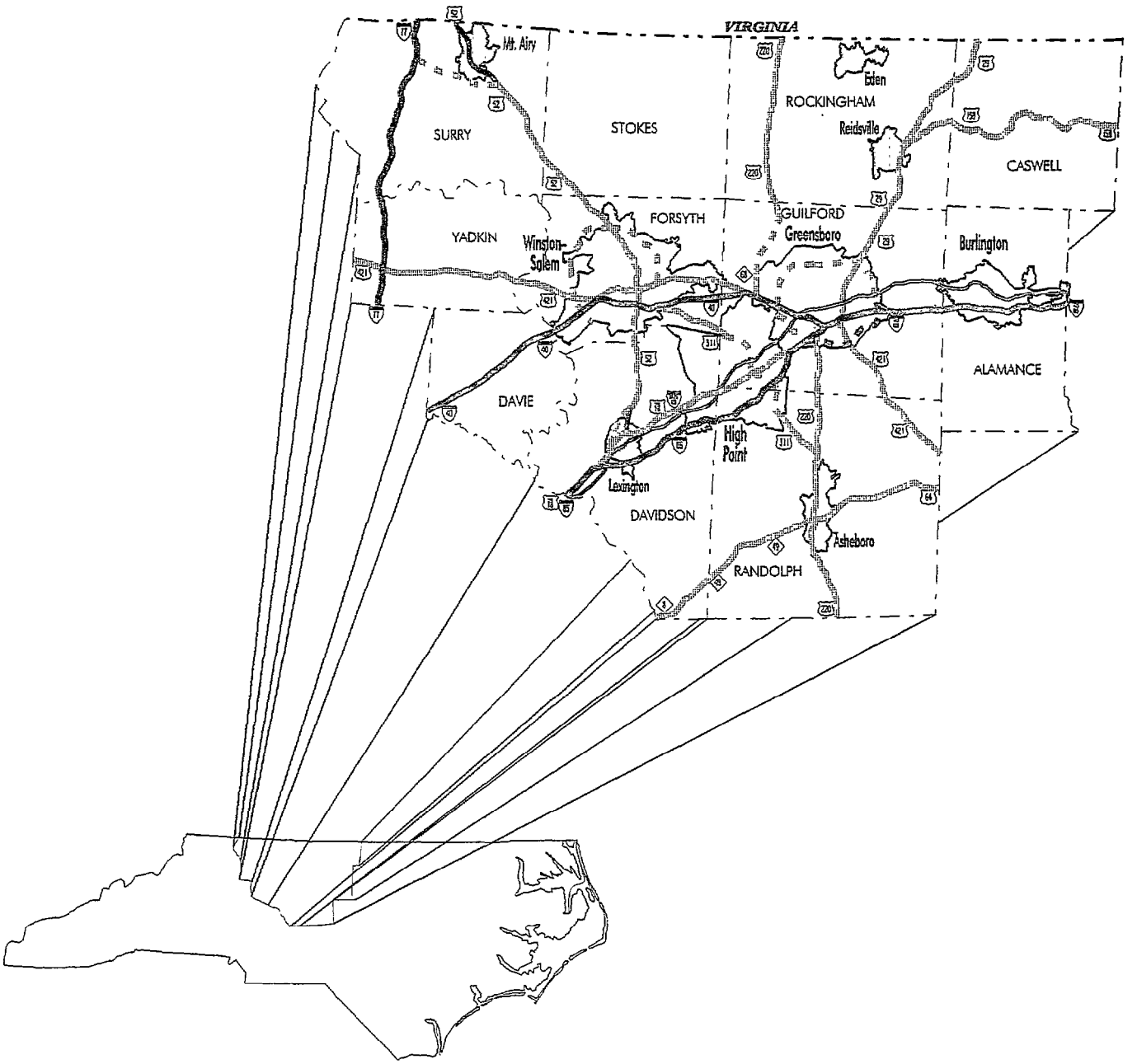
Advanced Transportation System Improvements for North Carolina's Piedmont Triad



August 1994

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

DOT/FHWA

ADVANCED TRANSPORTATION SYSTEM IMPROVEMENTS FOR NORTH CAROLINA'S PIEDMONT TRIAD:

AN IVHS AREA-WIDE/CORRIDOR PLAN

Submitted to the

Federal Highway Administration
U.S. Department of Transportation

Prepared by the

Division of Highways
North Carolina Department of Transportation

In cooperation with the

Burlington MPO
Greensboro MPO
High Point MPO
Winston-Salem MPO
and the
Public Transportation and Rail Division
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Executive Summary

Residents, transportation professionals, and decision-makers throughout the Piedmont Triad generally agree that the prosperity of the region depends on having an adequate transportation system. The ability to move people and goods quickly, efficiently, and safely affects both this region's economy and the quality of life. The purpose of this report is to describe the implementation of Advanced Transportation Systems (ATS) Technologies for the eleven Piedmont Triad Counties. Particular emphasis is being placed on the Interstate 40/ Interstate 85 corridor.

Advanced technologies including so-called "smart highway" or IVHS technologies will be utilized in order to help solve the traffic problems in the Triad. IVHS, which stands for "Intelligent Vehicle-Highway Systems" actually is a misnomer because transit systems are also included. Hence, ATS (Advanced Transportation Systems) is the title that has been adopted to describe such transportation improvements in the Triad. ATS (or IVHS) means using advanced technology to improve traffic flow on highways without necessarily adding more lanes or roads. In addition, ATS means using advanced technology to provide safer, more efficient transit service.

This report discusses transportation issues in the Piedmont Triad, including travel demand management, a potential ATS corridor (I-40/I-85), current ATS/IVHS projects in the Triad, and possible ATS projects for the future.

Specific high priority ATS initiatives for future deployment include:

- Quick detection of accidents and other incidents and quick, appropriate response
- Better coordination among transportation agencies, traffic enforcement agencies, and emergency responders
- Real-time freeway traffic monitoring
- Better communications with the public on traffic conditions
- Marketing and system enhancements to increase transit system usage
- Surveillance and incident detection on key arterial routes

There are many benefits of implementing Advanced Transportation Systems. Quantifiable benefits include reduced delay caused by recurrent and non-recurrent-induced congestion. Other benefits attributable to ATS include reduction in energy consumption, accidents, and emissions. In addition, lost time that for some travelers is unproductive time will be reclaimed by a reduction in congestion.

It is clearly shown in this report that ADVANCED TRANSPORTATION SYSTEM IMPROVEMENTS should be an increasingly important component of future state and local programs in order to increase mobility and improve safety on Piedmont Triad transportation systems.

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1 .0 **Introduction**

Travelers, transportation professionals, and decision-makers throughout the United States generally agree that the national transportation system is facing a crisis. Recognition of this crisis led to the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. The purpose of ISTEA is; "...to develop a National Intermodal Transportation System that is economically efficient and environmentally sound, provides the foundation for the nation to compete in the global economy, and moves people and goods in an efficient manner." In order to help obtain the goals of ISTEA, the North Carolina Department of Transportation and the communities of the Piedmont Triad are committed to using the best technology available to build Advanced Transportation Systems,

2.0 **Purposes of the Report**

The Piedmont Triad is no exception to the nationwide transportation crisis. The prosperity of this region depends on having an adequate transportation system. The ability to move people and goods quickly, efficiently, and safely affects both this regions economy and the quality of life. The purposes of this report are as follows:

- To define transportation problems facing the Triad;
- To define current transportation systems and development strategies in the Triad;
- To describe how Advanced Transportation Systems complementing other transportation construction programs and identify a vision for future deployment.

Particular emphasis is being placed on the Interstate 40-85 corridor. A map representing the communities and major transportation facilities of the Triad is shown in Figure 1.

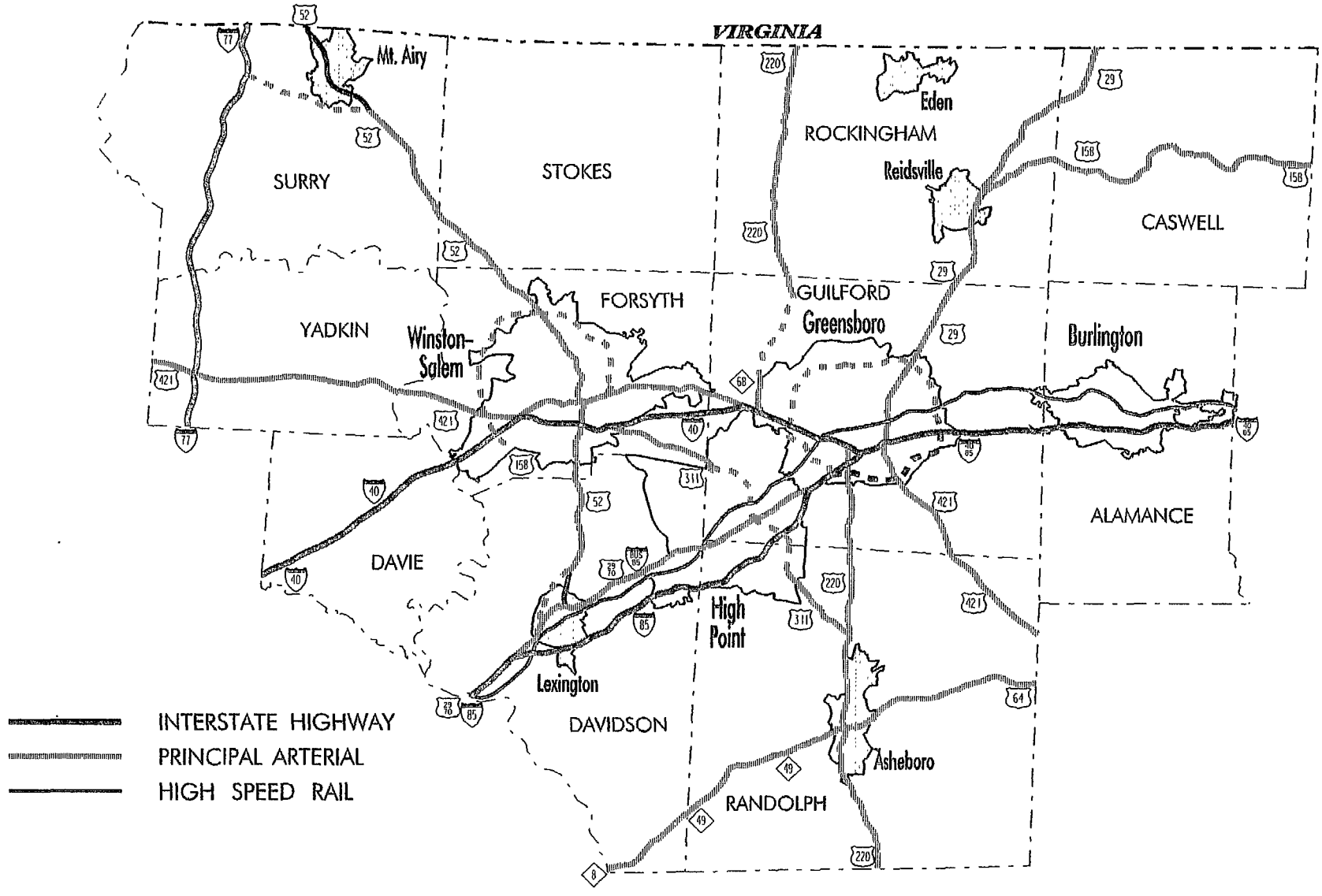


FIGURE 1. PIEDMONT TRIAD REGION

3.0 Transportation Issues in the Piedmont Triad

Advanced technologies including so-called “smart highway” or IVHS technologies will be utilized in order to help solve the problems in the Triad. IVHS, which stands for “Intelligent Vehicle-Highway Systems“ actually is a misnomer because it includes transit systems as well. This report uses the term “Advanced Transportation Systems’ to include both highway and transit technologies.

Congestion on interstate 85 and Interstate 40 from the Orange County-Alamance County line through Guilford and Forsyth Counties is perhaps the major current problem area. A second problem area is inadequate alternate routing in case of incidents. When there is an incident, it is not unusual for most alternate routes to exceed their capacity. Studies have shown that traffic on alternate routes would generate disproportionately higher user costs than interstate traffic user costs, even under congested conditions.

