of Highways, Division of Transportation Planning, Frankfort.

Traffic Count Summaries, Average Weekday & Peak-Hour Volumes for METRO Cutline Locations, 1986-1988-1990-1992-1994, Metropolitan Service District (METRO), Portland, October 1995.

Traffic Management, Lexington, KY, October 3, 1995

Traffic Counting Program, Toledo Metropolitan Area Council of Governments, Toledo, August 1990.

Traffic Growth - Omaha Council Bluffs Metro Area - 1980-1994, Metropolitan Area Planning Agency, Omaha 1995.

Traffic Impacts of I-476, Delaware Valley Regional Planning Commission, Philadelphia, December 1993.

Traffic Monitoring Guide, Federal Highway Administration, Office of Highway Information Management, Washington, DC, February 1995.

Traffic Monitoring System for Highways - State of Kansas, Kansas Department of Transportation, October 1994.

Traffic Monitoring System for Highways - TMS/H - Work Plan, Nevada Department of Transportation, Carson City 1995.

Traffic Monitoring Program for Selected Highway Corridors - Phase III, Delaware Valley Regional Planning Commission, Philadelphia, December 1993.

Traffic Monitoring System - Highway Component, Implementation Plan, New Jersey Department of Transportation, Trenton, 9/30/94.

Traffic Summary 1995, Bureau of Traffic, Delaware Department of Transportation, Dover, 1996.

Traffic Volume Report 1993, Traffic Engineering Division, Department of Transportation, City of Madison, Madison.

Traffic Volumes on Limited-Access Highways Radiating From Downtown Boston, Central Transportation Planning Staff, February 1995.

Transportation Improvement Program for the Northern Middlesex Region, Fiscal Years 1996-1998, The Northern Middlesex Council of Governments, Lowell, August 1996.

Transportation Management Through the Application of Intelligent Transportation Systems (ITS) in Montgomery County, Maryland.

Transportation System Monitoring Activities, Metropolitan Service District (METRO), Portland, January 1993.

Travel Trends in the Philadelphia Central Business District, 1960-1985-1990, Delaware Valley Regional Planning Commission, Philadelphia, October 1991.

Unified Transportation Planning Work Plan, The Northern Middlesex Council of Governments, Lowell, July 1995.

Vonderohe, A.P., et.al., "Adaptation of Geographic Information Systems for Transportation", *NCHRP Report 359*, Transportation Research Board, Washington, DC, 1993.

Wisconsin Automatic Traffic Recorder Data, Division of Planning, Wisconsin Department of Transportation, Madison, July 1995.

Wisconsin Highway Traffic Volume Data, Division of Planning, Wisconsin Department of Transportation, Madison, July 1995.

Wisconsin Vehicle Classification Data, Division of Planning, Wisconsin Department of Transportation, Madison, July 1995.

Work Plan, Congestion Management System (CMS), prepared for the Delaware Department of Transportation, Parsons Brinckerhoff and Cambridge Systematics, Inc., January 1, 1995.

Work Plan, Congestion Management System for Kansas, Three Subsystems, Mid-America Regional Council, Wichita Sedgwick County Metropolitan Area Planning Department, and Kansas Department of Transportation, August 23, 1994.

Work Plan for the Development of a Congestion Management System for the State of Georgia, undated.

1991 - Ventura County Congestion Management Program.

1993 - Indianapolis Travel Time Study, Prepared by City of Indianapolis, Department of Metropolitan Development, Division of Planning, March 1994.

1993 - Ventura County Congestion Management Program.

1993 Travel Survey of Students at the Albuquerque Technical-Vocational Institute, MRGCOG, Albuquerque, January 3,1994.

1993 Traffic Monitoring Statistics - Supplement to the Traffic Flow Map for the Albuquerque Metropolitan Planning Area, MRGCOG, Albuquerque, September 19,1994.

1994 24 Hour Quarterly Traffic Count Report, Yuma Metropolitan Planning Organization.