A third problem area is the congestion in the Greensboro Coliseum area. The Greensboro Coliseum has recently been expanded to seat greater than 30,000 total in all venues. Traffic before and after an event at the Greensboro Coliseum was already a problem before the new addition. Larger events create more of a traffic problem.

Another typical traffic problem in the Triad is inadequate travel information for motorists and the general public. No means currently exists to provide “real-time”, up-to-the-minute traffic information. Although studies are underway to address a regional public transportation system, the existing service provided serves only a small-percentage of daily commuter trips.

4.0 Travel Demand Management In The Piedmont Triad

Travel demand management for the cities of Greensboro, High Point, and Winston-Salem consists primarily of public transportation services. These include transit, vanpools, carpools, park-and-ride, and other modes of transportation which offer environmental and economical benefits to the community. These public transportation methods promote conservation of energy, reduce air pollution, decrease peak-hour traffic congestion, and reduce parking demand. All transit services are capable of being upgraded through the use of advanced technologies.

Greensboro has a bus transit system, and a paratransit system. The Greensboro Transit Authority (GTA) currently operates 22 transit buses on 14 fixed routes. It is a radial system, with downtown Greensboro as the transfer

center. There are 14 paratransit vehicles provided by GTA's Specialized Community Area Transportation (SCATS), designed for those unable to use the fixed route system. Twelve of these vehicles are wheel chair accessible.

Greensboro and High Point Jointly sponsor a "Municipool" ridesharing program which is handled through the Greensboro Department of Transportation. There are currently 20 active vanpools which serve Guilford county and 8 surrounding counties. These vans have a capacity of 7, 8, or 15 passengers. However, only one is wheel chair accessible. Municipool also provides carpool matching, and arranges for park-and-ride locations.

High Point also provides a transit and paratransit system. The High Point Transit System (Hi Tran) operates 16 buses on 13 fixed routes. This system mostly serves the City of High Point. The Hi Tran System also operates a Dial-A-Lift paratransit service for the elderly (60 years or older) and disabled. Certification is required in order to obtain access to this community service. Trips must by scheduled at least 24 hours in advance and pick-up times are within 15 minutes of the scheduled time.

Winston-Salem provides a bus transit system, ridesharing, and paratransit. The Winston-Salem Transit Authority (WSTA) presently operates 41 peak-hour transit buses on 21 fixed routes. There is one express route, and 4 downtown shuttle services. The ridesharing program is available in Forsyth County and the Surrounding counties. This program provides carpool matching services, and vanpool leasing for residents and employees. The WSTA maintains a fleet of 40 ridesharing vehicles. Trans-Aid is the paratransit system that is also operated by the WSTA. It provides specialized transportation for pre-school children, the elderly, disabled, and the economically disadvantaged residents. WSTA also operates Transportation of the Elderly (TOTE) which is a service **funded by** Trans-Aid. It provides a fixed route service for elderly neighborhoods and housing complexes at no charge.

Other travel demand management or improved efficiency strategies are in the planning stage, or under development, by several Piedmont Triad Communities:

- Flex-time, or Alternate Work Schedules
- Parking Management
- Regional Rail Service
- Traffic Signal Improvements, including:
  - Closed Loop Systems
  - Updated Timing Plans
  - Updated Equipment
- "Super Street" Arterials
- Intermodal Transfer Terminals
- Telecommuting

Continued study and implementation of these transportation improvement strategies will compliment the deployment of Advanced Transportation Systems in the Triad.

5.0 Advanced Transportation Systems

Major arterial highways in the Triad are becoming more and more congested every year. Congestion takes a toll in lost productivity, costing the nation $100 billion each year. Traffic accidents, many caused by congestion, costs another $70 billion a year. Sixty percent of urban congestion is caused by accidents and other "non-recurring" incidents. Safety is a major concern. 41,000 people died and another 5 million sustained injuries nationwide in 1991. Loss of life or consequences of long term injury have large economic impact. Other costs include inefficient movement of vehicles. Productivity is reduced, energy is wasted, and emissions are increased when vehicles move inefficiently. Trucks, buses, and autos idled in traffic waste billions of gallons of fuel every day. These national issues are also true for the Piedmont Triad. One conventional approach to this problem is to build more roads and add lanes to existing facilities. However, this will not work in many areas for both financial and environmental reasons.

Advanced Transportation System (ATS) make use of advanced technologies designed to help solve some of our transportation problems. ATS uses advanced technology to improve traffic flow on highways without necessarily adding more lanes. ATS attempts to optimize resources and use existing capacity more efficiently. "Capacity" includes both highway capacity and additional capacity of the public transportation and rail system.

The goals of ATS in the United States and North Carolina are:

- Improved safety
- Reduced congestion
- Increased level of service and improved mobility
- Reduced environmental consequences of transport
- Improved energy efficiency
- Improved economic productivity
- A viable industrial base

Obtaining these goals will save lives, time, and money. Advanced Technologies can be an important part of the solution to our surface transportation problems. The benefits of ATS will be experienced by all segments of the population. The beneficiaries and benefits of ATS are listed in Table 1.

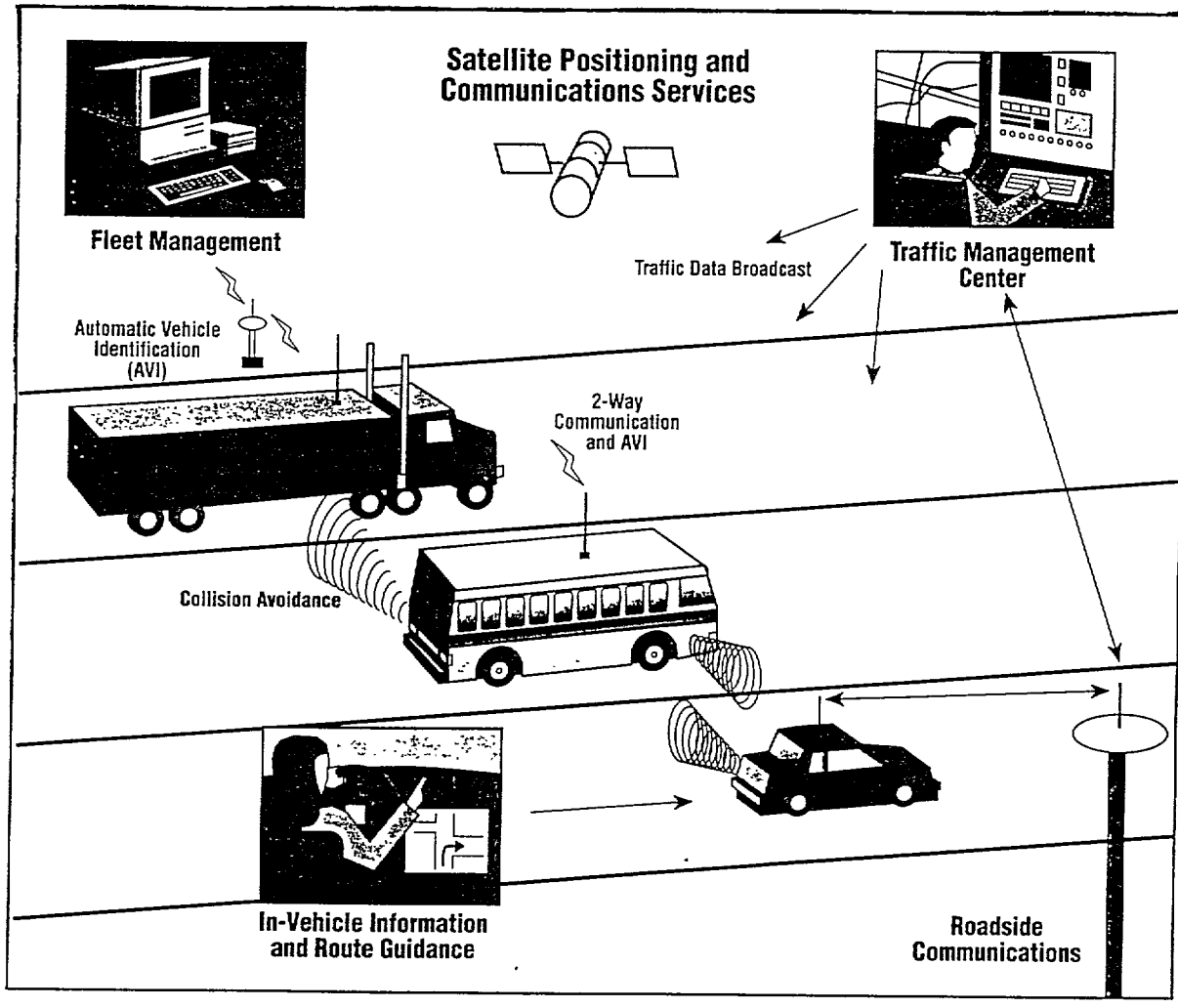
Beneficiaries	
Society as a whole	Commuters Shoppers **Public Transportation** Users **Tourists** Air Quality Fewer road widenings and less new construction
Sector Operators	Trucking companies Bus companies Taxis Small package delivery Emergency services
Industry	**Automotive** manufacturers Electronic manufacturers Traffic system suppliers Researchers
Public Sector Operators	State DOT's Traffic departments Transit agencies

Benefits	
Travel	Decreased travel time Increased safety **Increased comfort and convenience** Increased security Decreased cost
Economic	Increased productivity and reliability Improved international competitiveness Product innovation On-time delivery
Environmental	Decreased air pollution Decreased noise pollution Increased fuel savings
Information	Increased trip efficiency More **uniform and** effective traffic enforcement Improved trip planning Improved emergency response

Benefits & Beneficiaries of ATS
Table 1

Elements of ATS include: private, commercial, transit, public service, and emergency vehicles, traffic monitoring and control devices; communication systems; transportation system controllers and operators; collision avoidance systems; traveler information systems. While these ATS concepts, and others, will be introduced gradually over the long term, they will have dramatic and enormously beneficial implications for our nation's and state's surface transportation system and the safety of the traveling public. Figure 2 is an illustration of some of the basic ATS concepts, showing a long-range concept for nationwide ATS deployment.

Elements of ATS



Source: IVHS-America
Figure 2

ATS will require increased levels of cooperation and coordination between the private and public sector. Federal, state and local governments are involved in promoting, organizing, and implementing ATS technologies. Other involved entities includes the private sector; organizations representing scientists, engineers, and users of surface transportation systems; and the academic community. Each of these communities of interest has its own expertise to offer and role to play in the development, implementation, and use of ATS technologies. Figure 3 illustrates the importance of public-private partnerships to the development and deployment of ATS in an effective manner.

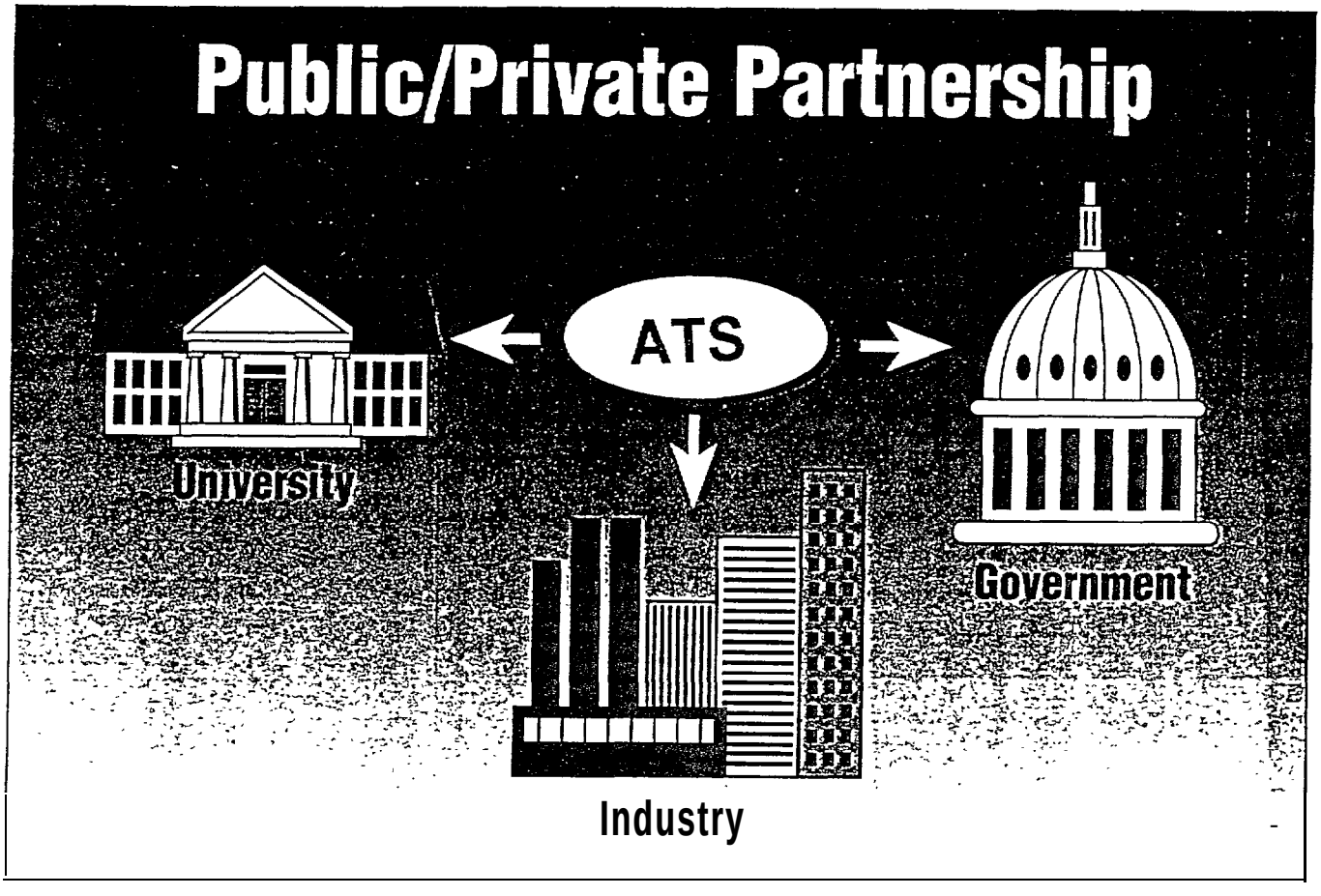


Figure 3

6.0 A Potential ATS Corridor In The Triad: I-40/I-85

Interstate routes 40 and 85 form the backbone of the transportation system through North Carolina's Piedmont Triad. In addition, within a few miles of this freeway, the state-owned railroad provides right-of-way for a planned high speed rail line from Raleigh, through Burlington, Greensboro and High Point, to Charlotte.

Within five miles of I-40 and west of Greensboro is the Piedmont Triad International Airport. An intermodal freight transfer point connecting to North Carolina's ports at Morehead City and Wilmington is located in the I-40 corridor. A number of trucking terminals are located within a few miles of these two inter-state routes. Plans are underway for rail/transit/highway transfer stations in several locations throughout the Triad, providing a true intermodal transportation corridor.

Appendix A graphically describes the current (1993) and projected (2005) traffic volumes for the I-40/I-85 corridor. Congestion is expected to worsen for the forseeable future. Figure 4 shows a concept for Statewide major arterial surveillance and incident management for long-range consideration by the NCDOT and communities throughout the state.

The I-40/I-85 segments through the Triad region present another high volume, high congestion, high growth corridor that is being addressed by the NCDOT. Studies and plans are being jointly developed through Federal-State-Local government partnerships with private industry and university participation, as appropriate.

Advanced Transportation Systems (ATS) improvements provide the latest technology and traffic management tools to help increase the safety and efficiency of this corridor. Those elements of ATS that are currently being implemented in Piedmont Triad communities are described in Section 9.0 of this report. Those elements include current efforts to upgrade the downtown coordinated signal systems in High Point, Greensboro and Winston-Salem.

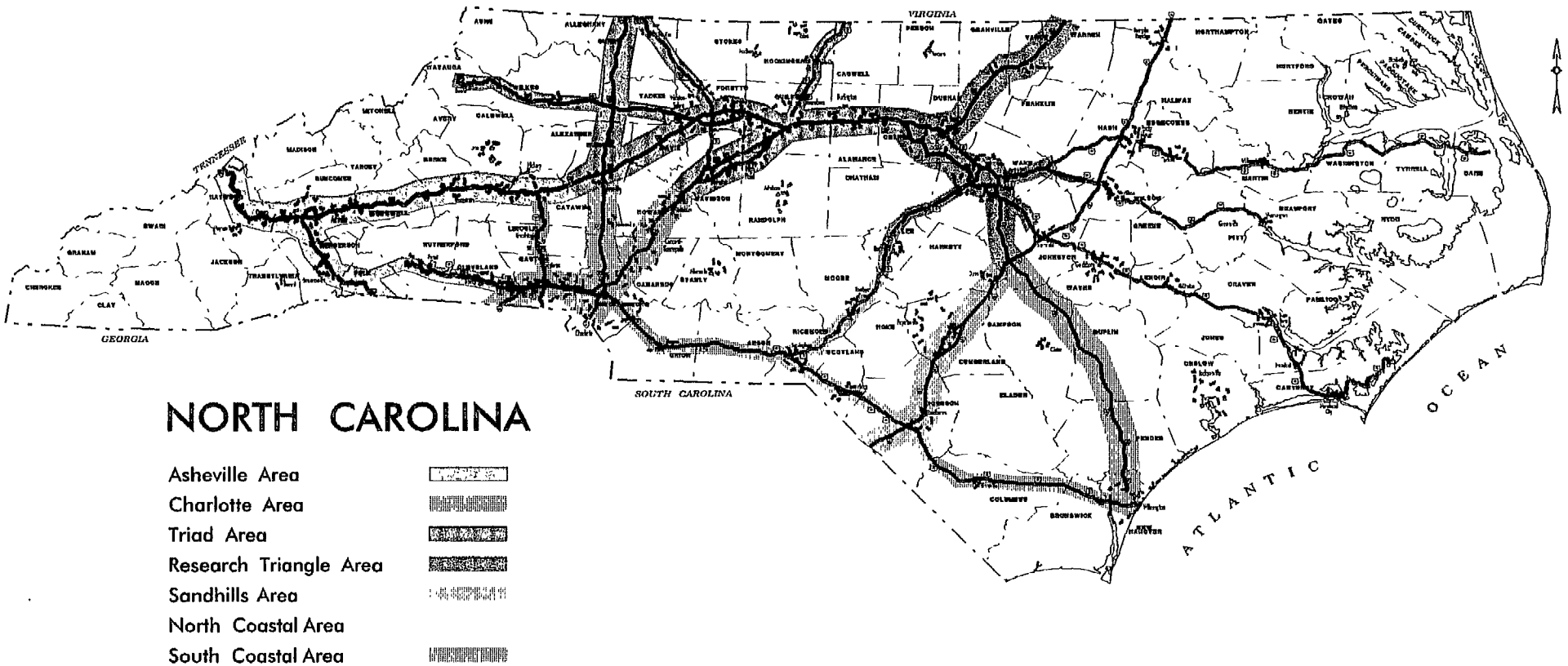
A number of freeway and surface arterial system improvements that utilize advanced technologies offer a number of advantages for Triad highways. These routes are identified in section 8.0. ATS program elements and technologies that are recommended for further deployment in the Triad include:

Travel and Traffic Management

- **Traffic Operations Center:** All electronic components are interconnected at the TOC via a fiber optic communications system, data is processed and transmitted to the traveling public. Enforcement and emergency crews are also dispatched from the TOC. The first local TOC for the Triad (other than downtown signal systems) is currently being planned in the Greensboro Coliseum to manage traffic on the High Point Road reversible lanes.

FIGURE 4

NCDOT Concept for Statewide Major Arterial Surveillance/Incident Management



- **Detectors:** Sensors can be placed in the pavement or overhead to provide real-time traffic flow information to a traffic operations center

- **Closed Circuit** TV: Provides a means to visually confirm highway incidents and accidents and monitor highway traffic

- **Variable Message Signs:** Various technologies, such as light-emitting, fiber optic, overhead signs give advance warning to motorists concerning roadway conditions, accidents, alternate routes

- **Roadway Lighting:** High pressure 400 watt sodium lights on 45 ft. standards, or 100 watt lights on 100 ft. high mast towers provide increased traveler safety and security and better night-time surveillance

- **Travel Advisory Information:** The public is informed by TV, cable, radio, or "kiosks" (information centers located at hotels, malls, employment centers, the airport, etc.) about travel or weather conditions; also real-time congestion information is transmitted from the TOC

- **Reversible Lanes:** More efficient use of current capacity is made by using overhead signals to direct traffic, especially in peak hours or for high-use events such as at coliseums and stadiums

- **Coordinated Signal System:** Winston-Salem, Greensboro, and High Point are all at different stages of applying advanced technologies to upgrade their downtown signal systems; the three cities can ultimately upgrade to over 500, 560, and 150 intersections, respectively, that will eventually be covered by the upgrade; normal and incident management conditions will have different control regimes

Public Transportation Management

- **Smart Traveler:** Users of the public transit system, including van-pool and human service paratransit vehicles are provided accurate information to make choices about their trip

- **Two-Way Communications:** Operators of transit vehicles act as vehicle "probes" to provide traffic congestion information to the TOC, and also receive dispatching instructions

- **Automatic Train Control:** A NCDOT proposed system that uses global Positioning Satellite (GPS) or alternate technology to provide integrated, communications-based, at-grade rail crossing protection

Emergency Management

Incident Management: State Highway Patrol, local police, fire, and emergency management personnel work with NCDOT to provide traffic control and other assistance at freeway incident sites. Motorist Assistance Patrols (MAP) identify traffic hazards and provide assistance to motorists with disabled vehicles. MAP operations are coordinated from the TOC.

7.0 Current ATS/IVHS Projects in the Triad

The following projects are being jointly developed by Piedmont Triad Communities and the NCDOT, often with Federal Aid funding. However, many projects have been undertaken through local initiatives.

7.1 Greensboro Coliseum Area Improvements

The recent expansion of the Greensboro Coliseum Complex has been a tremendous challenge for traffic managers to move Coliseum patrons as well as other motorists during Coliseum events. The Coliseum can now seat up to 30,400. Expansion of the coliseum has placed additional demands on a transportation system that is already nearing capacity. The Greensboro Department of Transportation is developing a traffic management system that integrates traditional traffic management techniques with new traffic management technologies (see Figure 5). The following improvements are being integrated into a traffic management system that will improve mobility to, from, and around the Coliseum Complex:

- Chapman Street extended to Freeman Mill Road and widened to 5 lanes,
- 17 variable message signs on High Point Road and Chapman Street,
- 15 variable message signs on major freeways in Guilford County,
- Reversible lanes in place on High Point Road,
- Machine vision at three intersections and at lot entrances to provide vehicle detection

Permanent dual left turn lanes at the intersection of Lee Street and Chapman Street,

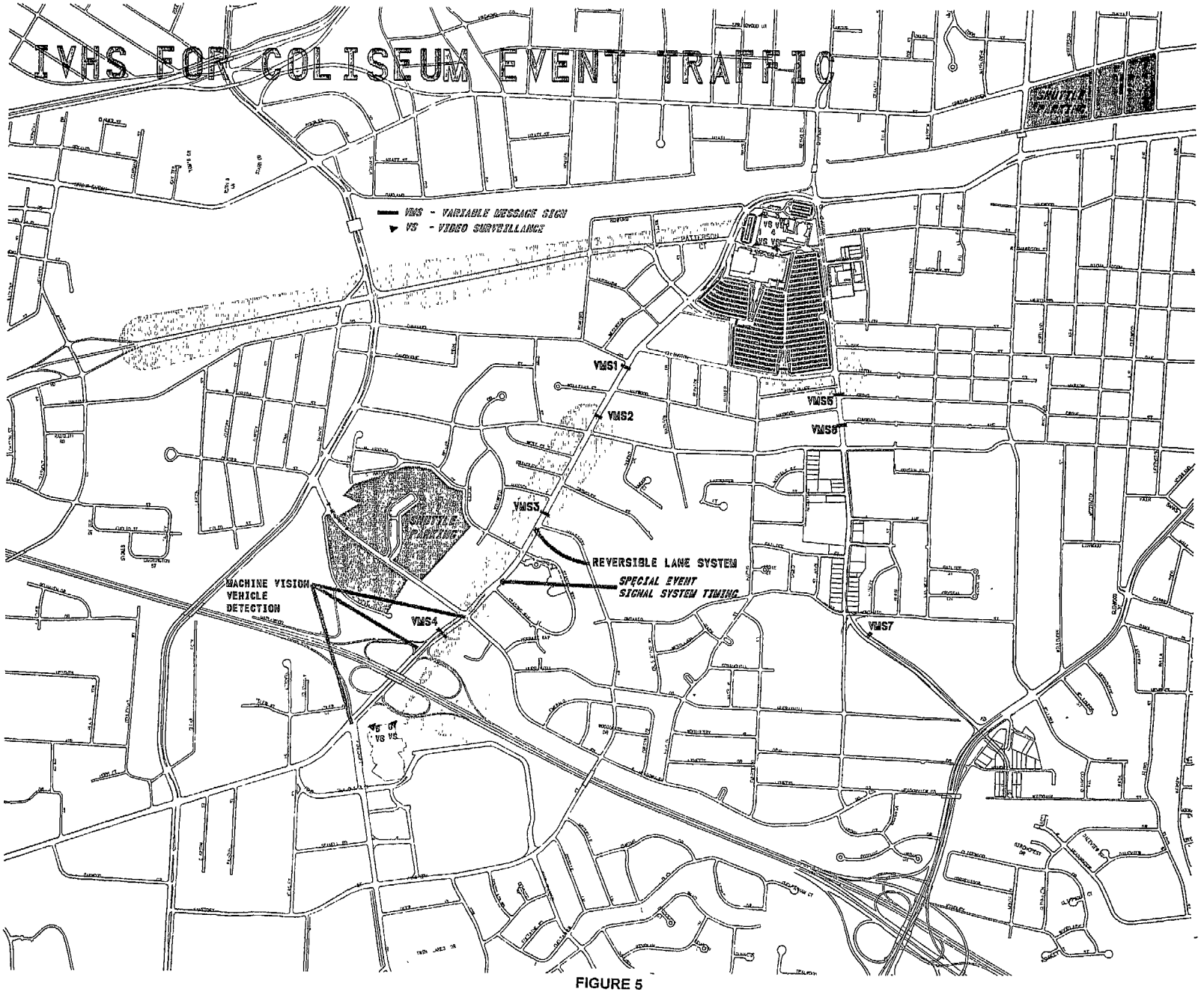

IVHS FOR COLISEUM EVENT TRAFFIC
VMS - VARIABLE MESSAGE SIGN
VS - VIDEO SURVEILLANCE
VMS1
VMS2
VMS3
VMS4
VMS5
VMS6
VMS7
REVERSIBLE LANE SYSTEM
SPECIAL EVENT SIGNAL SYSTEM TIMING
MACHINE VISION VEHICLE DETECTION
SHUTTLE PARKING
PATTERSON

FIGURE 5

- A bus turning lane on Lee Street in front of the Coliseum,
- Special timing plans on High Point Road and Lee Street before and after Coliseum events,
- Video surveillance,
- Traffic Management Control Room in the Coliseum.
- Satellite parking with shuttle service.

7.2 Winston-Salem Mobility Management

Winston-Salem has implemented Phase 1 of a mobility management system, which will be run by the Winston-Salem Transit Authority. This is one of 15 nationwide APTS demonstration projects. This system applies advanced technologies in order to integrate the paratransit and fixed route bus transit system. It integrates dispatching, scheduling, record keeping, billing, and other functions.

Eventually the system will incorporate what is called “Smart Traveler”. The system will be entirely scheduled and tracked by computer and satellite technology. Passengers will be able to request service and receive prompt response, or information on how to access the nearest bus.

“Smart Vehicle” technology is a future, expanded component of the Mobility Management Systems. These vehicles will have the capability of adaptive signal timing and communication control, route destination display, automatic passenger counter, smart card reader, vehicle diagnostics, silent alarm, driver information display, and automatic vehicle location (see Figure 6). The implementation of all these technologies will greatly improve public transportation in Winston-Salem.

7.3 High Point Traffic Surveillance

High Point installed a video surveillance system in 1979. The original system included 4 black and white cameras located in the downtown area and mounted on the roof tops of three prominent buildings. In 1988, since there had been many problems throughout the years, the coaxial cables and twisted pair cables were replaced with fiber optic cables. Since then the system has experienced very few problems. In May 1994 the system was updated to install two color cameras, one on the north end and one on the south end of Main Street.

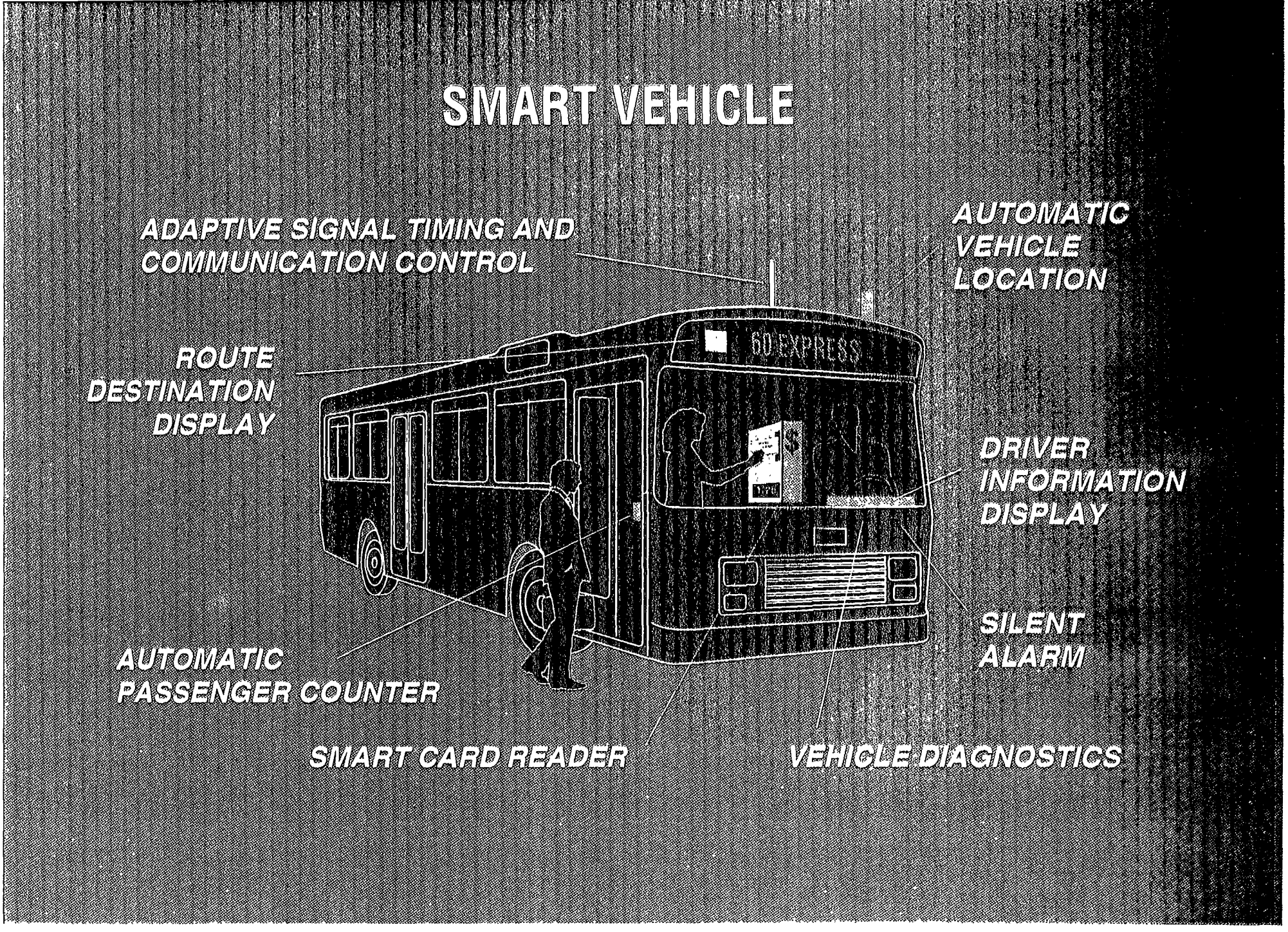

SMART VEHICLE
ADAPTIVE SIGNAL TIMING AND COMMUNICATION CONTROL
AUTOMATIC VEHICLE LOCATION
ROUTE DESTINATION DISPLAY
60 EXPRESS
DRIVER INFORMATION DISPLAY
SILENT ALARM
AUTOMATIC PASSENGER COUNTER
SMART CARD READER
VEHICLE DIAGNOSTICS

FIGURE 6

High Point has found the camera system to be a very useful tool in traffic control. It has been used to observe heavy traffic flow during the biannual furniture markets, to observe adverse weather conditions and take appropriate action, to observe construction projects such as the replacement of a vital downtown bridge, to do parking turnover studies using tape delay, to do pedestrian studies using tape delay and to observe much more. High Point is now in the design and engineering phase of its signal system replacement and the new cameras will extend from Jamestown, Archdale and other important corridors into High Point. It is anticipated that the new camera system will be used extensively and will be an integral part of the overall system. Variable message signs are needed at strategic locations to enhance overall traffic management in High Point.

7.4 Advanced Traveler Information Systems

One of the most pressing needs of travelers is being able to receive current, up-to-the-minute information on traffic conditions within an urban area, particularly to avoid accidents or congestion. Further, information from forward locations on a long-distance traveler's route would be helpful in over-all trip planning. This information should ideally be received at the earliest possible time, before the traveler leaves his residence, business, the airport or other point of origin. With this type of information, travelers will voluntarily help "smooth out" periods of peak congestion by avoiding congestion locations, delaying or modifying their routes. Most motorists would simply prefer to avoid congestion and unsafe conditions on the highway.

Construction is underway to install Variable Message Signs (VMS) in Forsyth, Guilford, and Alamance Counties on I-40, l-85, US 52, and US 421. These large, overhead signs will be operated temporarily by cellular phone connection, based on information provided the NCDOT by NCDOT Incident Responders, other employees, emergency and law enforcement personnel, the media and the general public. Figure 7 shows the location of NCDOT Variable Message Signs (VMS) and closed circuit TV (CCTV) cameras operated by the city. In the future, the VMS system will be connected to the TOC through real-time traffic surveillance systems. Overhead variable message signs in the High Point and Burlington areas would enhance traffic control, especially in work zones.

7.5 Coordinated Signal System Improvements

The cities of Greensboro, Winston-Salem, and High Point have all had coordinated signal systems since the mid-seventies. However, these systems are in the process of being improved or have already been improved. Advanced technologies offer significant improvements and safety.

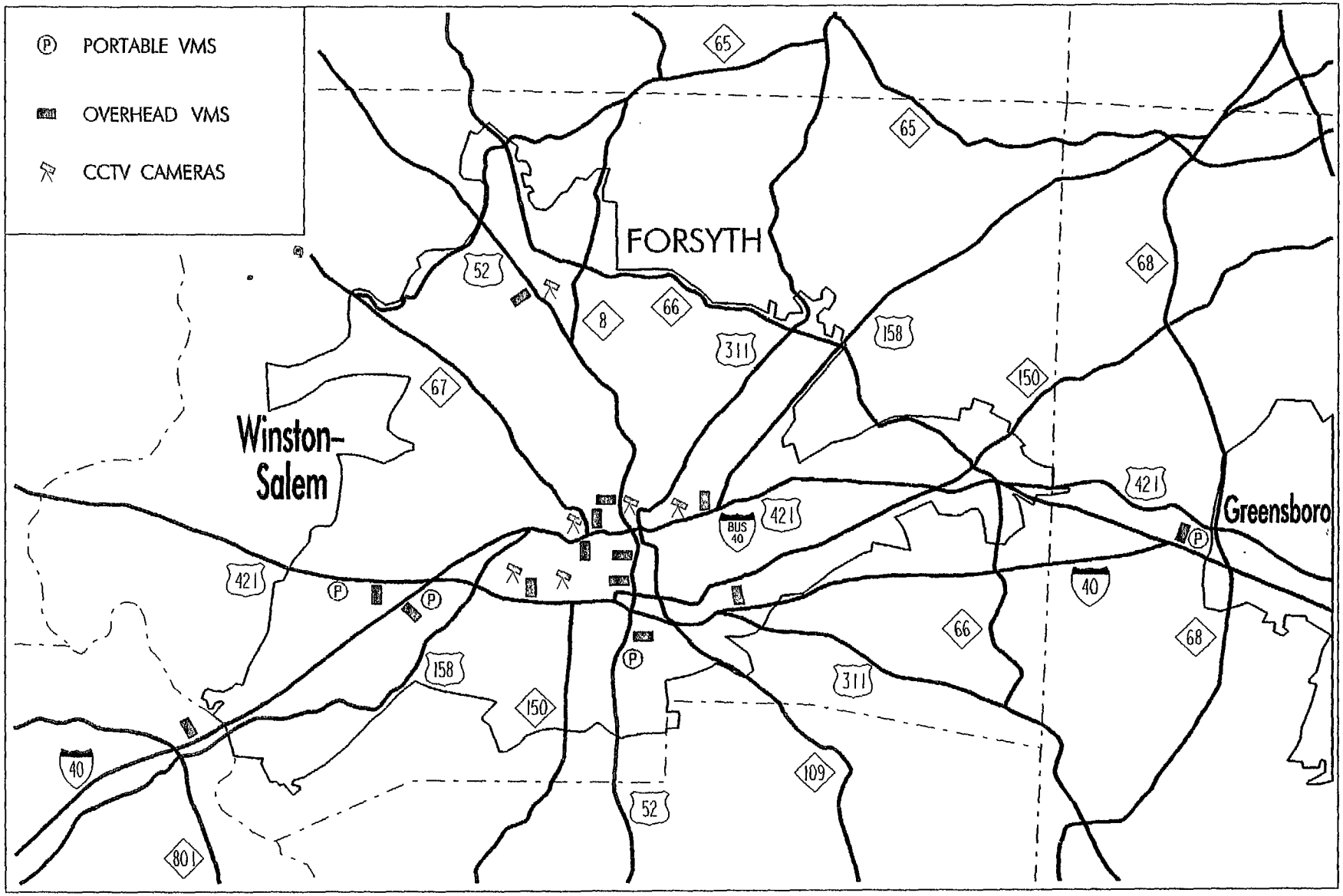


FIGURE 7. WINSTON-SALEM/ FORSYTH COUNTY/ DIVISION 9 VMS SYSTEM

The Series 2000 is the urban traffic signal control system that has already been implemented in Greensboro. The system provides coordinated operation of a series of signalized intersections. This enables progressive traffic movement through the system which reduces delay and fuel consumption, and improves air quality to meet Clean Air Act Amendment (CAAA) guidelines.

The Greensboro system is designed to coordinate a maximum of 560 signalized intersections. There are currently 346 signalized intersections within the city. About 300 of these are controlled by Series 2000. The design capacity of the system will allow additional intersections to be added as the communications cable network is expanded.

The current traffic signal control system for Winston-Salem was first installed in 1977. Since this time it has aged gracefully but is now unable to meet the needs and growth potential of the city.

To deal with and effectively manage traffic for the next ten years, the city is in the process of up-grading this signal system. The new system will be capable of coordinating the operation of 500 traffic signals under both normal and incident management conditions. Integration of variable message sign control with traffic signal control as well as traffic monitoring camera system are both proposed. Other features of the system include: Computer generated and real time animated map displays, menu driven and operator interface language (OIL), supported command entry, communications units internal to the field traffic control units, expansion of the city traffic signal communications cable systems, and up-grading of all field traffic controllers.

The High Point coordinated signal system began operation in 1979, in conjunction with video surveillance. The time of day method is used in selecting traffic control plans. This system controls 49 intersections in the downtown area, and operates 6 surveillance cameras (see section 9.3). Although the current system has served well, it is obsolete by today's computer standards. Little can be done to improve the current system because of the very low memory, small amount of disk space and single user environment. High Point is now in the design and engineering phase of replacing the current system. The new system will include approximately 150 intersections, 20 cameras, and will extend to Jamestown, Archdale and to NC 68 at I-40. With these broader limits High Point can control traffic and manage incidents much easier and faster; thus, traffic will move more efficiently.

7.6 Incident Management Program

In Winston-Salem and Greensboro, Inter-agency teams have been formed as part of the NCDOT's Incident Management Program. Members of these teams include representatives from NCDOT, municipal DOT's, State Highway Patrol, State

Division of Emergency Management, and local responding agencies such as law enforcement, fire, and emergency medical services. These teams work to improve coordination, communication and cooperation so that incidents can be detected and cleared as quickly as possible.

Motorist Assistance Patrol (MAP) operations are in place in both Winston-Salem and Greensboro as part of the Incident Management Program. NCDOT Incident Responders provide traffic control and other types of assistance at incident scenes, travel congested section of freeways identifying traffic hazards, and provide assistance to motorists with disabled vehicles.

Working with the municipal DOT's and local law enforcement, the NCDOT has developed detour routes for use in the event of incidents. Each responding agency is provided with copies of the maps for their personnel. Figure 8 shows detour routes on the State primary system and the limits of MAP coverage on freeways in the Greensboro area.

8.0 A Vision For The Future

There is no single solution to the many transportation problems facing the nation, North Carolina, and the Piedmont Triad region. In recognizing the complexity of these problems, the NCDOT and the Piedmont Triad communities are building now what will be part of a more comprehensive short-term and future solution.

The Piedmont Triad cities of Greensboro, Winston-Salem, and High Point together were ranked seventh among the nation's top 10 areas for new industrial or commercial facilities and expansions in 1993. The Piedmont Triad International Airport is predicted-to have the fastest growth in passenger boarding of any airport nationwide over the next five years. There is ample reason to believe that these and other growth trends and patterns will continue well into the future.

The NORTH CAROLINA TRANSPORTATION 2001 Plan identified some 20 major TIP projects in the 1 l-county region that are due for completion or accelerated construction in the Triad over the next seven years. The TIP includes measures to encourage development of regional transit service, regional rail or transit centers, and a high-speed rail corridor from Raleigh to Charlotte through the Triad.

Key transportation professionals involved in delivering the transportation program in the Piedmont Triad region have identified the following High-Priority Advanced Transportation System Initiatives for future deployment:

- Quick detection of accidents and other incidents and quick, appropriate response

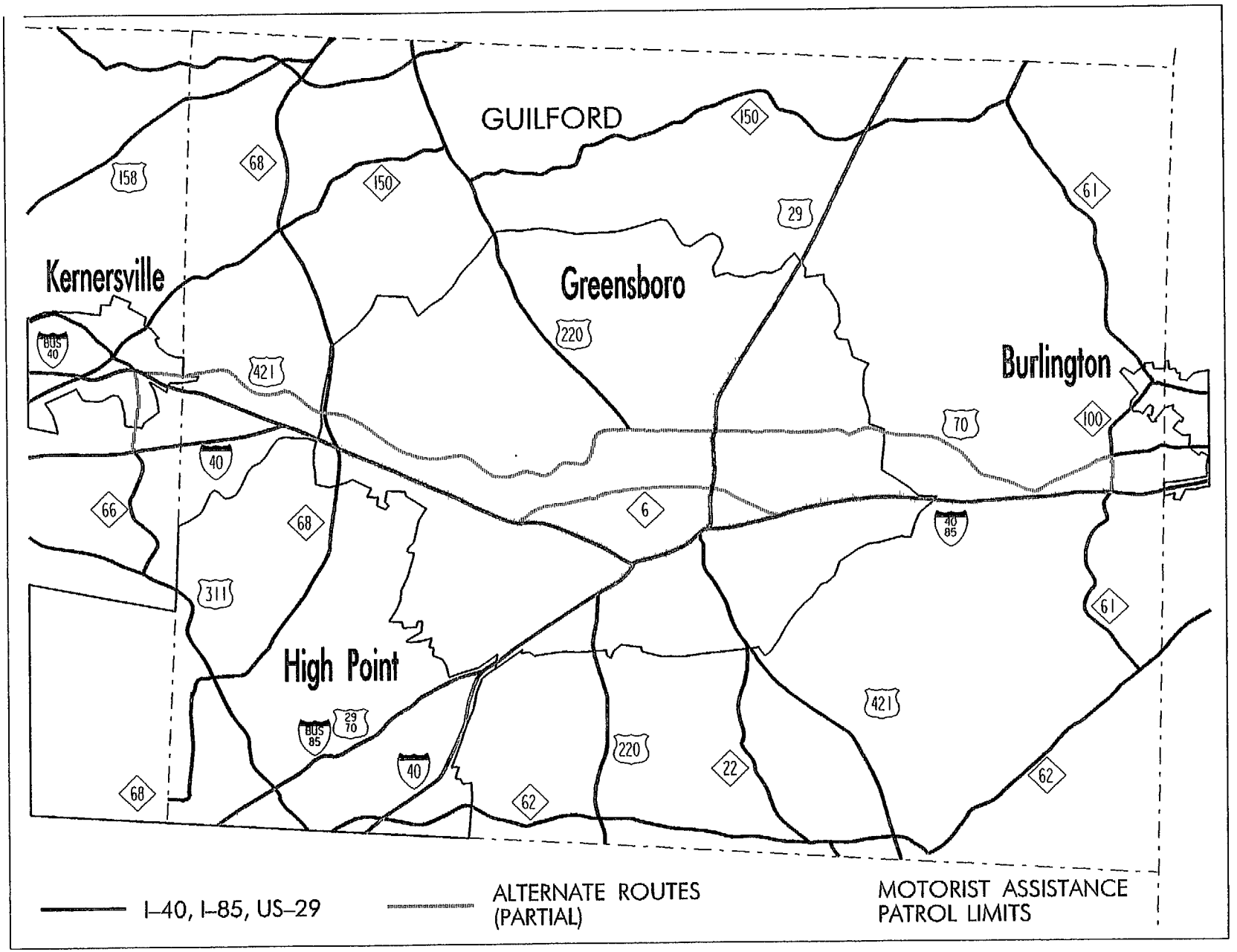


FIGURE 8. GREENSBORO/ GUILFORD COUNTY/ DIVISION 7 INCIDENT MANAGEMENT

- Better coordination among transportation agencies, traffic enforcement agencies, and emergency responders
- Real-time freeway traffic monitoring (see Figure 9 for Potential Routes)
- Better communications with the public on traffic conditions
- Marketing and system enhancements to increase transit system usage
- Surveillance and incident detection on key arterial routes

Piedmont Triad communities have a major advantage in implementing Advanced Transportation Systems on a regional basis. For a number of years, a combined MPO technical group, called the Triad Transportation Technical Coordinating Committee has been involved in regular meetings to plan and program regional transportation improvements. Several issues will need to be addressed by this committee and the three MPO's in the region, as well as by the State Board of Transportation, in order to continue to implement these advanced technologies effectively:

- Continue to work toward achieving the goals developed in the 1992-93 Triad Regional Transportation Planning Study

- Include the Burlington MPO in the combined MPO technical committee, particularly to plan an effective incident management program region-wide

- Further implement an effective Traffic Monitoring Program for selected Piedmont Triad highways

- Implement the regional traffic modeling project now underway in the Triad

- Provide on integrated freeway and arterial traffic control element by coordinating freeway monitoring systems with specialized surface street systems, such as the reversible lanes on High Point Road at the Greensboro Coliseum

- Expand implementation of the l-40/I-85 and US 52 corridors Variable Message Signing projects to other Freeways and Principal Arterial highways, particularly l-40/I-85 in Burlington and l-85 in High Point

- Develop an effective media outreach for Traveler Information for the entire region

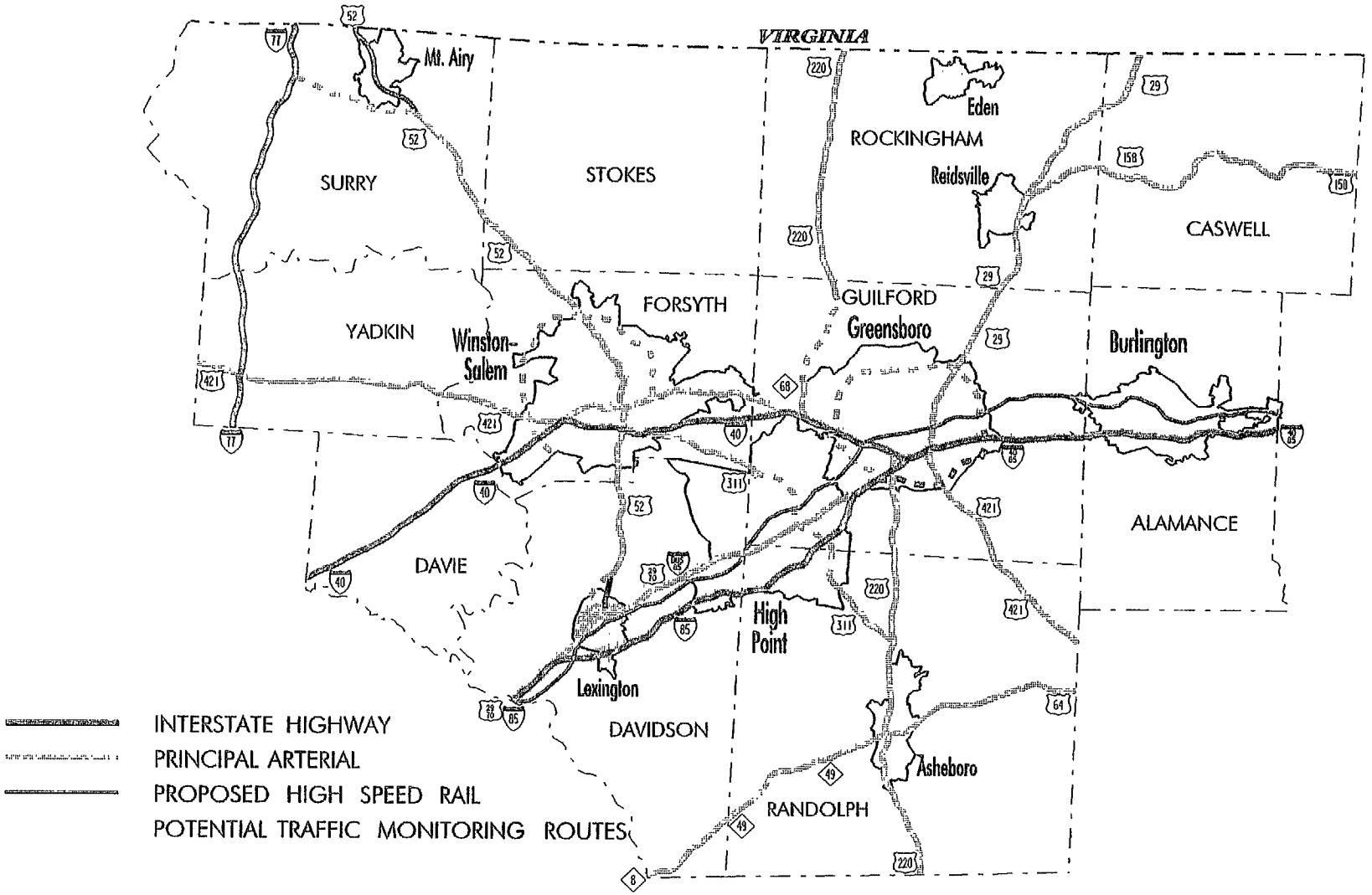


FIGURE 9. POTENTIAL FUTURE TRAFFIC MONITORING ROUTES IN THE PIEDMONT TRIAD

- Develop cost estimates for implementing a regional freeway surveillance and incident management system for “high priority” routes. (A July 1993 “Feasibility Study” by the Traffic Engineering Branch estimated the cost of a Traffic Management System through Greensboro to be over $18 million. This system included a Traffic Operations Center (TOC), geometric improvements, a Freeway Management System, and an adaptive Traffic Management System on connecting arterials and alternate routes.)

- Expand the current Operational Test of the “Smart Traveler” Mobility Management project at the Winston-Salem Transit Authority to fixed route coverage, and to all urban transit systems in Piedmont Triad communities

- Install Weigh-in-Motion (WIM) on I-40 between Greensboro and Winston-Salem

- Install emission testing sites on I-40 in Winston-Salem and Greensboro

- Install an adaptive Traffic Management System for alternate routes in Greensboro

- Expand video surveillance in Winston-Salem to include US 52

- Develop an Evaluation Plan for all Operational Tests or Deployment of Advanced Transportation System projects in the Triad. (A General Evaluation Plan for the CARAT Project in Charlotte is currently under development by the UNC Highway Safety Research Center under an R&D contract with NCDOT; this Evaluation Plan could be adapted as a model for Triad projects.)

- Determine effective funding mechanisms for implementing further deployment of Advanced Transportation Systems

- Present this ATS Area-Wide/Corridor Plan to the MPO’s in the Region, various elected councils and decision-makers, and the general public

- Integrate the concepts of this plan with the developmental elements of other ISTEA Management Systems as those systems are implemented in the Triad: Traffic Monitoring, Intermodal, Congestion Management, and Safety Management

There are many benefits of implementing Advanced Transportation Systems. Quantifiable benefits include reduced delay caused by recurrent and non-recurrent-induced congestion. Other benefits attributable to ATS include reduction in energy consumption, accidents, and emissions. In addition, lost time that for some travelers is unproductive time will be reclaimed by a reduction in congestion.

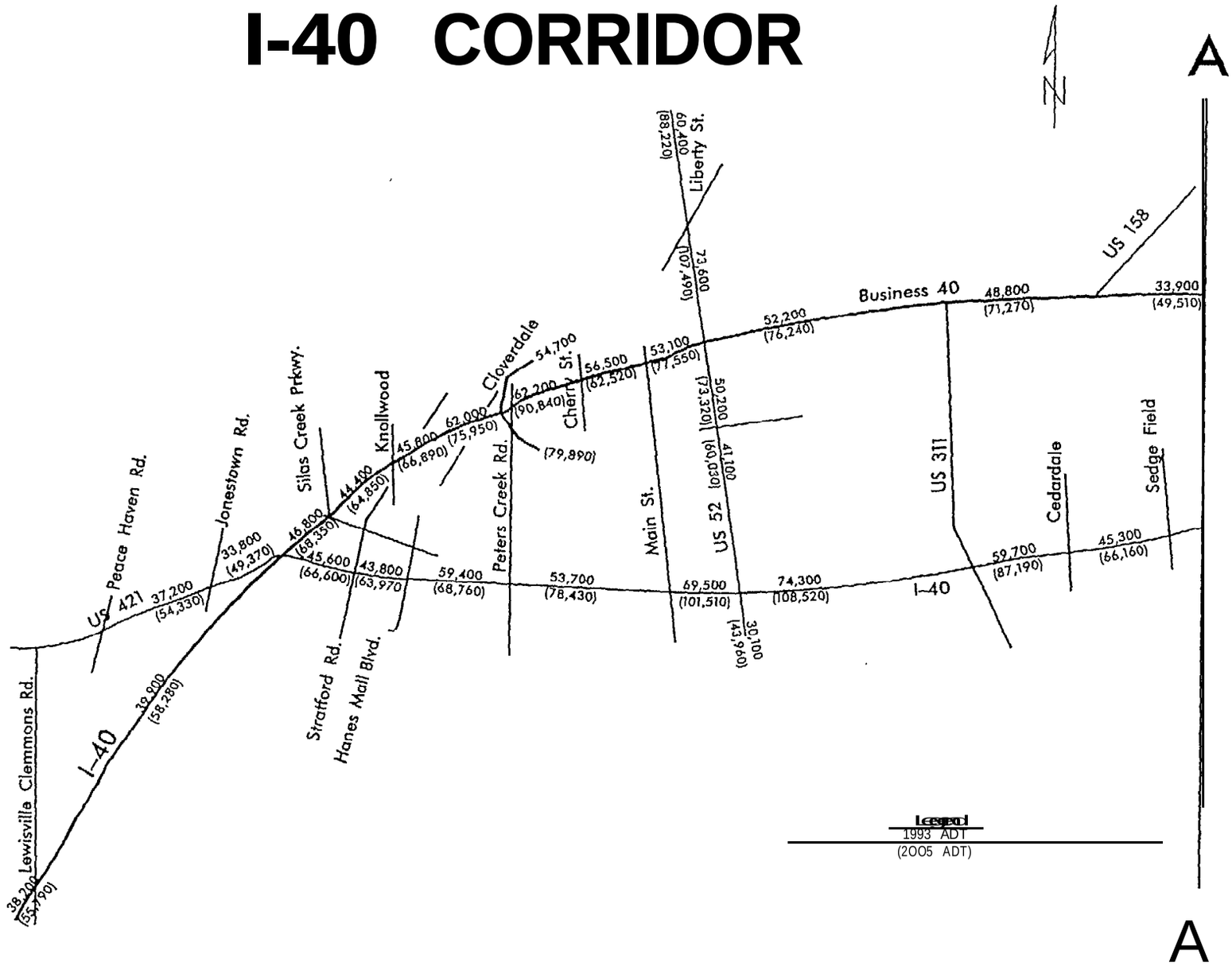
Additionally, improved efficiency due to coordinated and cooperative agency actions can produce long-term cost savings, particularly in relation to other regional planning activities. Estimated benefits of implemented such system-wide, regional improvement programs in other areas of the country have produced four or five-to-one benefit/cost ratios. Decreases in congestion and accidents have been documented to improve between 15 and 30 percent.

Clearly, ADVANCED TRANSPORTATION SYSTEM IMPROVEMENTS should be an increasingly important component of future state and local programs, in order to increase mobility and improve safety on Piedmont Triad transportation systems.

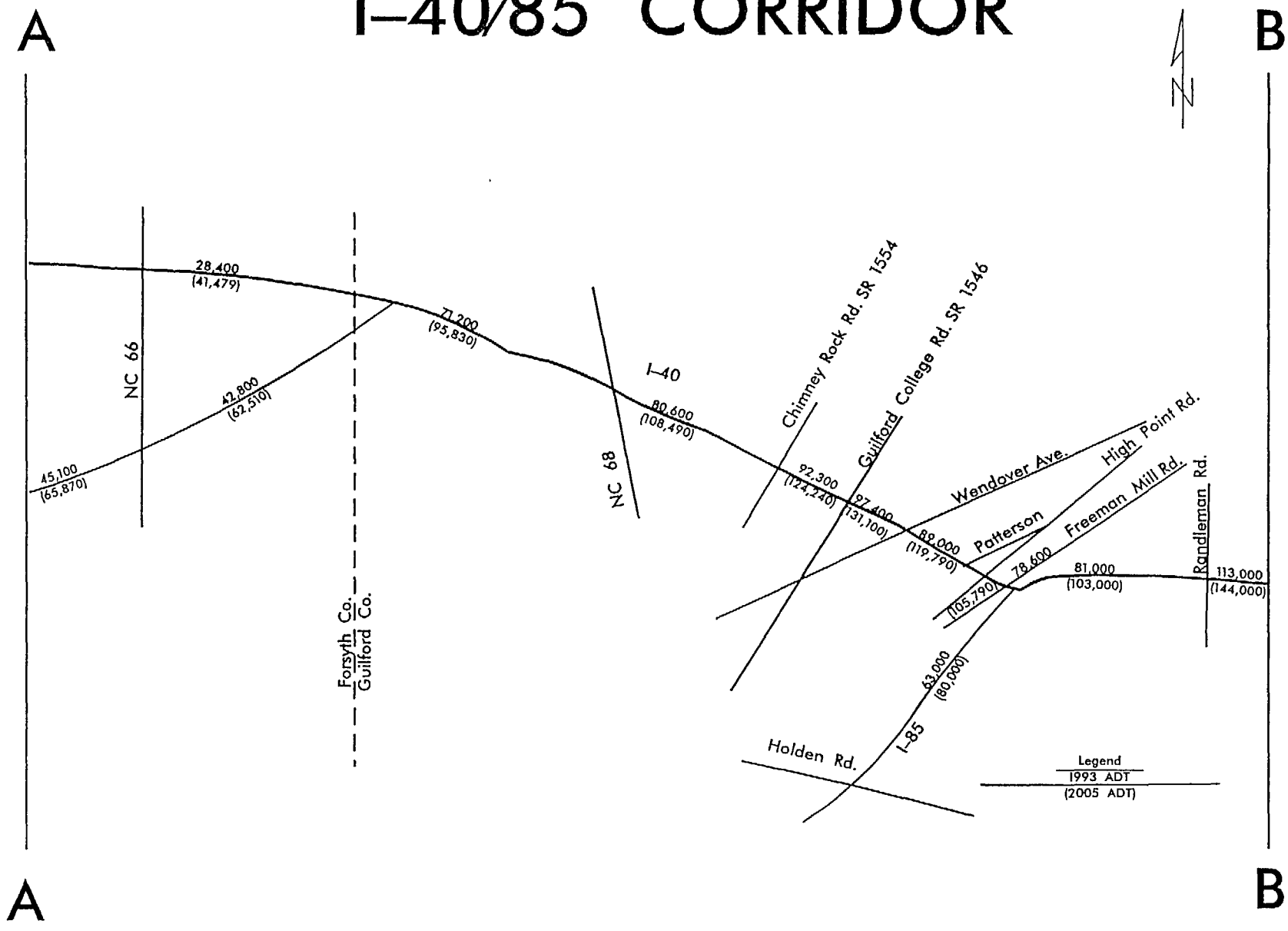
Appendix A.

Current and Future Traffic Volumes (AADT's): I-40 and I-85 Corridor

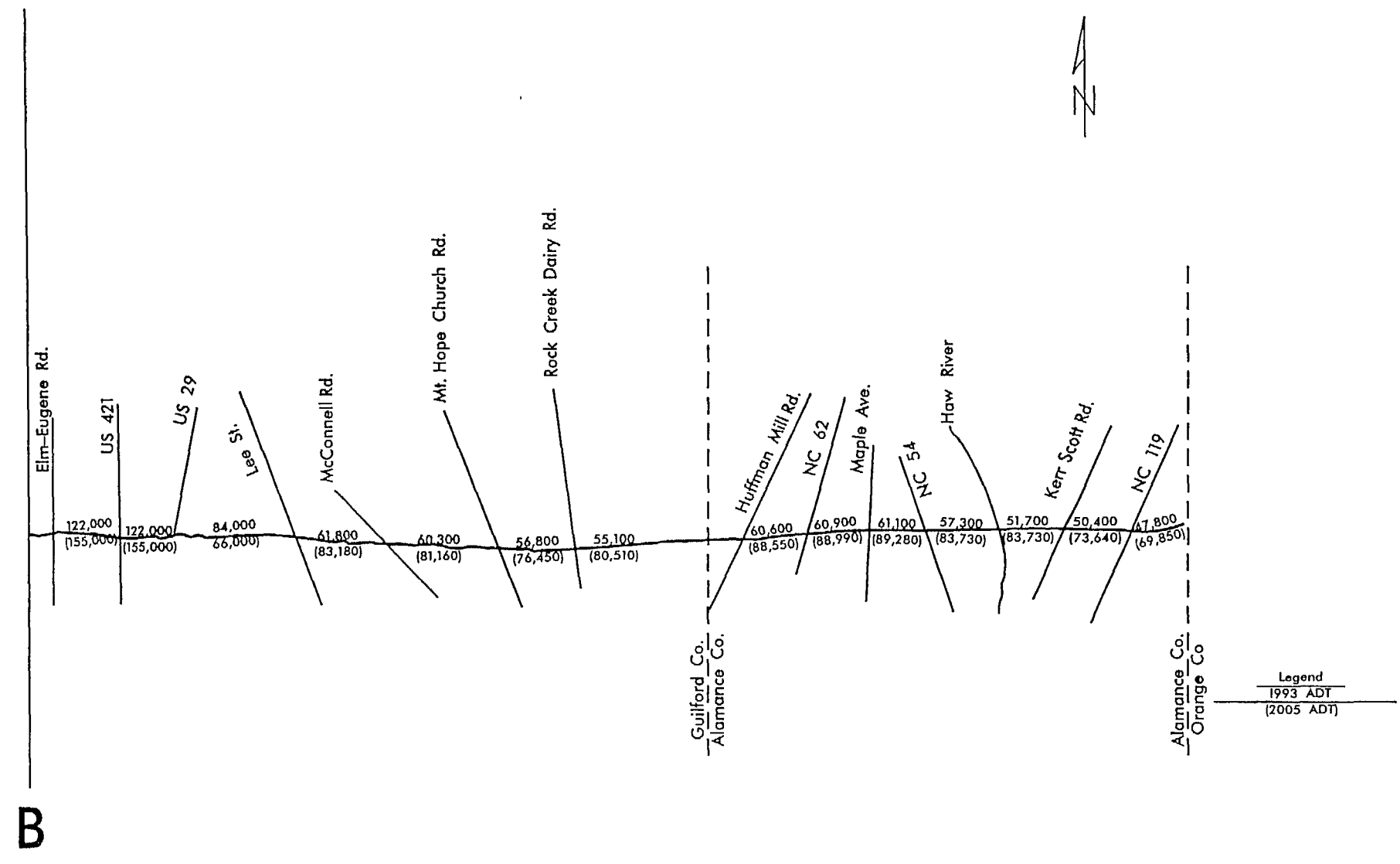
I-40 CORRIDOR



I–40/85 CORRIDOR



I-40/85 CORRIDOR



Appendix B

ATS/IVHS Glossary

Appendix B

LIST OF ACRONYMS/ABBREVIATIONS

A	Total Number of Accidents on a Specific Category of Roadway Under Study
AASHTO	American Association of State Highway and Transportation Officials
ABS	Automatic Braking System
ADT	Annual Average Daily Traffic
AEI	Automatic Equipment Identification
AHAR	Automatic Highway Advisory Radio
ANSI	American National Standards Institute
APTS	Advanced Public Transportation System
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
ATC	Automated (electronic) Toll Collection
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
ATS	Advanced Transportation Systems
AVCS	Advanced Vehicle Control System
AVC	Automated Vehicle Classification
AVI	Automated Vehicle Identification
AVL	Automated Vehicle Location System
AVM	Automatic Vehicle Monitoring
B/C	Benefit/Cost Ratio
BOT	North Carolina State Board of Transportation
3-C	Three “C” Planning Process (Continuing, Comprehensive, Coordinated)
CAAA	Clean Air Act Amendments of 1990
CAD	Computer-Aided Dispatching
CADD	Computer-Aided Drafting and Design
CMAQ	Congestion Mitigation for Air Quality
CMS	Congestion Management System
CO	Carbon Monoxide
CVO	Commercial Vehicle Operations
DIME	Dual Incidence Matrix Encoded Files
DMV	North Carolina Division of Motor Vehicles
DRS	Dead Reckoning System

ECPA	Electronic Communications Privacy Act
ENTERPRISE	Evaluating New TEchnologies for Roads Program Initiative in Safety and Efficiency, a multi-state IVHS research consortium
EPDO	Equivalent Property-Damage-Only (Accidents)
ERGS	Electronic Route Guidance System
ETC	Electronic Toll Collection
ETTM	Electronic Toll and Traffic Management
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
FMS	Freeway Management System
FTA	Federal Transit Administration (formerly UMTA)
GDF	Geographic Data Format
GIS	Geographic Information System
GPS	Global Positioning System/Global Positioning Satellite
HAR	Highway Advisory Radio
HAZMAT	HAZardous MATerial(s)
HOV	High Occupancy Vehicle
HP&R	Highway Planning and Research
HUD	Head-Up Display
HUFSAM	Highway Users Federation for Safety And Mobility
I	Interstate Highway
IA	Number of Class A Injury Accidents at Location Under Study
IB	Number of Class B Injury Accidents at Location Under Study
IBTTA	International Bridge, Tunnel and Turnpike Association
IC	Number of Class C Injury Accidents at Location Under Study
IEEE	Institute of Electrical and Electronics Engineers
I/M	Inspection and Maintenance Program (for motor vehicles)
IMS	Incident Management System
IR	Infra-red
IRP	International Registration Plan
IS0	International Standards Organization
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991 (PL102-240)

ITE	Institute of Transportation Engineers
IVHS	Intelligent Vehicle Highway System (Similar to ATS)
K	Number of Fatal Accidents at Location Under Study
KIOSK	An information center (for traffic) located in shopping malls, parking lots, hotels, businesses, etc., usually with interactive computer ability.
L	Length of Section
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LOS	Level of Service
LRT	Light Rail Transit
LTL	Less Than Truck Load
MMI	Man-Machine Interface/Man-Machine Interaction
MPO	Metropolitan Planning Organization
MVMA	Motor Vehicle Manufacturers Association
NCDOH	North Carolina Division of Highways of the NCDOT
NCDOT	North Carolina Department of Transportation
NCPTRD	North Carolina Public Transportation and Rail Division, NCDOT
NCHRP	National Cooperative Highway Research Program
NHS	National Highway System
NHTSA	National Highway Traffic Safety Administration
NIMC	National Incident Management Coalition
NTIA	National Telecommunications and Information Administration
OBC	On-Board Computer
P	Number of Property-Damage-Only Accidents at location Under Study
PDF	Predictive Data Fusion
Plan	The Triad ATS Area-Wide/Corridor Plan
RDS	Radio Data Systems
Region	The Eleven-County Triad Region, including the counties of Alamance, Caswell, Davidson, Davie, Forsyth, Guilford, Randolph, Rockingham, Stokes, Surry, and Yadkin Counties in North Carolina
RGD	Route Guidance Database
RMVM	Accidents Per Million Vehicle-Miles
RNS	Radio Navigation System
RSPA	Research and Special Programs Administration

RTA	Regional Transit Authority
SAE	Society of Automotive Engineers
SHP	North Carolina State Highway Patrol
SI	Severity Index
STP	Surface Transportation Program
T	Total Number of Accidents at Location Under Study
TAC	Transportation Advisory Committee (of a MAO)
TAR	Travel Advisory Radio
TCC	1. Traffic Control Center 2. Technical Coordinating Committee (of a MAO)
TDM	Travel Demand Management
TIGER	Topologically Integrated Geographic Encoding and Referencing
TIP	Transportation Improvement Plan (State)
TL	Truck Load
TMA	1. Transportation Management Areas 2. Transportation Management Association
TMC	Traffic Message Channel
TOC	Traffic Operations Center
TRB	Transportation Research Board
TSM	Transportation System Management
USGS	United States Geological Survey
V/C	Volume/Capacity Ratio
VMS	Variable Message Signs
VMT	Vehicle Miles Traveled
VORAD	Vehicle On-board RADar
VRC	Vehicle/Roadside Communications
WAVM	Wide-Area Vehicle Monitoring
WIM	Weigh-In-Motion

Appendix C

ATS/IVHS Program Areas and User Services

Appendix C ATS/IVHS Program Areas and User Services

C.1 ATS Program Areas

A convenient way of grouping various ATS technologies is by function. There are six basic program areas of Advanced Transportation Systems:

- Advanced Traffic Management Systems (ATMS)
- Advanced Traveler information Systems (ATIS)
- Advanced Vehicle Control Systems (AVCS)
- Commercial Vehicle Operations (CVO)
- Advanced Public Transportation Systems (APTS)
- Advanced Rural Transportation Systems (ARTS)

The main goal of ATMS is to develop real-time, adaptive traffic control systems. ATMS is the basic building block of ATS. All other functional areas will utilize the information provided by ATMS. The seven primary characteristics of ATMS are:

- Works in real time;
- Responds to changes in traffic flow and in the future may predict where congestion will occur based on collected origin-destination information;
- Provides area-wide surveillance and detection;
- Integrates management of various functions, including transportation information, demand management, reversible lanes, and arterial signal control;
- Provides collaborative action on the part of the transportation management agencies and jurisdictions involved;
- Provides rapid response incident-management strategies
- Overall safety improvements.

The role of ATIS is to provide real-time traffic data to a transportation operation center (TOC) where it would be combined with all other sources of information. This information would be analyzed and the location of congestion predicted or visually confirmed and then broadcast to public. Direct access to transportation information systems is needed, and available in homes, at places of employment, at transportation terminals, and in vehicles. It is important that motorists and other travelers have access to “real time” traffic information so that major delays caused by incidents can be avoided, goods can be delivered on time , and people will be able to make informed choices about when to travel and the best modes and routes to choose. The characteristics of ATIS are:

- Provides drivers with information on congestion and alternate routes, navigation and location, and roadway conditions through audio and visual displays in the vehicle or on the highway, or through broadcast media;

Provides information that will assist trip planning at home, at work, or by operators of vehicle fleets;
- Provides information on motorist services;
- Provides information that would warn a driver of potentially dangerous situations;
- Provides the capability to summon emergency assistance;
- Provides vehicle location automatically.

The vehicle industry is also working in collaboration with public agencies to improve safety and to potentially make dramatic improvements in highway capacity by providing information about the changing conditions in vehicles' immediate environment. Several types of AVCS are:

Driver warning systems;
- Vision enhancement and assistance systems;

Automatic headway control;
- Obstacle avoidance and automatic braking;
- Automatic trip routing and scheduling;
- Control merging of streams of traffic;
- Transitioning to and from automatic control.

Vehicles that use ATS technologies also include transit vehicles, trucks, police, and emergency service vehicles. The characteristics of CVO are:

- Improves productivity, safety, and regulation of all commercial vehicle operations;
- Makes possible faster dispatching, efficient routing, and more timely pick-ups and deliveries;
- Improves quality and competitiveness of businesses and industries on a national and international levels.

APTS will utilize the technologies of ATMS, ATIS, and AVCS to improve operation of high-occupancy vehicles: carpools, vanpools, buses, taxis, and paratransit vehicles. SmartCards will enable consumers to board transit vehicles, as well as to pay tolls and parking fees by using a debit or credit system. APTS will provide mass transport users with up-to-date information on status, schedules, and availability of public transit systems. Other elements of APTS include:

- Smart Vehicles are sensor and communication-equipped to provide more efficient service;
- Automatic Vehicle Locator systems provide greater security; Automated scheduling and routing provides cost savings to the industry, and overall better service.

ARTS applies these technologies in rural areas, and on high use routes such as recreational access corridors. These program areas do not work independently, but interactively. It is very important that these programs and services work together in order to achieve a transportation system that runs as smoothly as possible.

C.2 ATS User Services

There are presently 28 user services being proposed for deployment by the USDOT and IVHS-America. These are being updated annually and adapted by local and state agencies to respond to specific identified needs. Each of these services is classified under one of six primary functions. These areas are Travel and Traffic Management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, and Advanced Vehicle Safety Systems.

These current ATS user services will change over time as more information is gained from tests and more groups get involved in ATS. As time goes by the ATS technologies and services will become more and more technologically advanced.

ATS User Services

Travel and Traffic Manaaement

- Pre Trip Travel Information
- En Route Driver Information
- Traveler Services Information
- Route Guidance
- Ride Matching and Reservation
- Incident Management
- Travel Demand Management
- Traffic Control
- Increased Night-time Visibility

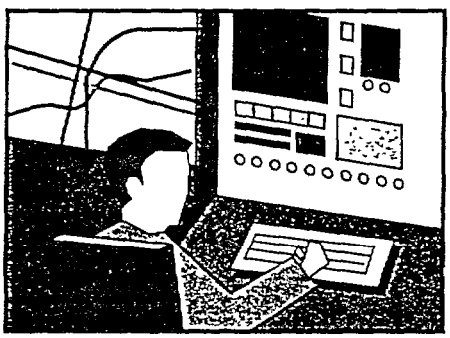
Public Transportation Manaaement

- En Route Transit Information
- Public Transportation Management
- Personalized Public Transit
- Public Travel Security

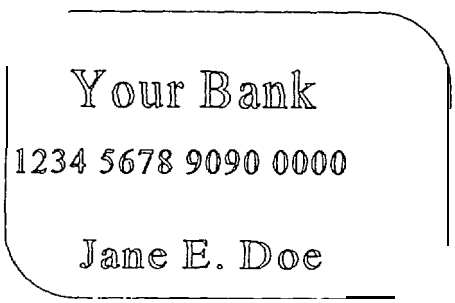
Electronic Payment

- Electronic Payment Services

Traffic Control Center



Advanced Fare Collection



Smart Card

Commercial Vehicle Operations

- Commercial Vehicle Electronic Clearance
- Automated Roadside Safety Inspection
- Commercial Vehicle Administrative Processes
- On-Board Safety Monitoring
- Commercial Fleet Management
- Hazardous Material Incident Notification

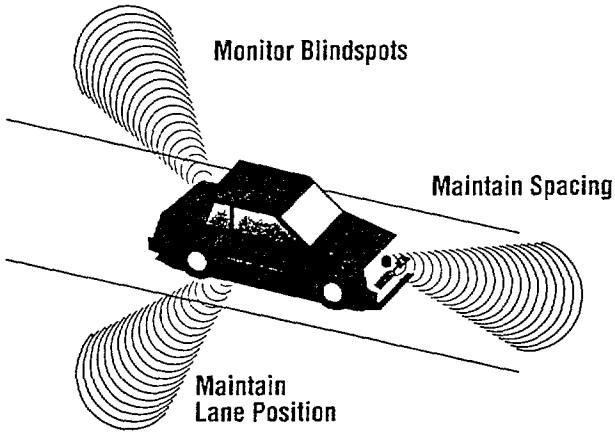
Emergency Management

- Emergency Vehicle Management
- Emergency Notification and Personal Security

Advanced Vehicle Safety Systems

- Longitudinal Collision Avoidance
- Intersection Collision Avoidance
- Vision Enhancement for Crash Avoidance
- Safety Readiness
- Pre-Crash Restraint Deployment
- Automated Vehicle Operation

Collision Warning/Avoidance



File 870

Memorandum

Shelley

U.S. Department of Transportation
Federal Highway Administration

Subject: Greensboro Early Deployment Project, Final Report

Date: November 17, 1994

From: Director, Office of Engineering Services
Atlanta, Georgia

Reply to Attn. of: HES-04

To: Ms. Susan B. Lauffer
Director, Office of Traffic Management and Intelligent Vehicle/Highway Systems (HTV-31)
Washington, D.C.

Attached please find one copy of the Final Report for the Greensboro Early Deployment Project, titled "Advanced Transportation System Improvements for North Carolina's Piedmont Triad: An IVHS Area-Wide/Corridor Plan". Please contact Susan Bruce if there are any questions.

Susan M
for Andrew H. Hughes

Attachment

Memorandum

U.S. Department of Transportation
Federal Hiqhway Administration

Subject: Final Report; Project IVH-9237(602) Greensboro, Winston-Salem, High Point Metropolitan Area

Date: November 10, 1994

RECEIVED
Reg. 4 F.H.W.A.
NOV 14 1994

From: Division Administrator
Raleigh, North Carolina

Reply to Attn. of: HRT-NC

To: Mr. Leon N. Larson
Regional Federal Highway
Administrator (HES-04)
Atlanta, Georgia

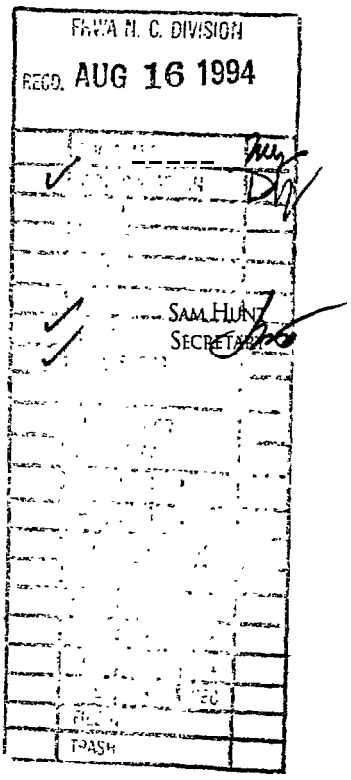
One copy each of the State's August 12 and September 12 transmittal letters and two copies of the final report for the Greensboro, Winston-Salem, High Point IVHS Early Deployment Corridor Study are attached. The report is titled "Advanced Transportation System Improvements for North Carolina's Piedmont Triad: an IVHS Area-Wide/Corridor Plan." Please forward one copy of the final report to our headquarters office.

J. M. Tate

Nicholas L. Graf, P.E.

Attachments

	REG ADM
	DEP REG ADM
	REG COUNSEL
	DIR CIVIL RTS
	DIR ADMIN
V	DIR ENG SRVS
	[illegible]
	DIR STRS
	DIR P&PP
	DIR OMC
	FILES



STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

JAMES B. HUNT, JR
GOVERNOR

DIVISION OF HIGHWAYS
P.O. BOX 25201 RALEIGH, N.C. 276115201

August 12, 1994

Mr. Nicholas L. Graf, P.E.
Division Administrator
Federal Highway Administration
310 New Bern Avenue, Suite 410
Raleigh, North Carolina 27601

Dear Nick:

RE: Final Report, FHWA Project No. IVH-9237(602), IVHS Early Deployment Study for the Greensboro, Winston-Salem, High Point Urban Area

Four copies of the Final Report, entitled "Advanced Transportation System Improvements for North Carolina's Piedmont Triad: an IVHS Area-Wide/Corridor Plan" were delivered today to your office. I'm sorry I was not able to talk with Max Tate before he left on travel, but I covered the report with Lori Cove today. I expressed my interest in working with your office if there are other issues remaining on this project.

In particular, I discussed a continuing effort in the DOT to complete an Executive Summary" report for public distribution on the Triad project. That work is in the hands of Bill Jones, Ellen Holding, and Elsie Hinton in Public Affairs. Pat Strong and Portia McLean in this office are aware of what needs to be done to complete that piece of the project.

In addition, I told Lori that there is a tremendous amount of documentation in this office, particularly the results of the computer simulations using the CORFLO/NETSIM family of models. Dr. Larry McPherson would be happy to work with Max and Lori to demonstrate what has been, and is being done with these models.

I've enjoyed the many projects over the past three years that I've worked on with you and your staff. I wish all of the FHWA Division Office well, and hope to see you again soon.

Sincerely

Edd Hauser, P.E., PhD
Project Director

PHONE (919)733-7384 FAX

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

JAMES B. HUNT. JR
GOVERNOR

DIVISION OF HIGHWAYS
P.O. BOX 25201. RALEIGH. N.C. 27611-5201

R. SAMUEL HUNT III
SECRETARY

September 12, 1994

Mr. Nicholas L. Graf, P.E.
Division Administrator
Federal Highway Administration
310 New Bern Avenue, Suite 4 10
Raleigh, North Carolina 2760 1

Dear Mr. Graf:

SUBJECT: Final Report, FHWA Project Number IVH-9237(602),
IVHS Early Deployment Study for the Greensboro, Winston-Salem,
High Point Urban Area

Submitted herewith are-five copies of the subject final report for your further handling. Dr. E. W. Hauser had previously provided you comments dated August 12,1994 concerning the disposition of final issues concerning this study. Incidentally, a decision has not been made as of this date concerning the distribution of an executive flier.

Sincerely,

M.P. Strong, P.E.
State Highway Research Engineer

Enclosures

cc. Selected NCDOT Distribution List